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 8
JULY 1, 2016 – JUNE 30, 2017

Cooperative Agreement No. 2009-ST-061-CI0001

PURDUE UNIVERSITY

Georgia Tech | UHD | FIU | JUSTICE INSTITUTE of BRITISH COLUMBIA | UNC CHARLOTTE | SFU SIMON FRASER UNIVERSITY THINKING OF THE WORLD | UBC | Swansea University Prifysgol Abertawe | MORGAN STATE UNIVERSITY | VT | Universität Stuttgart | U.S. AIR FORCE

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

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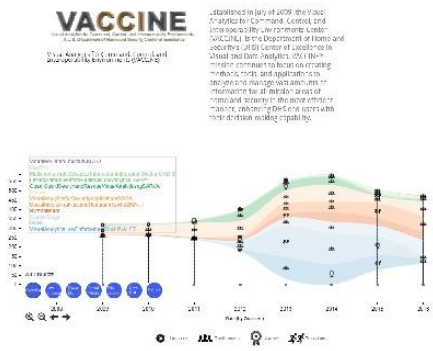
I. Executive Overview

a. Introduction

The Visual Analytics for Command, Control, and Interoperability Environments Center (VACCINE) was established on July 1, 2009 to co-lead, with Rutgers University, the Department of Homeland Security's (DHS) Center for Visualization and Data Analytics (CVADA). VACCINE's mission is dedicated to 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. Center strengths include:

i. Broad network of schools: partners with 38 universities both domestic and international aimed at turning massive data into actionable knowledge through innovative visual analytics techniques.
ii. Extensive end-user community: possesses strong, collaborative history and experience that helped to guide VACCINE's tool/technology development. This community of end-users makes it possible for VACCINE's research to result in the development of robust tools that are helping to make an impact on law enforcement, first responders, and homeland security personnel across the country.

In the paragraphs that follow this introduction, the key successes of VACCINE in the primary focus areas of research, technology/tool development and education initiatives are summarized in this executive overview, and detailed in Sections II and III. Additionally, a hyperlink is provided to SuccessVis below this paragraph. SuccessVis is a time-based visualization of the successful tools/technologies created by VACCINE that depicts the key events for each tool in the form of an "event river." The width of the "event river" is based upon the volume of activity produced by the tool/technology and news articles are linked to specific events during the development of the tool/technology. Furthermore, the tools/technologies are categorized by their emphasis area - public safety, resource planning and education.



http://voxel.ecn.purdue.edu/successvis/

b. <u>Key VACCINE Successes in Research, Tools and Education Include:</u>

VACCINE employed a broad network of schools to develop an integrated program of research, education and outreach in visualization and visual analytics. Some of the key successes of VACCINE are briefly described below.

i. Created twelve (12) significant tools for the Homeland Security Enterprise in a broad range of functional areas.

1. **Emergency Preparedness Tools.** A number of Visual Analytics tools to assist first responders and emergency management planning were developed.

2. **Public Health Visual Analytics Tools.** VACCINE researched novel visual analytics tools for Rift Valley Fever using a tool from the FAZD Center, incorporating epidemiological modeling as well as economic modeling and analysis.

3. **Interactive Visual Analysis and Decision Making Environments for Law Enforcement.** The creation of tools like VALET, Visual Analytics for Law Enforcement Toolkit, enabled police departments to map crime occurrences and plan patrol distributions.

4. **Resource Allocation Visual Analytic Tools.** Provided operational support using cgSARVA which was the only tool in COE history produced by one of the DHS Centers of Excellence to be accredited by the USCG.

5. **Fraud Detection Financial Visualization Tools.** UNCC partner, Dr. William Ribarsky, developed RiskVA which applied risk analytics to large and multi-faceted financial resources.

ii. More than 4,000 students introduced to Visual Analytics knowledge and techniques. (Please see section IV. Achievements in Education for more detailed information.)

iii. Created a Public Safety Consortium. VACCINE formed a multi-agency public safety consortium in Indiana to develop tools for crime analysis, law enforcement planning, and decision making.

iv. **Provided Intellectual Leadership for the Field of Visual Analytics.** VACCINE was a pioneer in the area of VA for eight (8) years, producing hundreds of peer reviewed journal articles and conference publications and presentations, many patent applications filed or awarded, and numerous graduate theses and comprehensive research projects.

v. **Led Efforts To Expand Inclusiveness in Visual Analytics.** During the life of the Center, Visual Analytics (VA) workshops for faculty members at many colleges/universities were conducted to introduce VA to faculty members and help them incorporate VA into their course curriculum.

vi. **Expanded Partnerships to Include European and US Allied Universities.** VACCINE expanded the Public Safety Consortium to international universities such as the University of Stuttgart, eight Canadian institutes of higher learning, and from the United Kingdom - Oxford and Swansea University.

vii. **Established a Non-Profit and for-Profit Entity.** The Purdue Research Foundation, PRF, created VACCINE, LLC, to accept and disburse charitable gifts and a for-profit entity, Davista Technologies LLC, to provide a commercial vehicle to transition VACCINE tools/technologies to the market place.

c. <u>Impact Of The Tools/Technology Created By VACCINE:</u>

VACCINE was strategically focused on the transition of technology and tools out of the research lab to local, regional, and national use with lasting impact on the Homeland Security Enterprise. Some of the most significant tools developed by VACCINE are:

i. **SMART** (Social Media Analytics and Reporting Toolkit), a social media analytics tool that provides actionable information, was deployed at many special events such as the 2017 Presidential Inauguration by Homeland Security components, and commercialized by Davista.

ii. **VALET** (Visual Analytics Law Enforcement Toolkit), an interactive interface for crime incidents, was deployed to several law

enforcement agencies and commercialized by Davista who delivered a modified version to a commercial customer.

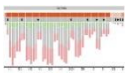
iii. **cgSARVA** (Coast Guard Search and Rescue Visual Analytics), an interactive system that enables analysts to assess operational efficiencies, was used successfully by the United States Coast Guard to right-size the USCG resources in the Great Lakes region. It was also used to avoid resource relocation costs following Super Storm Sandy along the eastern seaboard. It is the only DHS COE tool accredited for use by the USCG.

iv. **GARI** (Gang Graffiti Automatic Recognition and Interpretation)**,** a gang graffiti and tattoo recognition application, won 2nd place in the 2015 NIST- FBI tattoo recognition challenge and it is used by multiple law enforcement agencies for gang tattoo and graffiti recognition and interpretation.

v. **MERGE** (Mobile Emergency Response Guide), an application that automatically interprets HAZMAT placards, was deployed to several first responders groups to quickly identify HAZMAT signs and their meaning.

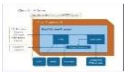
vi. **JIGSAW**, which acts like a visual index in a document collection that highlights connections between entities, has been downloaded by numerous organizations in the government and industry for document exploration and discovery.

vii. **FAVA** (Financial Anomaly Visual Analytics), is designed for government organizations to explore financial datasets and identify any potential anomalies with the help of additional data sources that provide contextual information.



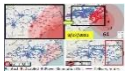
viii. **MADIS** (Multimedia-Aided Disaster Information Integration System), was tested and used by the Miami-Dade Department of Emergency Management.

ix. **GeoTxt** provides a geoparsing service to extract and geolocate place references from text that other software applications can connect to; its accuracy compared favorably to other geoparsers in an independent evaluation by a research team from the Language Technology Lab at Cambridge (published in Language Resources & Evaluation).



x. **vBOLO** (Virtual "Be on the Look-out"), was piloted successfully at the Cleveland Rapid Transit Authority to detect the re-entry of persons who had previously committed a crime on the commuter transit system.

xi. **VASA** (Visual Analytics for Security Applications), is a tool that helps analysts estimate the impact of a severe weather event, forecasting damage, and discovering optimal solutions. It provides scalable, situationally aware insight for understanding the cascading effects of hurricanes on critical infrastructure for emergency responders and city planners.



xii. **LAHVA** (Linked Animal-Human Health Visual Analysis), LAHVA technology provides public health officials with a suite of visual analytic tools that supports spatio-temporal exploration of multivariate health care data sets and also helps them design epidemic response strategies in different outbrea scenarios.

d. <u>Achievements in Education</u>

More than 4,000 students introduced to Visual Analytics knowledge and techniques.

i. **40+ Summer Undergraduate Research Fellows** (SURF) VACCINE students since 2007. SURF matches undergraduates with a faculty member and graduate student mentor who introduce them to the research tools used on the cutting edges of science, engineering, and technology.

ii. **30+ Minority Serving Institutions (MSI) Undergraduate participants** since 2011. VACCINE hosted HCBU/MSI students from Morgan State and Jackson State in one-week training events in which faculty and students led demonstrations of VACCINE tools and technology, providing an opportunity to gain hands-on experiences with VACCINE resources.

iii. **90+ total MSI faculty participants since 2013**. VACCINE has continued to support Minority Serving Institution (MSI) initiatives by providing an education program to expand the teaching of visual analytics at MSIs. The program focused on preparing MSI faculty to incorporate visual analytics courses into their programs.

iv. **Approximately 14 Air Force Academy & Coast Guard Academy Faculty in attendance at VACCINE and the U.S. Air Force Academy training workshop.** This workshop created a network of collaborators at the Service Academies who understand the need to develop and educate the Department of Defense and Department of Homeland Security personnel on the value of visual analytics.

v. **500+ participants registered in VACCINE and American Military University (AMU) webinar series** since 2015. In collaboration with American Military University, VACCINE presented a webinar series with a primary focus on topics related to homeland security technology and research. The webinar series was a launching platform for discussions about problems, challenges and solutions related to keeping our country safe.

vi. **22 HS-STEM (Homeland Security – Science, Technology, Engineering and Math) Career Development Program recipients.** This program is designed to support graduate students in developing the skills to become preeminent scientists in the

homeland security and technical communities. This United States Department of Homeland Security funded program offers career development scholarships and fellowships, as well as forgivable loans with summer research opportunities and one year service commitments.

vii. **250+ VACCINE student research assistants**. VACCINE has employed a diverse group of research assistants in the VACCINE labs. Many of these talented graduate students are now employed at America's most well-known companies such as Google, Amazon and Apple.

viii. **Developed 31+ related curriculum.** We collaborated with multiple partner universities to deliver various courses in areas related to visual analytics, including visualization techniques, geospatial intelligence, data management and data mining.

ix. **200+ students from Lafayette Jefferson High School participate outreach programs.** For the past several years, VACCINE engaged with a local high school to provide students with the foundational knowledge in visual and big data analytics necessary to promote and encourage postsecondary schooling.

e. Key Lessons Learned and Recommendations

As VACCINE pursued advancements in visual analytics in the areas of research, deployment of tools/technologies and education, many lessons were learned. These lessons learned were shared with the DHS OUP leadership during weekly program management meetings, periodic conferences and as specific situations arose.

i. **COE project delays and personnel retention issues can be minimized by accurate financial projections and timely funding distribution.** We recognize that DHS S&T funding is subject to congressional and internal DHS budget processes, so the purpose of this paragraph in Section II is to document the impact on COEs, while acknowledging that OUP has little ability to change this issue.

ii. **Semi-annual conferences/meetings with the COE leadership leads to greater collaboration.** Annual or semi-annual meetings are a great venue to exchange ideas, to build relationships/partnerships and to plan collaborations. Although there is an expense associated with these gatherings, it may be less expensive than redundant or uncoordinated research, education initiatives or technology development.

iii. **Proposal cohesion and alignment is better maintained when proposals are awarded as a unified group.** While the rationale to initiate projects based upon component capability gaps is sound, those capability gaps should be a part of the original RFP. Piece matching the initiatives from several proposals to fine tune an award to a set of capability gaps leads to a lack of overall program cohesion when the direction is applied after a proposal is developed.

iv. **Continue project reviews and competitions.** VACCINE conducted quarterly reviews of research projects to ensure that projects meet their milestone targets. Projects that could not be transitioned to tools for end-users were discontinued and competitions were conducted to initiate new projects.

v. **Encourage the use of Public Safety/Customer forums.** Our strong partnership with our stakeholder community has been key to VACCINE's success because they provided a framework where VACCINE can deploy its tools to the various agency members, and our end-users provide in-field or real world evaluation feedback on their requirements.

vi. **A webinar series is a great method to engage a broad range of HSE professionals and students**. VACCINE, and our online education partner, American Military University (AMU) have collaborated to present a quarterly webinar series. The webinars are conducted in coordination with The National Conversation on Homeland Security Technology in an effort to get people talking about problems, challenges, and solutions to keep our country safe.

vii. **Adopt a user centered approach to transition research into practice.** One of the major reasons for our success with transitioning our research into practice has been due to our agile research and development methodology and our efforts in nurturing strategic partnerships with our end-user groups.

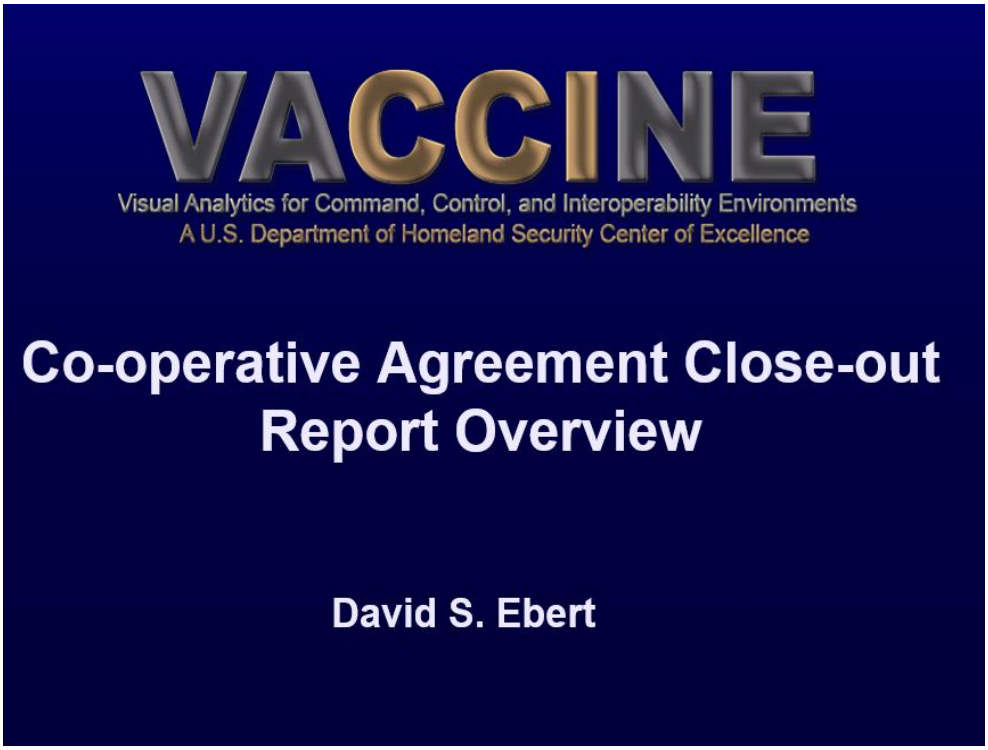
viii. **Low profit margins on public safety products present a challenge when attempting to commercialize solutions.** The main challenges that we have encountered regarding commercializing and licensing these technologies include a relatively small size of the total addressable market segment (especially for the first responder and law enforcement market), difficult sales cycle for this market, and difficult exit market strategies due to the diverse nature of the competition in this market space.

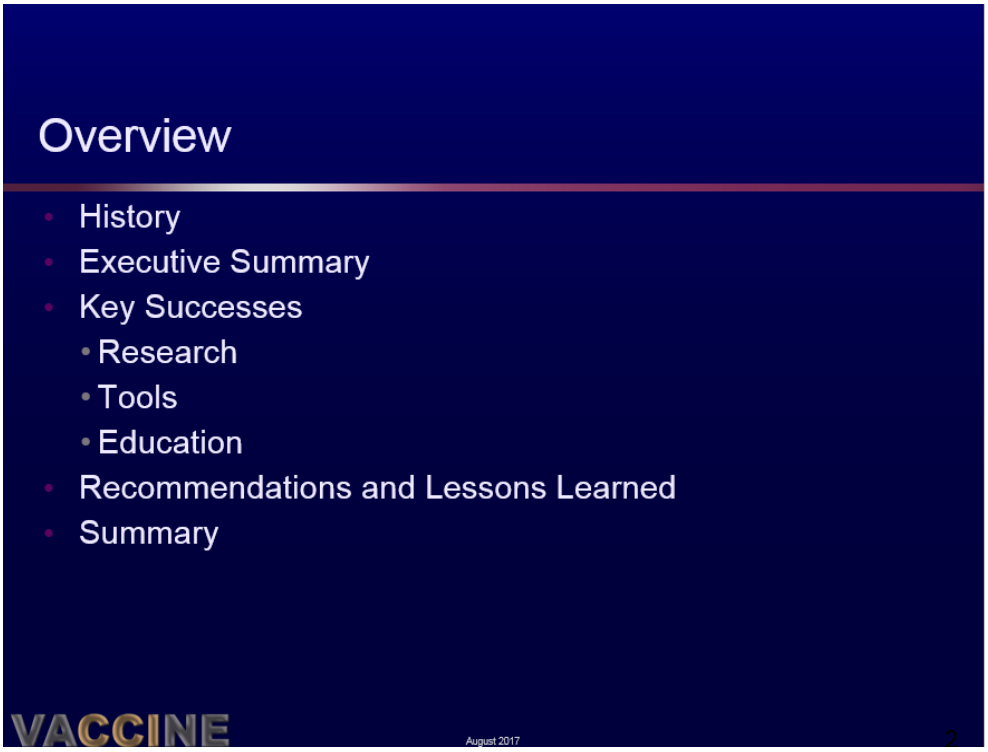
f. Summary

VACCINE was a pioneer in the area of VA for eight (8) years, producing; 4,000+ students introduced to VA, 300 peer reviewed journal articles, 24 patent applications filed or awarded, 325 conference publications and presentations, 40+ graduate theses and 34+ comprehensive research projects. More than seventy (75+) faculty partners from 38 institutions and 3 countries accomplished these achievements.

A presentation that summarizes the achievements of VACCINE in the areas of research, tool/technology development and education can be accessed via the hyperlink below.

II. Co-operative Agreement Closeout Presentation





CVADA-VACCINE History

Mission Statement: Explore and implement new science and technology to identify, analyze, and understand massive amounts of complex and dynamic information; disseminate, share, and secure such information in support of real-time decision-making by the homeland security enterprise

History:

- Established 2009
- Incorporates prior work under RVACS and IDS-UACs

Co-Leads:

- Purdue University – Visual Analytics for Command, Control and Interoperability Environments (VACCINE)
- Rutgers University – Command, Control and Interoperability Center for Advanced Data Analysis (CCICADA)

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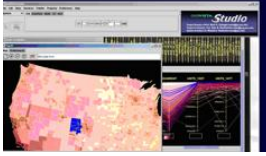
Why was CVADA-VACCINE Established? - Importance to Homeland Security

Problem: To solve today's and tomorrow's homeland security problems requires exploring, analyzing, and reasoning with massive, multi-source, multi-scale, heterogeneous, streaming data –**BIG DATA**

- Cuts across entire spectrum of DHS needs

We provide tools to enable end users to get the relevant information they need during any situation and in the time to make a decision or take action



August 2017

Executive Summary – Impact of VACCINE

Overview Video

- **Developed 33 tools; some used at significant national events.**
- **2nd place in national competition - GARI**
- **Funded > 350 students**
- **Produced > 1000 papers**
- **14 Patents awarded**
- **Grant value > $25,000,000**
- **More than 4000 students trained in VA**
- **Start-up company launched**
- **Only COE with a USCG accredited tool**

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Key Successes: Research

Link to SuccessVis

- **Provided Intellectual Leadership for VA field**
  - **300 peer reviewed journal articles, 325 conference publications and presentations, 40+ graduate theses, 34+ research projects**

- **Led Efforts to Expand Inclusiveness**
  - **MSIs/HBCUs**
- **Expanded International Partnerships**
  - **Created tools and conducted research**

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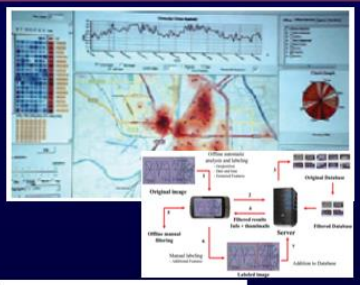
Public Safety Video

Key Successes: Tools

- **VALET**
  - Licensed to DAVISTA
  - Deployed to several law enforcement agencies
- **GARI**
  - Finished 2nd in the NIST/FBI TATT-C Challenge
  - Used by multiple law enforcement agencies
- **vBOLO**
  - Piloted successfully at the Cleveland Rapid Transit Authority
- **JIGSAW**
  - Approximately 7,000 downloads



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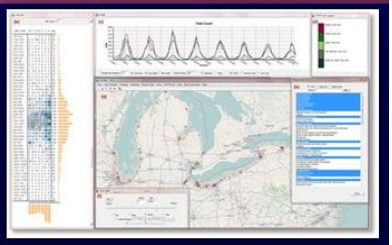
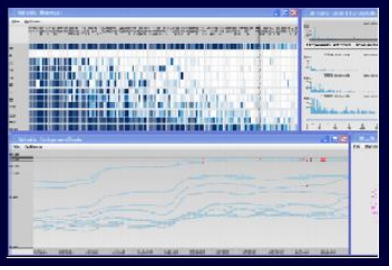
Response Planning Video

Key Successes: Tools

- **cgSARVA**
  - Rescource allocation tools for USCG saved millions
  - Only DHS COE tool accredited for use by USCG
- **MADIS**
  - Tested and used by Miami-Dade Department of Emergency Management



- **LAHVA**
  - Advanced detection capabilities for adverse chemical and biological occurrences in the general populace
- **FAVA**
  - Designed to explore financial datasets and identify potential anomalies



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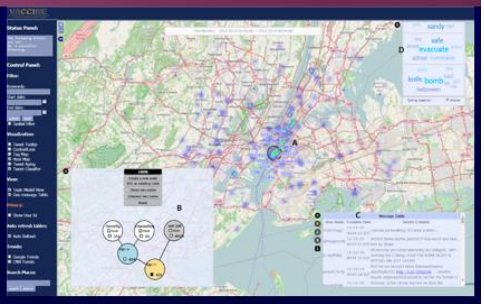
Key Successes: Tools

- **SMART**
  - **Licensed to DAVISTA**
  - **Used at Republican National Convention**
  - **Deployed at Presidential Inauguration 2017**



An example screenshot of the SMART software suite displaying social media feeds during Hurricane Sandy.

VACCINE

August 2017

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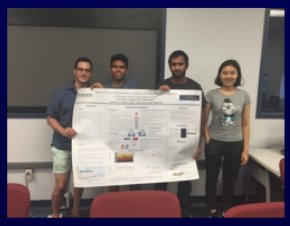
Key Successes: Education
> 4000 students impacted

Education Video

- Enabled student research
  - 40+ SURF VACCINE students since 2007
  - 250+ VACCINE student research assistants
- Funded education in HSE disciplines
  - 22 total HS-STEM recipients
  - 30+ MSI Undergrad participants since 2011
- Enhanced VA knowledge of university faculty
  - 90+ MSI faculty VA workshop participants since 2013
  - 31+ related curriculum developed by VACCINE universities
- Developed pathways to reach working professionals
  - With VACCINE partner, AMU, 500+ participants participated in webinar series since 2015
- Outreach to next generation of VA students
  - 200+ students from Lafayette Jefferson HS were participants in K-12 outreach program



2016 SURF Students

VACCINE

August 2017

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Key Lessons Learned and Recommendations

- **The uncertainty of funding leads to project delays and retention issues**
- **COE leadership meetings result in greater collaboration**
- **Combining projects from disparate proposals reduces cohesion**
- **Continue project competitions**
- **Encourage the use of Public Safety forums**
- **Use of webinars is an effective tool to reach a broad range of HSE personnel**
- **User centered approach was successful**
- **Low profit margins present a challenge to commercialization.**

2016 Annual Meeting

Hands-on training in the VACCINE lab

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Summary

- Take some notes from the Impact Report
- VACCINE was a pioneer in VA for eight (8) years.
- More than 75 faculty partners from 36 institutions
- Hundreds of peer reviewed journal articles
- Created tools that made an impact on end-users effectiveness
- New role as an Emeritus COE
  - Funded projects through task orders
  - CINA - video analytics

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III. VACCINE Videos

As a component of the 2016-2017 VACCINE Co-operative Agreement SOW, the following videos were developed to highlight the accomplishments of VACCINE in the areas of education, public safety and response planning. Each video contains interviews with the people that were most instrumental in the conduct of research, delivery of a technology or educational initiative.

a. **Overview** - An Overview of VACCINE and the Impact of VACCINE on the Field of Visual Analytics.

b. **Education** - VACCINE's Impact on Education and the Field of Visual Analytics.

c. **Public Safety** - VACCINE Supports Public Safety and Law Enforcement.

d. **Response Planning** - VACCINE's Tools are Used for Emergency Response Determination, Resource Allocation Decisions and Critical Infrastructure Impact Analysis.

IV. Impact of VACCINE Report

CLOSE OUT REPORT: A Retrospective Analysis of the Impact of VACCINE on the Field of Visual Analytics

Abstract

In 2004, the US Department of Homeland Security chartered the National Visualization and Analytics Center and charged them with defining the directions and priorities for future research and development programs focused on technology and tools for intelligence analysts and emergency responders [1]. Now, over a decade later, visual analytics is a thriving sub-discipline within computer science focused on the intersection of computer graphics, human-computer interaction, machine learning and cognition. In this report, we discuss the growth of visual analytics as a field, providing a retrospective on the 14-year history of visual analytics. Specifically, we focus on the impacts of DHS funded research through their Center of Excellence program, which established the Visual Analytics for Command, Control, and Interoperability Environments (VACCINE) Center in 2008. Here, we present a retrospective analysis of the impact that VACCINE and DHS has had on the growth and direction of the science of visual analytics. A qualitative impact analysis on the topics and themes in the conference is performed to explore how the publications from VACCINE affiliated scientists have influenced the shape and direction of the community. This report then concludes with a discussion of the educational activities associated with the VACCINE center and describes how these activities have led to the development of the next generation of technology and research scientists in the community.

Keywords: visual analytics, Department of Homeland Security, VACCINE

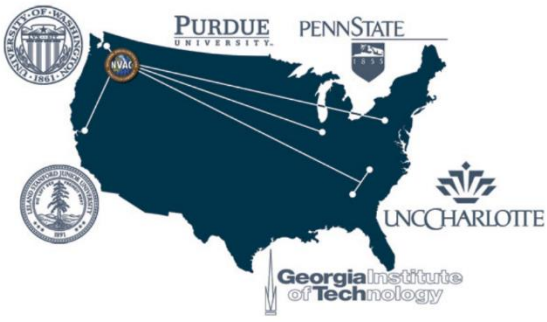

Figure 1: The Regional Visual Analytics Centers - 2006

I. The Outgrowth of Visual Analytics

In 2004, the Department of Homeland Security (DHS) established the National Visual Analytics Center (NVAC) at the Pacific Northwest National Laboratory to provide scientific guidance and coordination for the research and development of new tools and methods that DHS had identified as required for managing, visually representing and analyzing enormous amounts of diverse data and information. The goal was to develop visualization tools and analytic capabilites that can facilitate the application of human judgement to large complex data and enable action. that are designed to enable analysts to more effectively identify signs of terrorist attacks in their earliest stages and ultimately to prevent terrorist plots before they occur.

During the establishment of the NVAC, a panel of research leaders from academia, industry, government, and the national laboratory system developed a five year research and development agenda for the field of visual analytics [1]. From this research agenda, visual analytics is defined as "the science of analytical reasoning supported by interactive visual interfaces." Where the science of visual analytics is meant to "enable analysts of all types to overcome information overload so that they can detect the expected and discover the unexpected from massive, dynamic, conflicting, and incomplete information while rigorously adhering to privacy and security laws and policies" [1].

Figure 2: The VACCINE Partner Network (2017)

To address the proposed visual analytics research agenda, DHS and NVAC began establishing a network of partner universities in order to develop technology to turn data into actionable information for the homeland security enterprise (HSE) and train the next generation of scientists with skills relevant to problems in the homeland security domain. This network of centers (Figure 1) consisted of Stanford Unversity (led by Pat Hanrahan), Purdue University (led by David Ebert), Pennsylvania State University (led by Alan MacEachren), University of Washington (led by Tom Furness), Georgia Institute of Technology (led by John Stasko), and the University of North Carolina – Charlotte (led by William Ribarsky). As the university research matured, the Department of Homeland Security competed and established a Center of Excellence in Visual and Data Analytics in 2009 as a spin-off of the Regional Visual Analytics Centers begun in 2005.

Established in July of 2009, the Visual Analytics for Command, Control, and Interoperability Environments Center (VACCINE), is the Department of Homeland Security's (DHS) Center of Excellence in Visual and Data Analytics. VACCINE's mission

focus is on creating methods, tools, and applications to analyze and manage vast amounts of information for all mission areas of homeland security in the most efficient manner. The center was developed to span the disciplines of visualization and computer graphics, engineering, computer science, geographic information systems, cognitive psychology, information technology, and emergency management and public safety. In order to span such a broad set of disciplines, VACCINE developed a network of partner universities with 27 universities both domestic and international aimed at turning massive data into actionable knowledge through innovative visual analytics techniques (Figure 2). Investment by DHS in the science of visual analytics spurred international funding, and VACCINE was instrumental in the establishment of the United Kingdom Visual Analytics Center (UKVAC) and the Canadian Visual Analytics Center (CANVAC).

To date, the VACCINE center has focused on developing cutting-edge research focused on real-world problems. In this report, we present a retrospective analysis of the impact that VACCINE and DHS has had on the growth and direction of the science of visual analytics. This report provides a detailed analysis of the trends and publications in VACCINE from its inception to present day. Topics and themes in the VAST conference are analyzed, and discussions on technology transition and education are provided to further contextualize the impact of VACCINE.

II. IEEE Visual Analytics Science and Technology Conference (2006 – present)

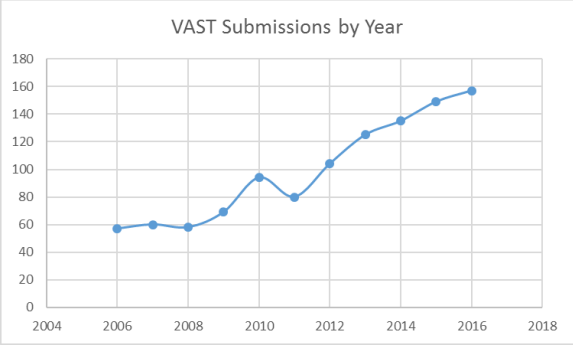

Figure 3: Submissions to IEEE VAST by Year

The IEEE Symposium on Visual Analytics Science and Technology (VAST) was established within what is now IEEE VIS in 2006, and was founded by researchers from VACCINE, NVAC, and their European partners. Since its inception, IEEE VAST has grown from a symposium to one of the three major tracks of IEEE VIS and serves as the premiere venue for visual analytics research papers with over 170 submissions in 2017. The growth of the conference is shown in Figure 3, where we can see that the number of yearly submissions has nearly tripled over the course of 10 years. In this section, we will describe the evolution of research trends and topics over time, their relevance to the homeland security mission, and the role that VACCINE affiliated researchers have taken in shaping the conference.

II.1 Topics and Trends

In order to explore the prevalent topics in visual analytics, we performed a qualitative analysis of session topics in IEEE VAST from 2006-2016. Results of this analysis are presented in Figure 4. Each column in Figure 4 represents one year of the IEEE VAST conference, where each larger colored box represents a conference session (typically consisting of 4-5 paper presentations). Since sessions (in general) attempt to group papers with similar topics, we performed an analysis of session names (provided as text

in each colored box) and their corresponding papers. We grouped sessions with similar themes together to create our color-coded categorization. Of the 78 conference sessions from 2006 – 2016, we identified 11 different categories.

Red – Spatial and Temporal Visual Analytics

Spatiotemporal analysis was the only topic found to exist across all years of the conference. Papers in this topic typically focus on geographic data with underlying temporal attributes. Sample data has ranged from public health records to criminal incident reports to taxi trajectory data.

This perennial topic is often a focus of the VAST challenge, where synthetic datasets tracking users in buildings and amusement parks conceal hidden agendas. This topic has been further bolstered by emerging technologies and high-resolution geographic data (e.g., GPS traces) that have become publically available (e.g., the New York City taxicab data). Recently, emerging trends in smart cities, resiliency and disaster management have also paved the way for new research in this sub-domain.

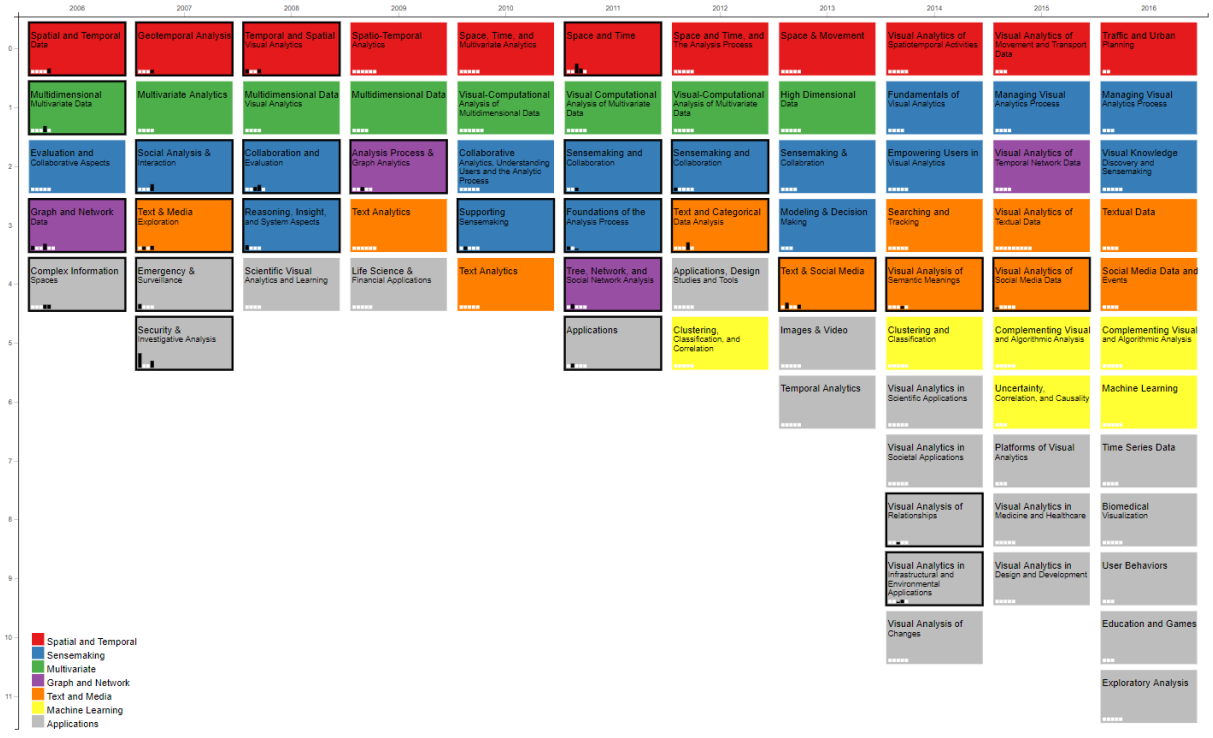

Figure 4: Classifying VAST Sessions by Topic (2006 - 2016). Each column represents one year of IEEE VAST. Each larger colored box represents one session in the conference. The small black-and-white squares in each session box represent an individual paper in the session. If a paper box is black, this indicates this paper was the result of direct funding from DHS. Six different paper session categories were identified during the analysis and are described in Section 2.1.

Researchers from VACCINE have made a variety of contributions to this field. As we can see that in the early years of IEEE VAST, researchers from VACCINE continuously published four papers per session from 2006 to 2008 [18, 19, 20, 21] and two following publications in 2011 [22, 23]. These publications have a high citation count indicating a strong impact on the development of future research in spatiotemporal visual analytics.

Blue – Sensemaking

Sensemaking has been another perennial favorite in VAST, appearing as a topic in all but one year of the conference. At its core, visual analytics has been heavily focused on supporting analysts in discovering knowledge, and discussions focus on how to generate and quantify insights. Topics include modeling users in the loop to identify personality factors that may influence analysis, methods for priming users to understand visualizations, and provenance analysis to identify analysis strategies of users. Papers in these sessions range from user studies describing tool usage, to theoretical models of sensemaking in visual analytics.

Research from VACCINE has delved into large-scale and multidimensional data analysis [2], collaborative and cognitive explorations [3, 4, 5], decision-making support [6] and evaluations for sensemaking assessment [7, 8]. These works covers both fundamental research that builds conceptual models of sensemaking and also applications of sensemaking that target domains from financial analysis [24] to geo-historical analysis [25].

Green – Multivariate Analysis

Multivariate analysis was a consistent topic in VAST from 2006 – 2013, with papers in this area focusing on multivariate data and methods for representation and analysis. While this topic has dwindled in popularity in recent years, it has been replaced with the introduction of machine learning techniques (the yellow category). This is likely due to the rise of machine learning algorithms becoming widespread via Python and R. In addition, data boom in recent years actually has forced the analysis in many topics to embrace multivariate analysis.

While multivariate analysis appears to not be a core topic of VACCINE researchers, techniques from VACCINE researchers appear in other categories that are related to multivariate analysis. Multivariate visual analytics from VACCINE has focus on applying techniques into many other topics, such as textual data analysis and geospatial analysis.

Purple - Graph and Network Analysis and Visualization

Methods for graph analysis and visualization appear frequently throughout the years in VAST, returning to prominence every few years. This research is often driven by large-scale social network data and data has been supported through synthetic datasets in the VAST challenge. It includes analyzing physical networks, for example, road networks [9], and social networks and integrating with other analysis approaches for pattern analysis [26].

Research in VACCINE has ranged from traffic network analysis [9] to design principles on graph visualization [10] to applications on tabular data [11], and VACCINE research has been present in all of the sessions in the graph and network analysis and visualization category except for 2015 [9, 10, 11, 27].

Orange – Text and Media Analytics

Another popular topic appearing almost yearly, is text and media analytics, which has surged in popularity due to new research in digital humanities and the digitization of large repositories of media and short blogs and social media (e.g, Twitter). Digitization and machine learning models provide researchers with access to automated and intelligent analysis for exploring text data. Popular models that have been developed and used in text and media visual analytics include topic modeling, information retrieval (e.g., document query and entity extraction), anomaly detection, etc. Results from these models have been visualized for corpus summarization, theme (and sentiment and attitude) discourse analysis, and storytelling with timeline and annotation.

Research in VACCINE has seven publications in this topic (based on the session categories). Work from 2007 focused on analyzing news media [12, 13]. In 2012, one VACCINE paper broke ground in text and media visual analytics by supporting event identification, considering lags between events and topics for relationship analysis, and linking media text to geospatial locations [14]. This work influenced the visualization community, and many text visual analytics researches began including more temporal analysis through topic models, intervention models, time series models, and other machine learning algorithms.

Yellow – Machine Learning Methods in Visual Analytics

Visual analytics was defined (partly) as the science of integrating machine intelligence and human intelligence, and visual analytics methods have focused not only on the integration of machine learning approaches to improve knowledge discovery, but also on methods for helping machine learning researchers understand their models. These topics have seen a larger outgrowth in the visual analytics community as machine learning methods have become more ubiquitous in the era of big data. Research work in this topic has more recently focused on machine learning models with the goal of explaining the model rational, supporting interactive adjustment of the modeling process, and integrating human efforts and model outputs for decision-making.

Grey – Applications

Visualization has been served as an effective way to bridge data analysis and domain experts for application-driven problems. These problems could have domain specific requirements that characterize the implementation of the visual analytics framework. Visual analytics approaches have contributed to a wide range of applications, such as healthcare, economics, life science, manufacturing, and education. The conference has

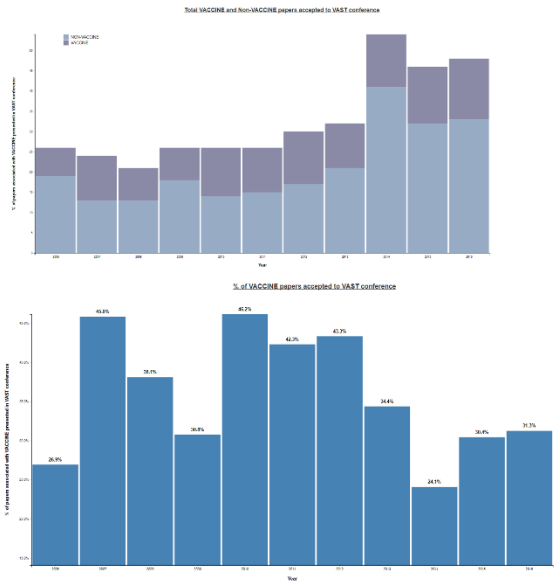

Figure 5: (Top) VAST Papers categorize by VACCINE or non-VACCINE publication. (Bottom) Percent of VAST papers associated with VACCINE by year.

seen an increasing amount of application-based visual analytics works that demonstrates the importance of visualization across domains. Research in VACCINE has also reached out to many application-based works, especially in emergency response and security [17]. Key domain applications from VACCINE have included healthcare [28], criminal analysis [29], and Coast Guard search and rescue [16].

II.2 VACCINE Impact in VAST

In order to define the impact of VACCINE on the field of visual analytics, we have analyzed the conference with respect to VACCINE publications per year (Figure 5). The first bar chart in Figure 5 shows the percentage of VACCINE associated VAST papers in all VAST paper publication over 2006 to 2016. The average percentage is about 35.8%, with 24% being the minimum and 46% being the maximum. The second stacked bar chart shows the distribution of the number of VACCINE associated VAST papers (dark purple) and non-VACCINE VAST papers (light purple). Here, we find that VACCINE research has been one of the major underlying drivers of the conference, accounting for upwards of 46% of the publications in this venue in a given year.

II.3 Awards and Recognition

Another measure of impact is the awards and recognitions that VACCINE researchers have achieved over the years. Of these awards, the most prestigious is the IEEE VGTC technical achievement award. VACCINE has supported two researchers (whose technical achievement awards were directly related to their VACCINE research). These two researchers are David Ebert (VACCINE Director) and John Stasko.

The 2016 Visualization Technical Achievement Award went to David Ebert in recognition of his foundational work in visual analytics, both through the development of fundamental predictive techniques and as Director of VACCINE. The 2012 Visualization Technical Achievement Award went to John Stasko in recognition of his seminal achievements in new visualization techniques and for the Jigsaw system which allows understanding large document collections [17].

More recently, the visualization community has create a Test of Time Award as an accolade given to recognize articles published at previous conferences whose contents are still vibrant and useful today and have had a major impact and influence within and beyond the visualization community. The 2017 VAST Test of Time Award was again the

Jigsaw System. The award described Jigsaw as a visual analytics system, developed by the Georgia Institute of Technology, for enabling analysts and researchers to explore, analyze, and make sense of document collections. This 2007 VAST paper, co-authored by John Stasko, Carsten Görg, Zhicheng Liu, and Kanupriya Singhal, brought Jigsaw to light for the first time. Since then, the software has been used extensively by investigators, analysts, and researchers in many fields, including visualization, text analysis, journalism, law enforcement, finance, and so on According to Google Scholar, the paper has received over 400 citations. While a number of papers published in IEEE VAST 2007 have made significant impact because of their novel scientific contributions, this VAST paper on Jigsaw stands the test of the time with the highest impact.

Along with the technical achievement awards, a variety of VACCINE researchers have participated in the annual VAST challenge. This is an annual contest with the goal of advancing the field of visual analytics through competition. The VAST Challenge is designed to help researchers understand how their software would be used in a novel analytic task and determine if their data transformations, visualizations, and interactions would be beneficial for particular analytic tasks. VAST Challenge problems provide researchers with realistic tasks and data sets for evaluating their software, as well as an opportunity to advance the field by solving more complex problems. Researchers and software providers have repeatedly used the data sets from throughout the life of the VAST Challenge as benchmarks to demonstrate and test the capabilities of their systems. The ground truth embedded in the data sets has helped researchers evaluate and strengthen the utility of their visualizations. With over a decade of contest awards, VACCINE researchers have been involved in over 27 award winning submissions.

III. VACCINE Education and Outreach

While VACCINE has been a driving force in the field of visual analytics, another broad impact of the center has been its educational mission. VACCINE's mission is to educate current homeland security stakeholders and the next generation of talent in effective development and use of visual analytics systems. The educational initiatives span the career development pipeline ranging from undergraduate and graduate level work to professional education and training programs. The goal is to build a diverse, highly capable, technical workforce for the Department of Homeland Security enterprise by administering various programs and initiatives at our center, partner research institutions, and minority-serving institutions.

Education and outreach initiatives from VACCINE have led to the worldwide development of visual analytic. VACCINE partners/collaborators started the European Union Visual Analytics Consortium and led visual analytics courses through the CANVAC summer program and the UKVAC summer program. These collaborations have led to the creation of the EuroVA symposium, Pacific VAST, and a variety of other publication venues capitalizing on the success of visual analytics. More recently, the

VACCINE consoritum has also begun publishing book series and other initiatives for education and outreach.

III.1 Next Generation Scientists

From this focus on education, VACCINE has trained a large cadre of next generation scientists in the field of visual analytics. Previous VACCINE-affiliated graduates are now faculty members at a variety of Reseach-1 Universities across the country. These students include:

- Carsten Gorg (University of Colorado – Denver)
- Anthony Robinson (Pennsylvania State University)
- Chris Weaver (University of Oklahoma)
- Robert Roth (University of Wisonsin)
- Remco Chang (Tufts University)
- Ross Maciejewski (Arizona State University)
- Wenwen Dou (University of North Carolina – Charlotte)
- Sungahn Ko (Ulsan National Institute of Science & Technology, South Korea)
- Victor Chen (Purdue University)
- Yun Jang (Sejong University, South Korea)

Among these young researchers, there are three NSF Career Award Winners (Chang, Maciejewski, Weaver), and Ross Maciejewski was recently chosen to lead the newest Department of Homeland Security Center of Excellence (Center for Accelerating Operational Efficiency).

Along with young researchers in academia, VACCINE has also focused on undergraduate education as well. To date, VACCINE has hosted over 40 summer undergraduate research fellows since 2007 and over 30 minority serving institution (MSI) undergraduate participants. VACCINE has further supported education by providing training programs to expand the teaching of visual analytics in MSIs.

III.2 Startups and Companies

Along with success in academia, research from VACCINE has also led to a variety of startups including Davista Technologies (led by Abish Malik) and Stratifyd Inc. (led by Derek Wang). Davista Technologies specializes in the field of visual analytics with a focus on spatiotemporal analytics. This company has spun out of the VACCINE work on criminal investigative analysis. Stratifyd Inc.'s focus is on a data analytics platform that allows users to integrate, analyze, and visualize data in a single platform, empowering analysts through a holistic view of both structured and unstructured data. This company spun out of the work on social media analytics to help analysts explore unstructured text.

Some of the most significant tools developed by VACCINE include:

- **SMART** (Social Media Analytics and Reporting Toolkit), a social media analytics tool that provides actionable information, was deployed at many special events

such as the 2017 Presidential Inauguration by Homeland Security components, and commercialized by Davista.

- **VALET** (Visual Analytics Law Enforcement Toolkit), an interactive interface for crime incidents, was deployed to several law enforcement agencies and commercialized by Davista who delivered a modified version to a commercial customer.
- **cgSARVA** (Coast Guard Search and Rescue Visual Analytics), an interactive system that enables analysts to assess operational efficiencies, was used successfully by the United States Coast Guard to right-size the USCG resources in the Great Lakes region. It was also used to avoid resource relocation costs following Super Storm Sandy along the eastern seaboard. It is the only DHS COE tool accredited for use by the USCG.
- **GARI** (Gang Graffiti Automatic Recognition and Interpretation)**,** a gang graffiti and tattoo recognition application, won 2nd place in the 2015 NIST- FBI tattoo recognition challenge and it is used by multiple law enforcement agencies for gang tattoo and graffiti recognition and interpretation.
- **MERGE** (Mobile Emergency Response Guide), an application that automatically interprets HAZMAT placards, was deployed to several first responders groups to quickly identify HAZMAT signs and their meaning.
- **JIGSAW**, which acts like a visual index in a document collection that highlights connections between entities, has been downloaded by numerous organizations in the government and industry for document exploration and discovery.
- **FAVA** (Financial Anomaly Visual Analytics), is designed for government organizations to explore financial datasets and identify any potential anomalies with the help of additional data sources that provide contextual information.
- **MADIS** (Multimedia-Aided Disaster Information Integration System), was tested and used by the Miami-Dade Department of Emergency Management.
- **GeoTxt** provides a geoparsing service to extract and geolocate place references from text that other software applications can connect to; its accuracy compared favorably to other geoparsers in an independent evaluation by a research team from the Language Technology Lab at Cambridge (published in Language Resources & Evaluation).
- **vBOLO** (Virtual “Be on the Look-out”), was piloted successfully at the Cleveland Rapid Transit Authority to detect the re-entry of persons who had previously committed a crime on the commuter transit system.

- **VASA** (Visual Analytics for Security Applications), is a tool that helps analysts estimate the impact of a severe weather event, forecasting damage, and discovering optimal solutions. It provides scalable, situationally aware insight for understanding the cascading effects of hurricanes on critical infrastructure for emergency responders and city planners.

- **LAHVA** (Linked Animal-Human Health Visual Analysis), LAHVA technology provides public health officials with a suite of visual analytic tools that supports spatio-temporal exploration of multivariate health care data sets and also helps them design epidemic response strategies in different outbreak scenarios.

Amongst these tools, the Government Accountability Office indicated that the cgSARVA work could save the government $290M based on analysis and closing of bases. Furthermore, the use of these tools at critical national events (e.g., SMART) underscores the impact of the technology.

IV. Conclusion

In summary, it is difficult to directly quantify the impact of the VACCINE Center. From all academic measures, it is clear that VACCINE was a pioneer in the area of visual analytics, introducig 4,000+ students introduced to visual analytics while generating 300 peer reviewed journal articles, 24 patent applications, 325 conference publications and presentations, 40+ graduate theses and 34+ comprehensive research projects. More than seventy (75+) faculty partners from 38 institutions and 3 countries participated in these achievements, allowing VACCINE to leave a global footprint in the area of visual analytics.

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Figure 6: The Regional Visual Analytics Centers - 2006

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I. Strategic Plan Initiatives

Overview

In the past eight (8) years, VACCINE has developed many strategic initiatives in the pursuit of its mission to create methods and tools to analyze and manage vast amounts of information for all mission areas of homeland security. These initiatives are summarized below:

a. Strategic Initiatives

i. **Developed Emergency Preparedness Tools.** A number of visual analytics tools to assist first responders and emergency management planning were developed. In collaboration with VACCINE and the Miami-Dade County Department of Emergency Management, Disaster Information Technologies Research Group (DITRG) at Florida International University produced a tool known as the Multimedia Aided Disaster Information Integration System (MADIS). This tool 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. As a second example of Emergency Preparedness VA tools, VACCINE and UNCC created VASA – Visual Analytics for Security Applications. This system provides a visual analysis and decision-making environment for severe weather and natural disaster planning and response for several critical infrastructures. As a last example, VACCINE developed the Mobile Emergency Response Guide (MERGE). MERGE uses image analysis of HAZMAT placards to automatically obtain information that allows emergency responders to work quickly and safely in volatile environments.

ii. **Created Public Health Visual Analytics Tools.** Assessing current and emerging public health threats is important for public health officials in order to make decisions regarding mitigative actions and allocation of resources. It also helps scientists understand the characteristics of syndromic diseases and improve their models. VACCINE has been researching novel visual analytics tools for Rift Valley Fever using a tool from the COE for Zoonotic and Animal Disease Defense (ZADD), incorporating epidemiological modeling as well as economic modeling and analysis. One tool created by VACCINE, Linked Animal-Human Health Visual Analytics (LAHVA) provides public health officials with a suite of visual analytic tools for spatio-temporal exploration of multivariate health care data sets in linked statistical and geospatial-temporal views. These tools provide advanced detection capabilities for adverse chemical and biological occurrences in the general populace.

iii. **Created Interactive Visual Analysis and Decision Making Environments for Law Enforcement.** The creation of tools like

iv. VALET, Visual Analytics for Law Enforcement Toolkit, enabled police departments to map crime occurrences and plan patrol distributions. Additionally, VALET was used for analysis and presentation of high-risk alcohol behavior in the Purdue campus area. The resulting findings and analysis were integrated into educational and enforcement programs at Purdue.

v. **Resource Allocation Visual Analytic Tools Saved the USCG Millions of Dollars.** The US Coast Guard needed a tool to make a credible case to Congress that the number of Coast Guard Stations on the Great Lakes was not optimized. cgSARVA helped them debate the point. VACCINE was awarded the Commander Atlantic Area's Excellence Coin, a prestigious award presented by the US Coast Guard, in recognition of our work with District 9 in search and rescue/resource allocation. In USCG District 1, VACCINE was recognized for its participation in the PROTECT project along with the Center for Risk and Economic Analysis of Terrorism Events. In a second instance, cgSARVA enabled the USCG LANT Command to analyze the resource requirements along the northeastern seaboard following Super Storm Sandy in October 2012. The result of this analysis was a significantly reduced resource "surge" response that saved the USCG millions of dollars. Not only did cgSARVA provide operational support to the USCG staff, but also it was first time in COE history that a tool produced by one of the DHS Centers of Excellence has been accredited by the USCG.

vi. Developed Fraud Detection Financial Visualization Tools. UNCC partner, Dr. William Ribarsky, developed RiskVA which applied risk analytics to large and multi-faceted financial resources, such as at a major bank or under the jurisdiction of a major government agency. Methods were 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 was 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. Separate from RiskVA, in 2013, VACCINE was awarded a $500,000 grant to explore financial data and predictive financial visual analytics by a U.S. government agency.

vii. Created a Public Safety Consortium. VACCINE formed a multi-agency public safety consortium in Indiana to develop tools for crime analysis, law enforcement planning, and decision making. This consortium expanded to an international network of VA researchers, and helped launch the Canadian VA Center (CANVAC) and the United Kingdom VA Center (UKVAC).

viii. **Provided Intellectual Leadership for the Field of Visual Analytics.** VACCINE was a pioneer in the area of VA for eight (8) years, producing; 300 peer reviewed journal articles, 24 patent applications filed or awarded, 325 conference publications and presentations, 40+ graduate theses and 34+ comprehensive research projects. More than seventy (75+) faculty partners from 38 institutions and 3 countries accomplished these achievements. Not only did VACCINE create a multitude of VA academic documents, they also created the "gold standard" curriculum/course in VA. Additionally, VACCINE led a series of workshops on VA that highlighted new directions and challenge areas in a range of areas such as personal VA, financial VA, public policy VA, and science of interaction for VA.

ix. **Led Efforts To Expand Inclusiveness in Visual Analytics.** During the life of the Center, Visual Analytics (VA) workshops for faculty members were conducted to introduce VA to faculty members and help them incorporate VA into their course curriculum. These workshops were conducted at Minority Serving Institutions (MSIs) and service academies. Additionally, each summer, students from Morgan State University, a HBCU, participated in a one-week "boot camp" in visual analytics to familiarize them with the field of study and create interest in a career in the Homeland Security Enterprise (HSE). As an outreach to Native Americans, VACCINE established a partnership with Navajo Tech College, an organization that experimented with GARI. More broadly, VACCINE participated in the Summer Undergraduate Research Fellowship (SURF). SURF Fellowships attracted a diverse group of undergraduates who were exposed to HSE VA projects.

x. **Expanded Partnerships to Include European and US Allied Universities.** As mentioned in paragraph one (1), VACCINE expanded the Public Safety Consortium to international universities such as the University of Stuttgart, eight Canadian institutes of higher learning, and from the United Kingdom - Oxford and Swansea University. Some of these international partners became collaborators for specific VACCINE tools. For example, the Principal Investigator from the University of Stuttgart was integral to the development of SMART.

xi. **Established a Non-Profit and for-Profit Entity.** The Purdue Research Foundation, PRF, created VACCINE, LLC, to accept and disburse charitable gifts to further the goals and purposes of PRF and Purdue by supporting the VACCINE Center, and for related purposes. Additionally, a for-profit entity, Davista Technologies LLC, was established by several members of VACCINE to provide a commercial vehicle to transition VACCINE tools/technologies to the

xii. market place. Davista obtained an exclusive license from PRF for two tools that were created in the VACCINE Center, VALET and SMART.

b. Stakeholder Outreach That Influenced the Strategic Plan

VACCINE employed an approach to the development of tools and technologies that focused on meeting HSE end-user requirements. As a result, the stakeholders influenced many decisions regarding our work. Some of the decisions that resulted in changes to the strategic plan are listed below.

i. **Creation of a For-Profit Entity. (Strategic Initiative #2)** The desire of DHS S&T OUP to transition VACCINE tools and technology to the private marketplace resulted in the creation of a for-profit entity, Davista Technologies, LLC. DHS provided the R&D funding, in the form of an award to VACCINE, so that the technology could benefit the public HSE, but they also wanted the technology to be widely used in the HSE private marketplace to result in the biggest impact on homeland security. Davista was able to purchase an exclusive licensing agreement from the Purdue Research Foundation for SMART and VALET at a very low cost and sell those tools in the private marketplace. To date, Davista has signed one contract with a commercial company to use a derivative of VALET for shopping mall security.

ii. **Expanded Interactive Visual Analysis and Decision Making Environments for Law Enforcement. (Strategic Initiative #8)** The Lafayette Police Chief significantly influenced visual analysis and decision making for law enforcement as his patrolmen experimented with VALET. VALET started as a tool to map crime incidents with several interactive filtering features, but with the input of the Lafayette PD, it grew from a desktop tool to iVALET which is a mobile version. The police chief was also interested in the performance of officers resulting in the development of a feature that links officer performance on each crime incident to which they responded.

iii. **Resource Allocation Visual Analytic Tools Saved the USCG Millions of Dollars. (Strategic Initiative #9)** The development of cgSARVA was greatly influenced by the operational and strategic priorities of the US Coast Guard. The Coast Guard was wasting assets on the Great Lakes, but they did not have a credible tool to analyze and present their argument to Congress. cgSARVA and the features added at the request of the USCG helped them make their case. The success of cgSARVA on the Great Lakes data resulted

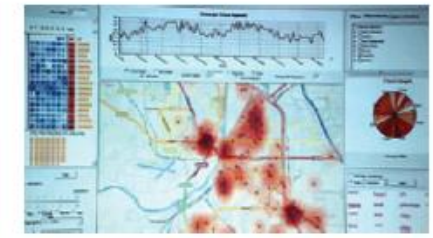
in the request to analyze the northeastern seaboard USCG predicted response requirements following super storm Sandy. Following the use of cgSARVA on these two significant Coast Guard issues, the tool was further improved so that it could meet the USCG IT standards and pass the software validation and evaluation requirements.

II. Significant Transition Successes

Two technologies created by VACCINE, VALET and SMART, were licensed by Purdue in 2015 to be used exclusively by Davista Technologies, LLC. Davista is a start-up company that was created by members of VACCINE who were integral to the development of the technologies. Another six technologies were delivered to end users, but were not licensed to a private entity. These tools are GARI, Jigsaw, cgSARVA, MERGE, MADIS, and GeoTxt. Each of these tools was deployed to various entities and will be discussed below.

a. **Licensed Tools**

i. **Visual Analytics Law Enforcement Toolkit (VALET)** The lead developer was Dr. Ross Maciejewski of Arizona State University while he was working in the VACCINE lab at Purdue University. VALET technology provides law enforcement agencies with a suite of tools that allows for the spatiotemporal exploration of multivariate data sets and police records. These tools provide advanced analytic capabilities that allow officers to develop and test hypotheses about law enforcement activities within various areas of their communities.



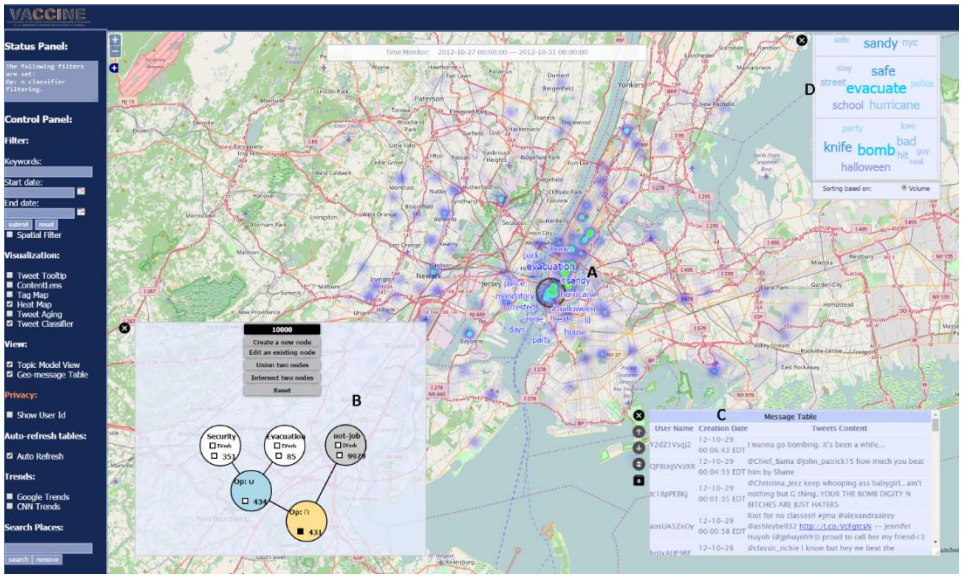
This image developed through the VALET tool highlights a map of a selected location surrounded by a line graph, calendar view, clock view and crime history, with a time slider that ties the data together so crime reports, for example, can be viewed over a selected time. The screen also includes a Twitter widget to help detect unusual activity, such as a protest or riot.

VALET was deployed at the Lafayette, Jeffersonville and Evansville Police Departments. Further, the Indianapolis Police Department, Tippecanoe County Sheriff's Office, Ohio State Highway Patrol, Illinois State Police, and New York Police Department have used VALET. As the predictive analytics component of the software continues to improve, input and feedback continues to be received to make adjustments to the technology in order to optimize it for use in the field. One of those modifications is the development of the Officer Performance/MetricVis

solution that displays the performance of police officers in Lafayette Police Department. The intention of this feature is to provide a tool for officer performance comparison and motivating maximized performance. The mobile version of VALET (iVALET) continues to be a popular option for law enforcement officers depending upon their roles and responsibilities. VALET has been utilized to devise novel data guided patrolling strategies and has led to a paradigm operational shift at several police departments. VALET has also supported investigative analysis tasks at the departments who utilize the system. For example, the system played a critical part in the investigation of a string of business burglaries by the Evansville police department.

In keeping with the goal of transitioning this software, Purdue Research Foundation has licensed the technology to a startup company, Davista Technologies, LLC, which was born out of the VACCINE center. Davista is developing a sustainable transition model in order to continue the development and commercialization efforts of the technology. The company is also currently engaged in developing a data driven solution for a large private corporate firm for optimally allocating their safety and security related resources. Davista is leveraging the core VALET technology in the development of this solution.

b. **Social Media Analytics and Reporting Toolkit (SMART)** The lead developer was Dr. David Ebert of Purdue University. The system provides users with scalable and interactive social media data (e.g., Twitter, Instagram) analysis and visualization, which includes real-time monitoring of social media channels, extraction of trending and abnormal topics, interactive geospatial and temporal visualizations, and task-tailored message categorization and dynamic filtering tools. In addition, web and news media sources are incorporated in the system so that users can search and correlate news articles of interest with social media posts. The system enables users to perform their exploration and analysis across a range of data scales from local (e.g., precinct, neighborhood) to global (e.g., city, state). In addition, SMART incorporates novel visual analytic techniques to extract and visualize crowd movement patterns and trajectories using social media data in order to allow users to detect anomalies and outlier patterns. SMART also provides an email alert/summary service to automatically send emails related to user defined topics. The system provides such functionalities through not only a desktop application, but also a highly interactive and accessible web interface.



An example screenshot of the SMART software suite displaying social media feeds during Hurricane Sandy.

SMART has been actively used by several local, state, and federal HSE organizations, including the US Coast Guard, US Customs and Border Protection (CBP), and US Citizenship and Immigration Services (USCIS). The US Coast Guard has utilized SMART to maintain situational awareness during several significant events (e.g. Fleet Week, Cincinnati Riverfest, Thunder-Over-Louisville, 2017 Presidential Inauguration and Presidential Address to a Joint Session of Congress). The Purdue University police and Ohio State Department of Homeland Security have utilized SMART during their home football games and have been able to obtain actionable information to thwart potential safety and security related incidents using the system. Additionally, SMART was deployed at the joint Canadian-US Enhanced Resiliency Experiment (CAUSE) organized by the US DHS S&T Directorate and the Defence Research and Development Canada's Centre for Security Science (DRDC CSS). The system was utilized to provide a shared situational awareness during the binational exercise. Moreover, SMART has been used to support the investigative analysis of hoax distress calls by Coast Guard analysts in order to utilize social media data as another source of information. This analysis was driven by approximate locational information obtained from the Rescue 21 system. Finally, the SMART system was utilized by over 12 law enforcement agencies and first responder groups at the Republican National Convention held in Cleveland in July 2016 in order to provide actionable intelligence and early warning indicators of potential demonstrations and acts of violence during the event.

SMART has also been licensed to Davista Technologies. Davista is actively seeking partnerships with commercial corporations to further refine their market penetration strategy with the technology.

c. Unlicensed Tools Deployed to End-Users

As mentioned in the opening paragraph, six tools/technologies have been delivered to various end users. These six technologies are listed below.

i. **Coast Guard Search and Rescue Visual Analytics (cgSARVA)** The lead developer was Dr. David Ebert of Purdue University. cgSARVA is a vital component for analyzing and assessing operational efficiencies of different Coast Guard missions across the United States. The system aids with the risk assessment of potential resourcing changes. The analyst is able to understand the distribution of incidents, the risks, and the benefits involved with the reallocation or reduction of resources. The cgSARVA system features include linked calendar and line graph views for analyzing data patterns and distributions. It also includes interactive filter controls for assessing case distribution loads and locations, as well as density estimation for hotspot generation, linked time slider controls for interactive temporal animation and exploration, and interactive statistical summary tools for report generation.

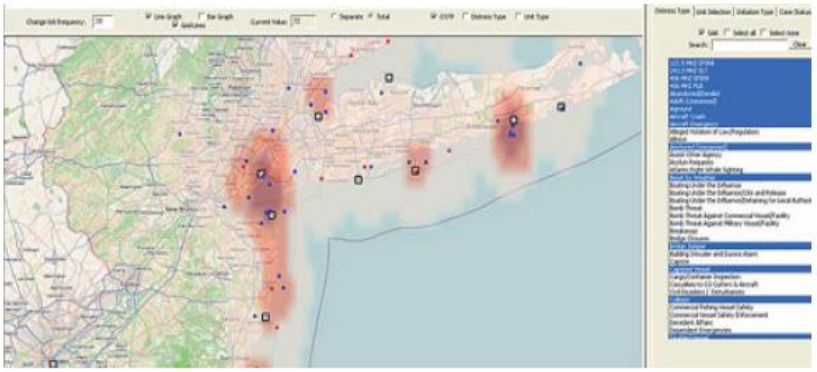
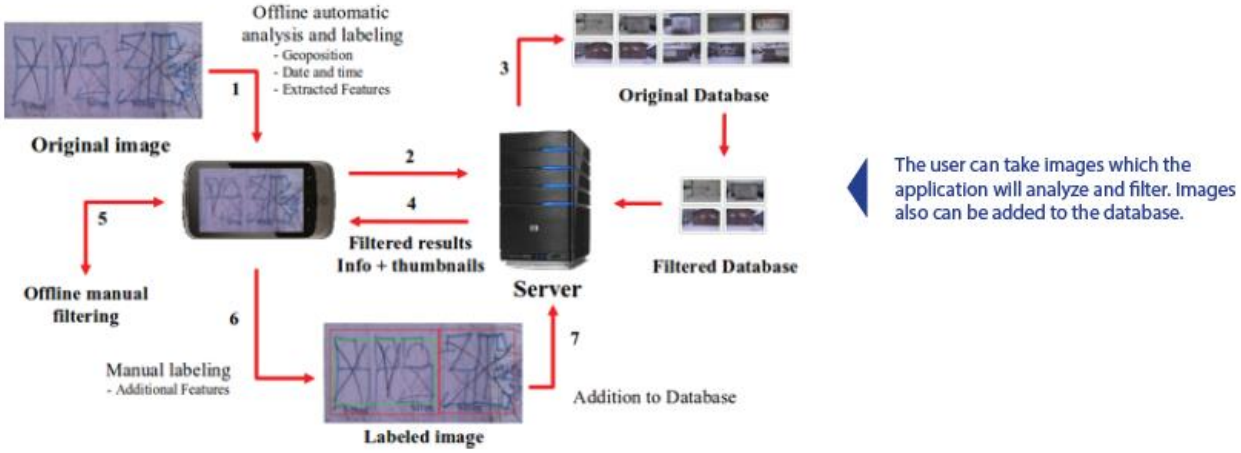


Image of cgSARVA analyzing Superstorm Sandy, and assessing how to reallocate resources in light of damage to stations in New Jersey.

cgSARVA is deployed and in use by the United States Coast Guard. cgSARVA was used successfully by the United States Coast Guard to right-size the USCG resources in the Great Lakes region, and it was used to avoid resource relocation costs following Super Storm Sandy along the eastern seaboard. It is the first DHS COE tool accredited for use by the USCG.

ii. **Gang Graffiti Automatic Recognition and Interpretation (GARI)** The lead developer was Dr. Edward Delp of Purdue University. GARI is a cell-phone and desktop based tool for gang graffiti and tattoo analysis and recognition. GARI uses image analysis techniques to identify, interpret and index gang graffiti and tattoos. The tool also uses metadata such as geoposition, date and time. Users can send images, retrieve and browse the database, and

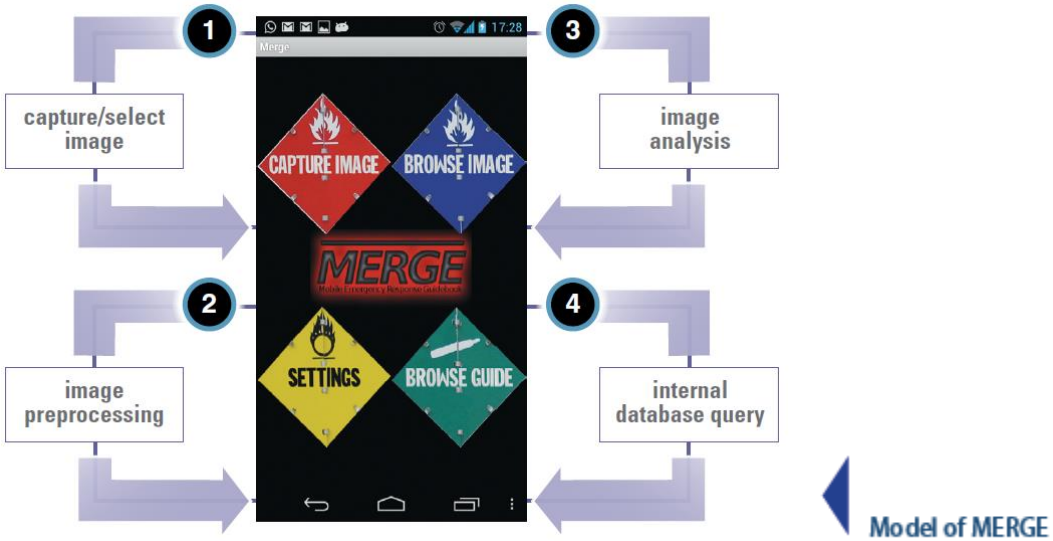
find similar graffiti/tattoos. This tattoo identification system earned a second place finish in the NIST/FBI TATT-C challenge in 2015.



GARI was deployed to the Indianapolis Metropolitan Police, Indiana Intelligence Fusion Center Gang Task Force, INGang program, Cook County Sherriff's Department, Navajo Nation, and the Illinois State Police. Additionally, a number of other law enforcement entities (approximately 400) have expressed interest in using and deploying the tool. A community version is available that functions in the same way, but only allows the user to report graffiti and does not make any information visible to the individual uploading and reporting the graffiti image. The law enforcement version of GARI has servers installed at the Indiana Intelligence Fusion Center in Indianapolis and the Cook Country Sherriff's Department in Chicago. There are currently 227 users of the system in Indianapolis, and 114 within Cook County and 17 users in Stockton, CA.

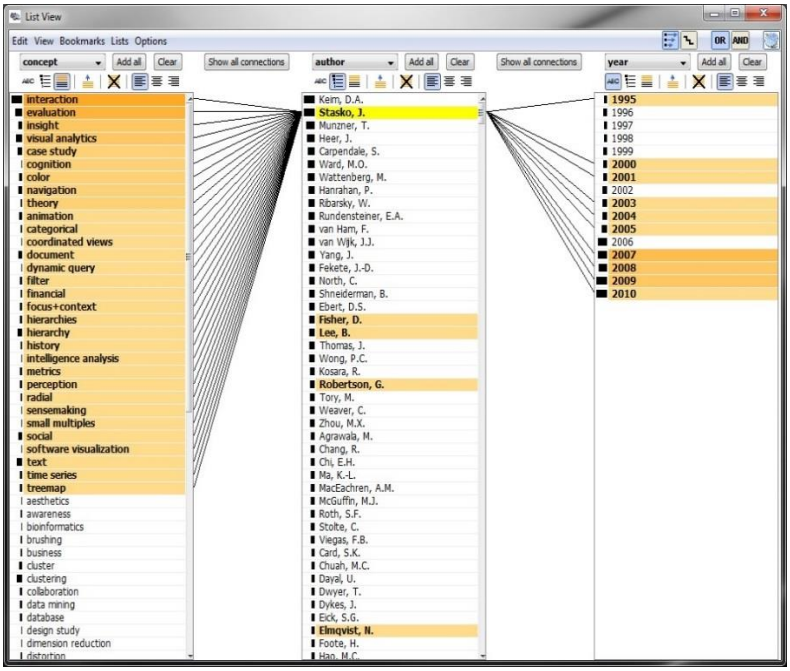
iii. **Mobile Emergency Response Guide (MERGE)** The lead developer was Dr. Edward Delp of Purdue University. The MERGE system is an electronic version of the Emergency Response Guidebook used by public safety personnel throughout the nation. Hazardous materials can react differently to stimuli and can 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 (ERG) was developed. The ERG is a ready reference to 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 Emergency Response Guidebook with many 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 has been deployed to several first responder groups and it has received very positive responses from our targeted user groups which include the Lafayette, West Lafayette, Indianapolis, and St. Clair, MI Fire Departments. MERGE was recently demonstrated to a manufacturer of detection sensors, who is interested in licensing the MERGE source code.

iv. **Jigsaw: Visual Analytics for Exploring and Understanding Document Collections** The lead developer was Dr. John Stasko of the Georgia Institute of Technology. Jigsaw is a visual analytics system developed to help investigators who 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. In one actual case, a fraud investigator in Kuala Lumpur, Malaysia reported that it was used to help resolve a $1.5 million fraud case. The system acts like a visual index in 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.



Model of Jigsaw

Jigsaw has been used by the Indianapolis Police Department, West Lafayette Police Department, Rock Hill Police Department (SC), and the Lafayette Police Department. The system is available for free download at http://www.cc.gatech.edu/gvu/ii/jigsaw. The default baseline version of the system is a Java-based desktop application. Recently, the research team also created a web-based version available at http://iilabgt.org/webjigsaw. There have been approximately 8000 downloads of the Jigsaw system in its history. It is being used in various university classes on visual analytics and intelligence analysis, and has been downloaded by a wide variety of organizations in government and industry. Examples of organizations that have downloaded Jigsaw are Air Force Intelligence, AFRL Wright Patterson, Army Counterintelligence, Boeing, Deloitte, Naval Research Lab, National Crime Information Center, PayPal, Thomson Reuters, United Nations Investigators Office, US Attorney's Office Organized Crime Taskforce, as well as numerous newspapers and police departments.

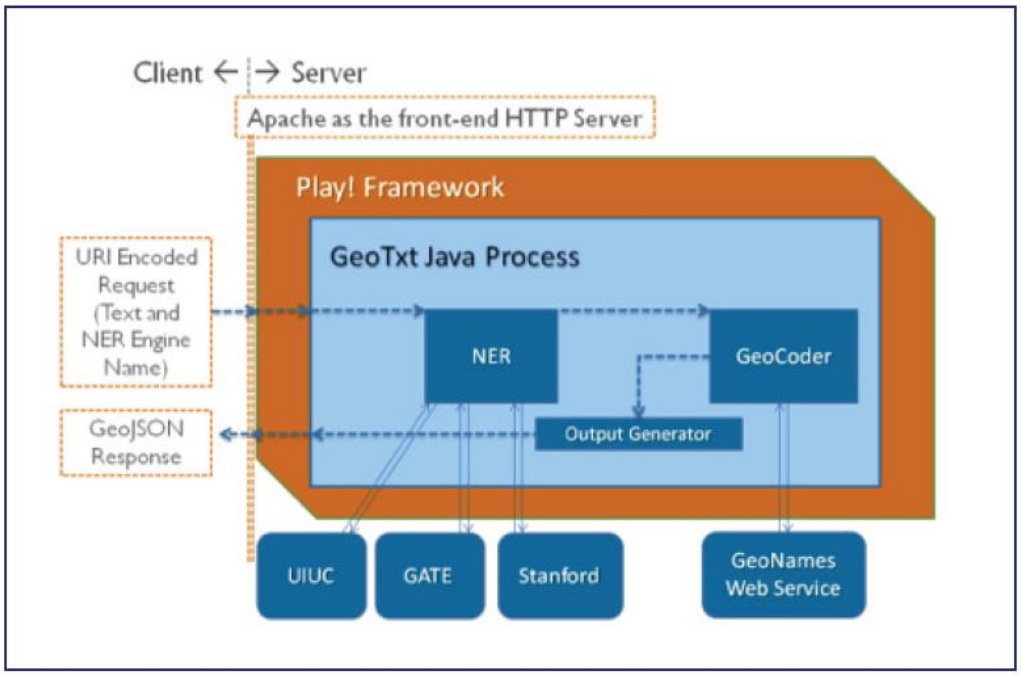
v. **Multimedia-Aided Disaster Information Integration System (MADIS)** The lead developer was Dr. Shu-Ching Chen of Florida International University. Thanks to the availability of mobile devices, emergency responders, supporting agencies and even private citizens can capture imagery of disaster events as they unfold. Once the crisis is contained, however, it's a daunting task for emergency managers to collect, organize and integrate disaster event data from multiple sources into incidence command systems where situation reports, incidence action plans, etc. are being held. MADIS uses advanced data integration and visual analysis techniques to

associate temporal, spatial and other textual features of a disaster event situation report with event images and related text annotations. This system can greatly help decision makers and emergency managers in the area to gain insight into the actual disaster situation and make quick decisions. In 2016-2017, a new component for the searching and retrieval of disaster videos that enables the system to retrieve both videos and images relevant to a specific disaster was added to the MADIS system. Moreover, situation reports which are uploaded by users will be automatically converted to the PDF format and highlighted with the defined keywords. Collaborating end-users are Federal Emergency Management Agency, Transportation Security Administration, Coast Guard, local law enforcement, and fire.

vi. **GeoTxt** The lead developer was Dr. Alan MacEachren of Pennsylvania State University. GeoTxt is a web service that enables the geolocation of places, people, and organizations described in common status updates from online social networks, as well as from other text sources such as news stories, status reports, and blog posts. It uses techniques from a wide array of research areas – applied linguistics, natural language, processing, search engine optimization, and geographic information science – to parse out places, people, and events explicitly or implicitly mentioned in text (e.g., in Twitter) and then to analyze and contextualize these entities to locate them in geographic space. The API is designed to be integrated into the development of dynamic, map-based, visual analytical interfaces, specifically in the context of crisis management and emergency response. GeoTxt also supports an associated visual web interface that enables users to extract and locate place references

vii. from individual documents submitted to the interface and to provide feedback to the system on result accuracy. The focus of work has been on building visual analytics methods and tools that support geoparsing corpus construction, application of those methods and tools to building a corpus of geoparsed tweets, and use of that corpus to train and text GeoTxt capabilities for geoparsing streaming tweets related to crisis and other events.

GeoTxt partnered with Parus Analytics (http://parusanalytics.com/), can provide geographic entity recognition, geographic disambiguation, and geo-coordinates for place references in news stories. Parsus Analytics is developing a new global event data set (PHOENIX), focused on political and related events (details at: http://openeventdata.org/datasets/phoenix/Phoenix.documentation.pdf).
GeoTxt has been integrated as the backend geographic entity recognition, disambiguation, and co-coding systems to support SensePlace 2, our spatial-temporal twitter analytics environment. The early stages of SensePlace 2 (and its precursor SensePlace) were funded through VACCINE. Current support comes from the U.S.Army Corps of Engineers, with a focus on supporting analysis of the geographic and social components of crises and other events globally. GeoTxt is now fully integrated into the dataflow pipeline of SensePlace 3 to support space-time analysis of microblog posts about natural disasters and other events relevant to security. As noted above, development for SensePlace 2, was initiated with DHS support, then subsequent work including the next phase as SensePlace 3 was supported by the U.S. Army Corps of Engineers.



The architecture of GeoTxt's application programming interface.

III. Commercialized COE Outputs

Two prominent VACCINE technologies, VALET and SMART, were licensed by Purdue in 2015 for exclusive use by Davista Technologies, LLC, a start-up company created by members of VACCINE who were integral to the development of the technologies.

a. **<u>Visual Analytics Law Enforcement Toolkit (VALET)</u>** (Figure 1) is actively in use at the following agencies:

- Lafayette Police Department (IN)
- West Lafayette Police Department (IN)
- Purdue University Police Department (IN)
- Clark County Office of Emergency Communications (IN)
- Evansville Police Departments (IN)

b. <u>Additionally, the following agencies have begun testing or deploying VALET:</u>

- Indianapolis Police Department (IN)
- Tippecanoe County Sheriff's Office (IN)
- Ohio State Highway Patrol
- Illinois State Police
- New York Police Department
- Jeffersonville Police Department

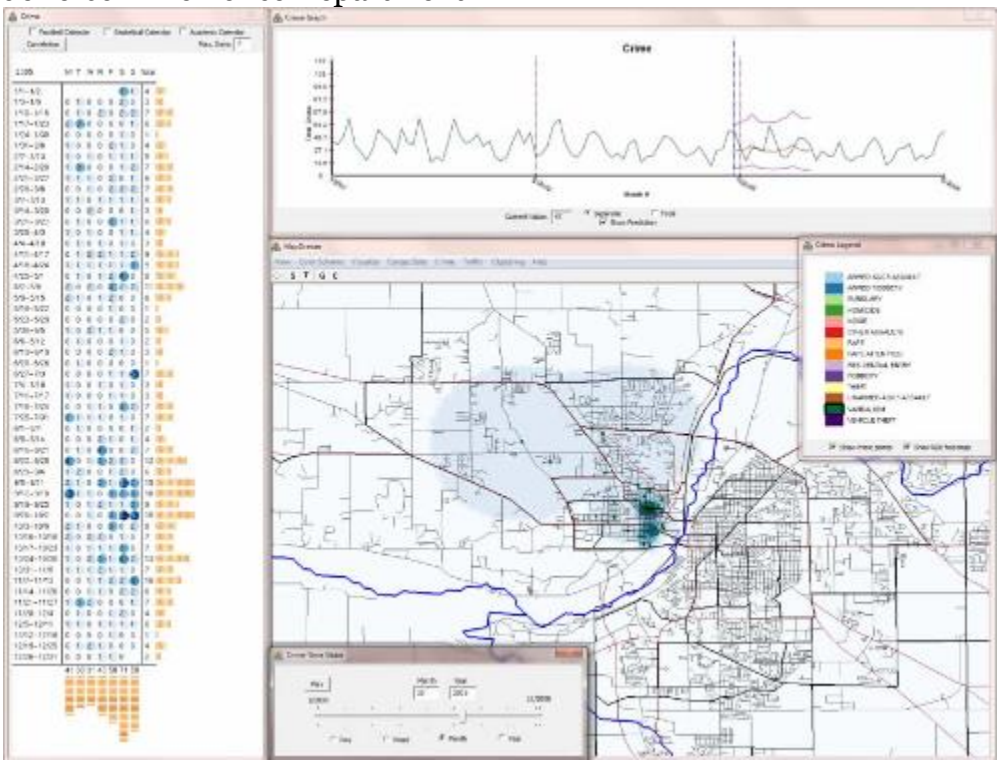


Figure 7. An example of VALET.

VALET has been utilized to devise novel data guided patrolling strategies, led to operational shifts at police departments, and supported investigative analysis. For example, VALET was crucial in the investigation of business burglaries by the Evansville Police Department.

iVALET, the mobile version, continues to be a popular option for law enforcement officers depending upon their roles and responsibilities. Additionally, a consulting firm was retained to ensure the VALET software is of commercial grade.

Currently, we are continuing to improve the predictive analytics component of VALET through input and feedback from our agency partners. This consistently iterative process optimizes VALET for field use and has led to new emergent technologies. For example, MetricVis (Figure 2) turns VALET's Record Management System databases into an Officer Experience Identification tool for the Lafayette Police Department (LPD). With MetricVis, the Chief of Police can readily identify each officer's experience with different incidents across all officers in the squad. In doing so, LPD's Chief can quickly find officers with particular expertise or skill sets.

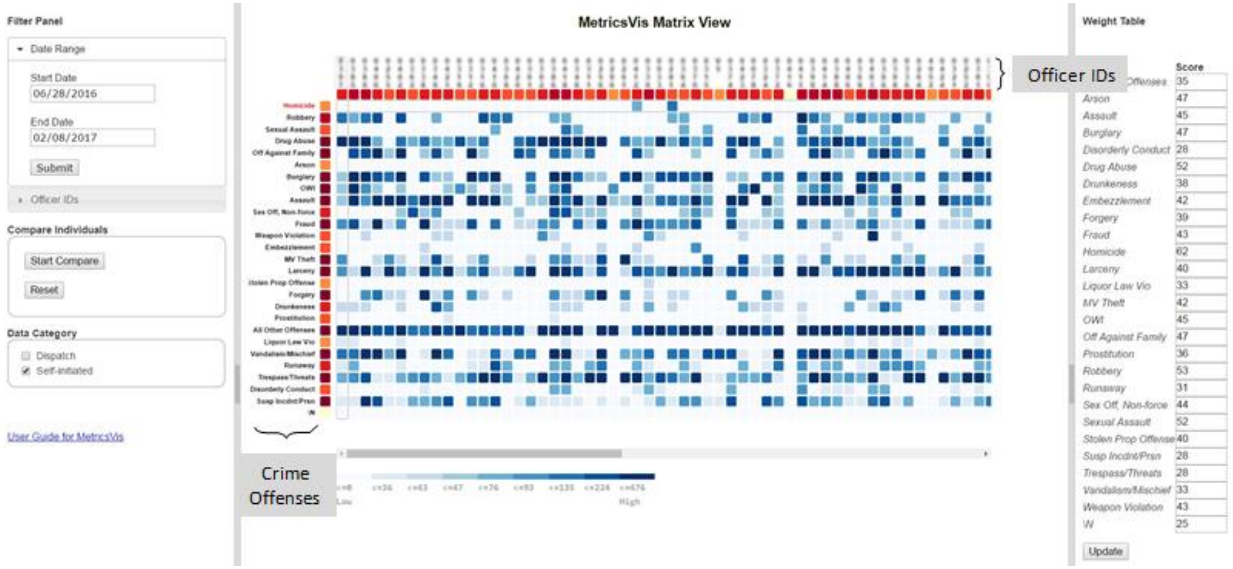


Figure 8. An example of MetricVis, an Officer Experience Identification Tool.

To transition VALET to more end users, VACCINE has licensed the technology to Davista Technologies LLC, a startup company born out of the VACCINE COE. Davista is currently developing a transition model to continue the development and commercialization efforts of the technology. These efforts have already resulted in one licensing agreement for the use of VALET in security at commercial shopping centers in the US, and have garnered interest from international police agencies (e.g., Singapore Police Force).

c. **<u>Social Media Analytics and Reporting Toolkit (SMART)</u>** (Figure 3) provides users with a scalable and interactive framework to analyze and visualize social media data (e.g., Twitter, Instagram). SMART incorporates:
   - real-time monitoring of social media channels,
   - extraction of trending and abnormal topics,
   - interactive geospatial and temporal visualizations,
   - task-tailored message categorization, and
   - dynamic filtering tools.

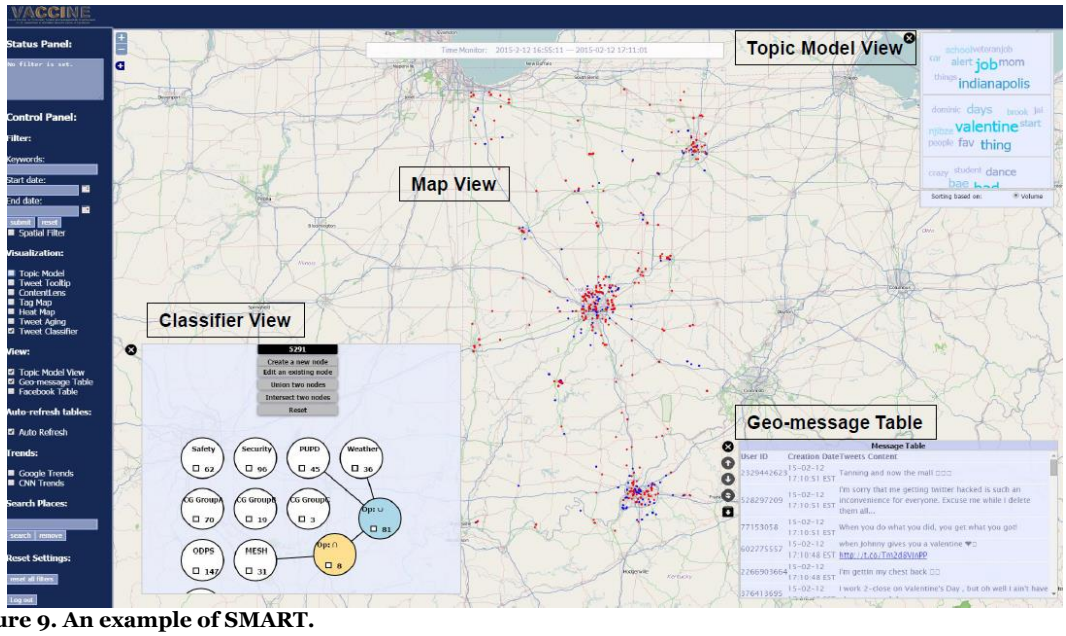


Figure 9. An example of SMART.

SMART enables data exploration and analyses across a range of local (e.g., precinct, neighborhood) to global (e.g., city, state) scales. Novel visual analytic techniques can extract and visualize crowd movement patterns and trajectories using social media data. In doing so, end users can detect anomalous and outlying patterns. SMART also provides an email alert/summary service to update end-users about topics of interest automatically.

The system functions through both a desktop application and a highly interactive and accessible web interface. SMART has been actively used by several local, state, and federal HSE organizations, including the:

- US Coast Guard
- US Customs and Border Protection (CBP)
- US Citizenship and Immigration Services (USCIS)

The US Coast Guard has utilized SMART to maintain situational awareness during several high profile events (e.g., Fleet Week, Cincinnati Riverfest, Thunder-Over-Louisville, 2017 Presidential Inauguration and Presidential Address to a Joint Session of Congress). Moreover, SMART supported the investigative analysis of hoax distress calls by Coast Guard analysts to corroborate information sources by using social media data.

The Purdue University Police and Ohio State Depart of Homeland Security have utilized SMART during their home football games, in which they have obtained actionable information to thwart potential safety and security related incidents.

Additionally, SMART was deployed at the joint Canadian-US Enhanced Resiliency Experiment (CAUSE) organized by the US DHS S&T Directorate and the Defence Research and Development Canada's Centre for Security Science (DRDC CSS). The system provided situation awareness support during the binational exercise.

Twelve law enforcement agencies and first responder groups used SMART at the Republican National Convention in July 2016 to provide actionable intelligence and early warning indicators of potential demonstrations, acts of violence, and disruptions during the event.

Most recently, VACCINE is communicating with researchers at the Queensland University of Technology in Australia to visualize and analyze social media data related to forest fires from January 2017. The findings from this work will be summarized in a report for the New South Wales Government.

SMART has also been licensed to Davista, who continues to support the existing end-user groups and is actively seeking partnerships with entities to disseminate the technology broadly.

IV. Transitions and Pilots

This section provides a narrative of the transition and piloting of VACCINE tools on an annual basis. It is intended to demonstrate the progression of the tools/technology over several years.

a. Tools/Technology

i. SMART

While working with the USCG on cgSARVA, VACCINE became aware of an emerging philosophy to improve situational awareness that was advocated by VADM Parker who was the Commander, LANTAREA. He believed that it was important to achieve shared synchronized situational awareness so that all decision-makers at every level have access to the same information at the same time. He thought that such awareness can be made possible by harnessing the tools of the information age, and social media is a critical part of this new knowledge network. They view each social media user as a "human sensor," in that each public post has the potential to provide vital information to assist them in anticipating and/or responding to an event. This led to the development of SMART.

2013-2014

The Social Media Analytics and Reporting Toolkit (SMART) was tested and used by a number of different agencies. The US Coast Guard was one of the bigger proponents for the tool – it was used at Thunder-Over-Louisville to support public safety efforts. Based upon the success of that event, it was used to examine hoax calls for the Coast Guard and to monitor Fleet

Week in San Francisco in October of 2014. SMART was also used by the Maine State Police, the Purdue Police, and the Boy Scouts of America. Additionally, other federal agencies such as CBP expressed interest in using the system.

2014-2015
SMART is used by the Ohio State Highway Patrol and a version of the tool was utilized by US Citizenship and Immigration Services (USCIS) to review the background of asylum seekers.

2015-2016
SMART was used by several local, state, and federal HSE organizations, including the US Coast Guard, US Customs and Border Protection (CBP), and US Citizenship and Immigration Services (USCIS). The US Coast Guard utilized SMART to obtain situational awareness during several of their events (e.g., Fleet Week, Cincinnati Riverfest, Thunder-Over-Louisville). The Purdue University police and Ohio State Department of Homeland Security utilized SMART during their home football games and have been able to obtain actionable information and thwart potential safety and security related incidents using the system.

SMART was deployed at the joint Canadian-US Enhanced Resiliency Experiment
(CAUSE) organized by the US DHS S&T Directorate and the Defense Research and Development Canada's Center for Security Science (DRDC CSS). The system was utilized to provide a shared situational awareness during the binational exercise.

SMART was used to support the investigative analysis of hoax distress calls by Coast Guard analysts in order to utilize social media data as another source of information. This analysis was driven by approximate locational information obtained from the Rescue 21 system.

SMART was utilized by over 12 law enforcement agencies and first responder
groups at the Republican National Convention held in Cleveland in July 2016 in order to provide actionable intelligence and early warning indicators of potential demonstrations and acts of violence or disruptions during the event.

SMART was licensed to Davista Technologies.

2016-2017
SMART was used by the Tennessee Homeland Security Intel Unit at Battle at Bristol – a football game between VA Tech and University of Tennessee at the Bristol Motor Speedway, the Oklahoma State Fair by the OK HS Intel Unit and Mira Costa College Police Department.

SMART was deployed by the National Capital Region USCG Intel Unit at the Presidential Inauguration in Jan 2017 and the Presidential Address to a Joint Session of Congress in Feb 2017.

ii. <u>VALET</u>

The idea to create VALET sprang from a question asked by the Tippecanoe County Sherriff, Tracy Brown. Tracy wanted to know how he could use the integrated county database, that consolidated police data from all four departments, to determine if they were accomplishing the goals that were submitted to and approved by the county commissioners. The Sheriff was familiar with another VACCINE tool, LAHVA, and he wondered if we could adopt some of the capabilities of LAHVA to this effort.

2010-2011
Visual Analytics Law Enforcement Toolkit (VALET) was deployed at the Lafayette, West Lafayette, and Purdue Police Departments. We worked with the Lafayette Police Department area crime analyst, Steven Hawthorne, to test, evaluate and provide feedback.

2012-2013
The Indianapolis Police Department, the Tippecanoe County Sheriff's Office, the Ohio State Highway Patrol, the Illinois State Police, and 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.

VALET is used for analysis and presentation of high-risk alcohol behavior in the Purdue campus area. Working with Purdue Student Health, Housing, EMS/Fire, and Purdue Police, a presentation was given to campus representatives at the annual Alcohol Summit held at Purdue University. The VALET output continues to be used annually for a variety of presentations and the resulting findings and analysis were

integrated into educational and enforcement programs at Purdue.

A new iPhone/iPad version of the VALET system, iVALET, is launched that provides users with a suite of interactive tools that allow them to perform analysis and detect trends, patterns and anomalies among criminal, traffic and civil (CTC) incidents. This mobile system also provides interactive risk assessment tools that allow users to identify regions of potential high risk and determine the risk at any user-specified location and time.

2013-2014
VALET & iVALET continue to be popular among police departments. New users include the Evansville Police Department, the New Albany Police Department, University of Texas-Austin Police Department, as well as the Indianapolis Public Safety leadership.

VALET received patent for the core technology.

2014-2015
The VACCINE team, via the Purdue Research Foundation, has licensed the technology to a startup company, Davista.

2015-2016
Based upon end-user feedback, system improvements continue in Year 7. One of those adjustments is the development of the Officer Performance solution to gamify the performance of police officers in Lafayette Police Department for better performance comparison and for motivating maximized performance. Additionally, VALET has been utilized to devise novel data guided patrolling strategies and has led to a paradigm operational shift at several police departments. VALET has also supported investigative analysis tasks at the departments who utilize the system. For example, the system played a critical part in the investigation of a string of business burglaries by the Evansville police department.

In the private sector, Davista is currently engaged in developing a data driven solution for a large private corporate firm for optimally allocating their safety and security related resources. Davista is leveraging the core VALET technology in the development of this solution.

2016-2017
Davista signed a contract with Simon Property Group to provide a data driven solution for allocating their safety and security resources. This revenue generating contract is a significant achievement for a VACCINE created technology.

iii. cgSARVA

The concept of cgSARVA was begun when a member of the USCG Research Development Center staff, Joe DiRenzo, asked if VALET could be adapted to look at Search and Rescue (SAR) cases. RDML Mike Parks, Commander of USCG 9th District, wanted to better understand the workload associated with SAR cases in the Great Lakes. Furthermore, he wanted to analyze the balance of workload between Coast Guard Auxiliary personnel and USCG stations in an effort to determine the impact of closing a USCG station.

2010-2011
Developed and deployed the Coast Guard Search and Rescue Visual Analytics (cgSARVA) technology to the Operations and Planning division of the USCG as well as District 9 Headquarters. The cgSARVA technology provides a detailed visual analytics model that allows a thorough assessment and analysis of the Coast Guard's Search and Rescue mission on the Great Lakes.

2011-2012
The cgSARVA technology was utilized to analyze swimmer deaths and provided information for the Coast Guard swimmer and boating safety public information campaign in 2011. Additionally, the cgSARVA analysis was an input to determine the number of patrols used in 2011, leading to a significant decrease in deaths in 2011.

cgSARVA was used to determine the allocation of resources during Hurricane Irene which occurred along the east coast in the summer of 2011. The Coast Guard initially discussed diverting resources from the Great Lakes area to the east coast, but the data from cgSARVA indicated that there was a demonstrated need to keep the Great Lakes region fully resourced at that time and to draw the resources from another region.

cgSARVA was used to analyze the effects of closing Port Arthur, TX in 2011, including the economic impact and the effectiveness of alternative mitigation strategies.

cgSARVA was also used to avoid resource relocation costs following Super Storm Sandy along the eastern seaboard in

2012. The output from cgSARVA demonstrated that the number of anticipated SAR missions would be low because of colder fall/winter temperatures and the number of private boats damaged during the storm. Although the USCG's ability to respond was diminished due to the storm damage, the requirement for SAR response was also lower. cgSARVA demonstrated that a lower cost solution was possible instead of a major shift of USCG assets from other regions.

2012-2013

The United States 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 Headquarters by Rear Admiral Lee on April 22nd of 2013.

2013-2014

cgSARVA was featured in the DHS S&T pilot Center of Excellence Virtual Technology Showcase.

2014-2015

cgSARVA was deployed for official agency-wide use.

iv. GARI

After participating in a MERGE demonstration, the Purdue Police Chief wanted to know if a tool could be created to recognize gang graffiti in the same manner that MERGE recognizes HAZMAT placards

2011-2012

GARI was initially deployed.

GARI was used by the Indianapolis Metropolitan Police, the Indiana Intelligence Fusion Center Gang Task Force and gang detectives across Indiana (fall 2011). During this year, there were currently approximately 30 users and nearly 700 graffiti images within the GARI database.

2012-2013

GARI 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.

2013-2014
There were 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. The tool can also handle tattoo images of gang related content.

2014-2015
There were 222 users of the system in Indianapolis, and 113 within Cook County. There are an additional 70 or so users testing from our own server and over 6,078 images have been collected and uploaded.

2015-2016
GARI system finished second in the NIST/FBI TATT-C challenge in 2015. There are currently 227 users of the system in Indianapolis with 3682 images, and 114 within Cook County with 6332 images and 17 users in Stockton, CA with 568 images.

v. MERGE

After speaking with several first responders groups, it was brought up that a tool to recognize HAZMAT placards would be very useful.

2011-2012
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 also used in an exercise with Carroll County Emergency Management (IN) personnel which demonstrated that first responders could identify the appropriate response protocol much more quickly using MERGE than the standard emergency response guidebook.

vi. JIGSAW

After participating in some "Solve the crime" exercises at the initial NVAC visual analytics research agenda workshops, John Stasko and others believed that a visual presentation of relevant text documents could help investigators to put the pieces together from many different threads of evidence.

2010-2011
A new release of the system was created and distributed to people and organizations who want to use it. To accompany the system, we created new tutorial videos that illustrate usage of the different components of the system, as well as improved written tutorial documentation. We have a growing and wide-ranging client set now and we continue to work on expanding this.

2011-2012
JIGSAW was deployed at the Indianapolis Police Department, the West Lafayette Police Department and the Lafayette Police Department. We worked with the Lafayette Police Department area crime analyst, Steven Hawthorne, to test, evaluate and provide feedback.

2012-2013
The development and distribution of the Jigsaw visual analytics system was continued. This year, Jigsaw was launched on the web where anyone can download it for free. We support the system with big fixes and new releases, and the project website includes a manual, tutorial videos to help with learning and using it, and example document collections. Over 150 people and organizations downloaded the system, including Air Force Intelligence, AFRL Wright Patterson, Army Counterintelligence, Associated Press, Boeing, Deloitte, DHS-ICE, Naval Research Lab, NCIS, NY Times, PayPal, SIGTARP, Thomson Reuters, United Nations Investigators Office, US Attorney's Office Organized Crime Taskforce, as well as numerous newspapers and police departments. We worked with police departments in West Lafayette and Lafayette, IN and Rock Hill, SC to use the system in investigations. One fraud investigator in Malaysia reported that it assisted in resolving a 1.5 million dollar fraud case.

2013-2014
We have had about 3000 downloads of the Jigsaw system now. People from the following organizations reported downloading it: DHS, FBI, IBM, Intel, Italian Police Dept., Kansas Attorney General's Office, MITRE, NYPD, Oak Ridge National Lab, Pfizer, US Army, and US Air Force.

2014-2015
We have had over 5000 downloads of the Jigsaw system now. People from the following organizations downloaded the system over the past year: Autodesk, Center for Disease Control and Prevention, Police Luzern, NSF, Netherlands Defence Academy, Deloitte, Oracle, DC Public Schools, Shreveport Police Dept., Chick-fil-A, Tableau.

2015-2016

We have had approximately 7000 downloads of the JIGSAW system in its history. It is being used in various university classes on visual analytics and intelligence analysis and has been downloaded by a wide variety of organizations in government and industry.

vii. MADIS

After meeting with Miami-Dade County office of Emergency Management, they said that it is a daunting task for emergency managers to collect, organize and integrate disaster event data from multiple sources into incidence command systems where situation reports, incidence action plans, etc. are being held. Therefore, we developed the Multimedia-Aided Disaster information Integration System (MADIS), which uses advanced data integration and visual analysis techniques to associate temporal, spatial and other textual features of a disaster event situation report with event images, videos and related text annotations.

2010-2011

An iPad application based on Florida International's —Integration Framework for Enhancing Emergency Response system has been developed and presented to the personnel at Miami-Dade Emergency Management (MDEM), where an evaluation activity regarding the developed application was successfully conducted. MDEM has expressed interest for FIU to further develop the system into an operational pilot.

2013-2014

In collaboration with VACCINE and the Miami-Dade County Department of
Emergency Management, DITRG (Disaster Information Technologies Research Group at Florida International University) has produced a tool known as the **Multimedia Aided Disaster Information Integration System (MADIS)**. This tool, which was successfully demonstrated 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.

An improved prototype system and iPad application based on Florida International's Integration Framework for Enhancing Emergency Response system was evaluated by personnel at Miami-Dade Emergency Management (MDEM), and future pilot activities are planned as part of the evaluation process.

2015-2016
This year, a new component for the searching and retrieval of disaster videos was added to the MADIS system, which enables the system to retrieve both videos and images relevant to a specific disaster. Additionally, situation reports which are uploaded by users will be automatically converted to the PDF format and highlighted with the defined keywords.

viii. <u>vBOLO</u>

Video "Be on the Look-out" was suggested by a retired TSA/Secret Service Senior Executive, Mike Young, based upon a need that he uncovered while consulting with the Greater Cleveland Regional Transit Authority.

2013-2014
VACCINE proposed and kicked off a collaborative project with the **ALERT** (another DHS COE) team to explore an electronic BOLO (be on the lookout – known as **EBolo**) system. The test bed for the project is Cleveland's light rail system. As Cleveland will be hosting the next Republican National Convention, having a system in place that can re-identify persons of interest entering a public transportation system could prove quite useful.

Name of project was changed to vBOLO to prevent confusion with disease, Ebola, that spread to the US in Oct.-Nov. 2014.

2015-2016
The first phase of the project demonstrated the potential effectiveness of computer-vision-based re-identification, but also indicated areas where more research or better physical infrastructure was required. The current vBOLO system can find the correct person in a lineup of 10 automatically-detected candidates 90% of the time for one camera. CVADA-Purdue and ALERT expect to improve performance of vBOLO to find the correct person in a lineup of five candidates 95% of the time. This would involve the addition of high resolution video, facial analysis, motion features, improved body features, and subject attributes.

No additional funds were provided/available to deploy the system to Cleveland Regional Transit Authority.

ix. <u>VASA</u>

The DHS Program Manager, Joe Kielman, requested VACCINE develop a tool to enable reasoning and action on the nation's integrated infrastructure – how to prevent cascading critical

infrastructure failure. This effort was part of a joint project that was associated with a treaty signed by the US and Germany.

2009-2010
VASA launched.

2010-2011
VACCINE is finalizing plans for a joint United States-Germany research project to apply visual analytics to disaster prevention and crisis response, with a focus on critical infrastructures in logistics, transportation, food safety, digital networks and power grids at the national levels. This project is in collaboration with several international partners, NVAC, and NCFPD.

2012-2013
The Charlotte Visualization Center created the "VASA Project Debrief" presentation. These updates included finishing 144 Cascading Simulations using cross-cutting Infrastructures (pre-food network), completing the first 48 inserting additional 8 Historical Hurricane Paths for comparative analysis and initiating R&D on the "Resiliency Index." Various visuals displayed the visualization of the interface and a map of each area.

x. PANVIS

The research scientists at VACCINE wanted to know if they could take their syndromic surveillance software and convert it into a tool for a CDC pandemic preparedness grant to train officials and evaluate alternatives.

2009-2010
VACCINE developed an interactive pandemic preparedness, surveillance, and training tool for the Indiana State Department of Health and adapted this tool for use by the State of Washington, New Jersey, and New York. This has been used for all health districts in Indiana and at least two county exercises in the state of Washington.

2010-2011
Expanded public health surveillance activities from Indiana to Pakistan with funding from the Nunn-Lugar act.

xi. Chicago LTE Project

LTE was initiated from DHS S&T.

2015-2016

The goal of this project was to test the viability and performance of the LTE National Public Safety Broadband Network (NPSBN) with respect to transport of video imagery. One cell using the NPSBN was installed in Chicago at the Chicago Police Department District 7. We conducted a test plan to characterize the performance of the network and analyzed the data collected. Based on the analysis of the data collected during our testing it was concluded that a PSBN LTE network provides an unprecedented opportunity to increase the capacity and to meet the needs and requirements of public safety with respect to video delivery. This test concluded that careful analysis should be used for Quality of Service (QoS), prioritization, and Radio Frequency (RF) planning when designing a NPSBN LTE system. It was also noted that adaptive video coding methods, used in many video systems, might not suit public service operational scenarios.

V. Education Initiatives

Overview

At the core of VACCINE's mission is educating current homeland security stakeholders and the next generation of talent. Our educational initiatives begin in high school and continue through professional development. We empower future homeland security professionals to harness the power of visual analytics and advanced computational tools and enable them to make effective decisions from the mass amount of data they will face in their careers. In addition to the broader mission of educating Homeland Security Stakeholders, VACCINE actively engaged Minority Serving Institutions (MSI) in the research and education initiatives. As a result we partnered with Jackson State University, Morgan State University, Florida International University, Bethune-Cookman University, Prairie View A&M University, California State University-Dominguez Hills, University of Houston, Downtown, and Navajo Technical University.

a. Education Programs

i. Undergraduate

1. Summer Undergraduate Research Fellowship Program (SURF)

The core of the Purdue SURF program is to provide students across engineering, science and technology disciplines a research experience with real-world applications. On the Purdue campus each summer, SURF brings undergraduate students into state-of-the-art research laboratories, teams them with a faculty

member and graduate student mentor, and introduces them to the research tools used on the cutting edges of science, engineering, and technology. By working closely with other creative and innovative people, students explore, discover and transform ideas into reality to advance society and improve people's lives. The interdisciplinary nature of discovery allows students to apply the concepts and skills from their own programs, contribute to interdisciplinary projects, and prepare for real-world environments. The campus setting also provides undergraduate students with an avenue to advance research in an academic environment and explore graduate study options in the process. In addition to the overall benefits of the SURF program, working in the VACCINE lab also introduces the students to the opportunities and challenges in homeland security fields. Over the last eight years, there have been 37+ students enrolled in the SURF program. The application process is open to Purdue students and undergraduate students enrolled at U.S. colleges and universities.

2. **MSI Partner Morgan State University Undergraduate Workshop on Visual Analytics**

As part of a continued effort to support the Minority Serving Institutions/Historically Black Colleges and Universities partnerships, VACCINE hosts undergraduate students from Morgan State University and Jackson State University for a weeklong summer boot camp on visual analytics, including an immersive experience at the VACCINE lab. Faculty and student-led demonstrations of our tools and technology give students an opportunity to gain hands-on experiences with VACCINE resources. There have been over 30 undergrad participants from MSI partner universities.

ii. **Graduate**

1. **HS-STEM Career Development Program**

This program is designed to support graduate students in developing the skills to become preeminent scientists in the homeland security and technical communities. Funded by the U.S. Department of Homeland Security, this program offers career development scholarships/fellowships, loans with summer research opportunities and one-year service commitments. Awards are provided to full-time graduate students with a research focus in the

visualization and data sciences and HS-STEM fields. So far, 22 students have been recipients.

Where some of our students have gone on to work:

CDC • Defense Cyber Crime Institute • Department of Energy • Epic Healthcare Systems • MIT Lincoln Lab • RAND Corporation • Trustwave • U.S. Department of Homeland Security

2. Research Assistants

There have been over 82 Purdue research assistants and over 170 at partner universities.

Where our research assistants are working now:

Adobe • Amazon • Apple • Bloomberg • ESRI • Facebook • GE • General Motors • Google • Intel Corporation • Microsoft • NSA • PROGNOS INC • Samsung • Siemens Healthineers • Tableau • Target

iii. **Visual Analytic Related Curriculum**

The VACCINE Center and Purdue are committed to sharing our gained knowledge with other institutions of higher learning. We collaborated with multiple partner universities to deliver various courses in areas related to visual analytics, including visualization techniques, geospatial intelligence, data management and data mining. There are now over 31 related curriculum between Purdue and partner universities

iv. **Educating the Next Generation of Talent through K-12 Outreach Programs**

For the past several years, VACCINE engaged with a local high school to provide students with the foundational knowledge in visual and big data analytics necessary to promote and encourage postsecondary schooling. High school students received an up-close look at the global impact our tools and applications can offer first responders and the Department of Homeland Security Enterprise. Two hundred students from Lafayette Jefferson High School have visited VACCINE. Additionally, VACCINE created a Visualization and Data Analysis workshop for over 29 middle school and high school teachers across Indiana, which led to the development and implementation of classroom learning modules that met the guidelines of the Indiana Statewide Testing for Educational Progress (ISTEP) program.

b. Professional Development

i. **Visual Analytics MSI Faculty Training Workshops**

Since 2013, VACCINE has continued to support Minority Serving Institution (MSI) initiatives by providing an education program to expand the teaching of visual analytics at MSIs. The program focuses on preparing MSI faculty to incorporate visual analytics courses into their programs. Topics and activities in the workshops focus on understanding the theory and foundation of visual analytics; integrating visual analytics into course curriculum; developing learning communities for interdisciplinary courses; hands-on instructor-supported tutorials on extracting various forms of big data; and a unique group-designed application learning assignment. There have been 90 plus total MSI faculty participants since the start of the program in 2013. Jackson State University, Morgan State University, Bethune-Cookman University, Florida International University and Prairie View A&M University were all hosts/facilitators of these workshops.

ii. **VACCINE and the U.S. Air Force Academy Faculty Training Workshop**

This workshop created a network of collaborators who understand the need to develop and educate the Department of Defense and Department of Homeland Security personnel on the value of visual analytics. It is anticipated that analysts and decision-makers will place an increased emphasis on predictive analytics and the visualization of data in the future. Visualization, specifically, will become a more important skill and tool for analysts. In fact, analysts and decision-makers will stop viewing static displays of data in presentations and start interacting with data "live" in a visual format. As a result, there is a need to understand and educate undergraduates on visual analytics.

Approximately 10 Air Force Academy faculty and four U.S. Coast Guard faculty attended the workshop. The workshop included an introduction to visual analytics followed by group discussions that were led by VACCINE researchers with the intent of developing outlines for visual analytic teaching modules. These modules will be designed so an instructor can easily adopt them for a one- or two-lesson sequence in their course. The design of the modules also will be flexible enough to be used in a wide range of disciplines such as mathematics, management, computer science and political science.

iii. **VACCINE and American Military University (AMU) Webinar Series**

Launched in 2015, and in collaboration with American Military University, VACCINE presents a webinar series with a primary focus on topics related to homeland security technology and research. There have been over 500 participants registered since the start. The webinar series is a launching platform for discussions about problems, challenges and solutions related to keeping our country safe. Eight webinars have been hosted since 2015. The webinars are conducted in coordination with the framework of the National Conversation on Homeland Security Technology, that was created by the Department of Homeland Security Science and Technology Directorate (DHS S&T).

iv. Summer Research Team Program for Minority Serving Institutions

To engage faculty and students from Minority Serving Institutions (MSI) with the science of visual analytics, VACCINE offers summer research opportunities that allow students and faculty to conduct research on campus at our Center of Excellence. The program is designed to provide research opportunities to increase and enhance the scientific leadership at MSIs in research areas that support the mission and goals of the Department of Homeland Security (DHS). VACCINE has hosted students and faculty from Prairie View A&M University, the University of Houston, and Texas A&M University-Kingsville.

v. Summer Research Team Program for Federal Service Academies

The Department of Homeland Security Science and Technology Directorate and the Department of Defense partnered to create a program that fosters a research environment for future military leaders. The program is exclusive to DOD faculty, rising senior cadets and midshipmen. VACCINE hosted a team of three cadets from the United States Air Force Academy.

c. Impact of VACCINE Education Initiatives

Over the last eight years, VACCINE has utilized innovative programs to educate current homeland security stakeholders and the next generation of talent in effective development and use of visual analytics systems. In total, we've reached hundreds of students across key demographics — from high school to professional development. Through this work, we have built a

diverse, highly capable, and technical workforce for the Department of Homeland Security enterprise.

VI. Recommendations and Lessons Learned

a. Overview

During the eight (8) years that VACCINE was a DHS COE, many lessons were learned regarding the most effective method to develop technologies that could quickly impact DHS components. Some of those lessons are summarized below along with recommendations.

i. **COE project delays and personnel retention issues can be minimized by accurate financial projections and timely funding distribution.** We recognize that DHS S&T funding is subject to congressional and internal DHS budget processes, so the purpose of this paragraph is to document the impact on COEs, while acknowledging that OUP has little ability to change this issue. As an example of one case in which a lack of funding prevented a technology transition "break-out," we were unable to enter GARI into the NIST gang tattoo recognition evaluation in the fall of 2017 because resources were not available. The evaluation required the software to be converted to C++, however, due to a lack of funding the graduate students supporting GARI were moved to other projects a year earlier. A satisfactory evaluation by NIST would have led to GARI being placed on list of products cleared for use by the FBI.

ii. **Semi-annual conferences/meetings with the COE leadership leads to greater collaboration.** Annual or semi-annual meetings are a great venue to exchange ideas, to build relationships/partnerships and to plan collaborations. Although there is an expense associated with these gatherings, it may be less expensive than redundant or uncoordinated research, education initiatives or technology development. There seems to be a spirit of collaboration that is accelerated by gathering people together that cannot be duplicated by a "University Programs" website or monthly director's conference call or video teleconferencing.

iii. **Proposal cohesion and alignment is better maintained when proposals are awarded as a unified group.** While the rationale to initiate projects based upon component capability gaps is sound, those capability gaps should be a part of the original RFP. Piece matching the initiatives from several proposals to fine tune an award to a set of capability gaps leads to a lack of overall program cohesion when the direction is applied after a proposal is developed. It would be less disruptive to the workflow if the decision was made before the proposal was published.

iv. **Continue project competitions.** Under the leadership of the VACCINE Director, Dr. David Ebert, the staff conducted quarterly reviews of research projects to ensure that projects meet their milestone targets. Projects that could not be transitioned to tools for end-users were discontinued and competitions were conducted to initiate new projects.

v. **Encourage the use of Public Safety/Customer forums**. Our strong partnership with our stakeholder community has been key to VACCINE's success. In 2010, VACCINE created a Public Safety Consortium with the goal of connecting homeland security researchers with the first responder community. Understanding the requirements of our end-users is key to the research and development of technologies that can be transitioned to the broader public safety community. The Consortium consists of local and regional law enforcement, fire, and emergency management agencies, that allow data to be shared and research conducted furthering the development of next generation homeland security technologies. The Consortium also provides a framework where VACCINE can deploy its tools to the various agency members, and our end-users provide in-field or real world evaluation feedback on their requirements. More importantly, quarterly meetings with the group on developing topics of interest provide the impetus and requirements for new projects and research directions and help establish partnerships and user-engagement from day one. We have taken a similar continual engagement from day one approach with our regional and national level stakeholders, utilizing frequent conference calls and regular visits to enable successful engagement. VACCINE often hosts agency personnel to enable effective work or has VACCINE personnel spend several days to a week working on-site, then continue development remotely with periodic visits.

vi. **A Webinar Series is a great method to engage a broad range of HSE professionals and students.** The VACCINE Center and American Military University (AMU) have collaborated to present a quarterly webinar series. The webinars are conducted in coordination with The National Conversation on Homeland Security Technology that was created by the Department of Homeland Security Science and Technology Directorate (DHS S&T). Each webinar is co-presented by a VACCINE Center Principle Investigator and AMU faculty member, and focuses on a specific structured dialogue topic related to homeland security technology in an effort to get people talking about problems, challenges, and solutions to keep our country safe.

vii. **Adopt a user centered approach to transition research into practice**. One of the major reasons for our success with

viii. transitioning our research into practice has been due to our agile research and development methodology and our efforts in nurturing strategic partnerships with our end-user groups. Our R&D efforts for many of our projects at the VACCINE center usually began with discussions with the key leadership of the organization in order to determine both short term and long term strategic goals for the project. This was critical in order to ensure that the problem set identified was not at a small or local scale, but instead could be applicable to a wider domain. The other aspect in our success with transition was developing relationships with the analysts and domain experts in the organization who would use the solution on a regular basis. Our strategy was to identify their pain points and develop a user centered solution that further aligned with the long term strategic vision for the project. We found applying this user centered approach to be effective in the eventual adoption of the technology at the larger organizational level as these end-users would often act as ambassadors for the solution in their specific organization. We adopted an agile R&D strategy that allowed us to be flexible in order to accommodate for any pivots that were necessary in the development process based on the dynamic end-user needs and also helped us establish a rapport with our end-users.

ix. **Low profit margins on public safety products present a challenge when attempting to commercialize solutions.** Many of the solutions developed at the VACCINE center have been designed to target the needs of the law enforcement and first responder groups (e.g., Jigsaw to support investigative analysis of document collections; VALET to enable visual analysis of criminal, traffic, and civil data; GARI to allow investigators to translate the meaning of gang graffiti; and SMART to investigate dynamic trends from unstructured social media data). In the pursuit of determining sustainable transition strategies for these solutions, our center has engaged in numerous discussions with government and corporate organizations. The main challenges that we have encountered in these discussions for commercializing and licensing these technologies include a relatively small size of the total addressable market segment (especially for the first responder and law enforcement market), difficult sales cycle for this market, and difficult exit market strategies due to the diverse nature of the competition in this market space. However, our market research has shown the potential for these technologies to be of much broader scope that can be extended into other market segments. With this in mind, several VACCINE management personnel have jointly formed a startup company named Davista Technologies and licensed the VALET and SMART technologies in order to explore generalizing the solutions and pursue commercialization efforts for the broader market segments.

VII. Aggregate Metrics for the Award

Totals - Yrs. 1-8	
Categories of Accomplishments	7/1/2009 through 08/31/2017 : (Number/Amount; numbers only)
Student Enrollment in COE Programs:	
Traditional undergraduate and graduate students attending classes	4442
Students registered in on-line or other distance learning courses	0
Homeland security professionals attending courses	0
COE Funded Students	400
Papers	1007
Software Products Developed	92
New Courses Developed	7
New Certificates or Degree Programs Developed:	0
New Degree Programs	11
New Certificates	1
New private or public licencees/partners using coursework licensed by the COE	0
Patent Applications	7
Patents Awarded	14
Requests for assistance or advice from DHS (# of different DHS contacts/projects/requests)	96
Requests for assistance or advice from Federal, State, Local Government	618
Follow-on funding from other sources	13306132
Presentations	343
Congressional Testimonies	0
Projects Completed	33
Collaborative Projects	5

Totals - Yr. 1	
Categories of Accomplishments	07/01/2009 - 03/31/2010 : (Number/Amount; numbers only)
Student Enrollment in COE Programs:	
Traditional undergraduate and graduate students attending classes	
Students registered in on-line or other distance learning courses	
Homeland security professionals attending courses	
COE Funded Students	28
Papers	54
Software Products Developed	
New Courses Developed	
New Certificates or Degree Programs Developed:	
New Degree Programs	
New Certificates	
New private or public licencees/partners using coursework licensed by the COE	
Patent Applications	
Patents Awarded	1
Requests for assistance or advice from DHS (# of different DHS contacts/projects/requests)	
Requests for assistance or advice from Federal, State, Local Government	
Follow-on funding from other sources	
Presentations	28
Congressional Testimonies	
Projects Completed	
Collaborative Projects	

Totals - Yr. 2	
Categories of Accomplishments	4/1/2011 through 03/31/2011 : (Number/Amount; numbers only)
Student Enrollment in COE Programs:	
Traditional undergraduate and graduate students attending classes	
Students registered in on-line or other distance learning courses	
Homeland security professionals attending courses	
COE Funded Students	55
Papers	113
Software Products Developed	
New Courses Developed	
New Certificates or Degree Programs Developed:	
New Degree Programs	
New Certificates	
New private or public licencees/partners using coursework licensed by the COE	
Patent Applications	
Patents Awarded	3
Requests for assistance or advice from DHS (# of different DHS contacts/projects/requests)	
Requests for assistance or advice from Federal, State, Local Government	
Follow-on funding from other sources	9088825
Presentations	63
Congressional Testimonies	
Projects Completed	
Collaborative Projects	

Totals - Yr. 3	
Categories of Accomplishments	Cumulative through 06/30/2016 : (Number/Amount; numbers only)
Student Enrollment in COE Programs:	
Traditional undergraduate and graduate students attending classes	254
Students registered in on-line or other distance learning courses	
Homeland security professionals attending courses	
COE Funded Students	56
Papers	406
Software Products Developed	16
New Courses Developed	3
New Certificates or Degree Programs Developed:	
New Degree Programs	2
New Certificates	0
New private or public licencees/partners using coursework licensed by the COE	
Patent Applications	2
Patents Awarded	2
Requests for assistance or advice from DHS (# of different DHS contacts/projects/requests)	11
Requests for assistance or advice from Federal, State, Local Government	43
Follow-on funding from other sources	1288677
Presentations	43
Congressional Testimonies	0
Projects Completed	
Collaborative Projects	

Totals - Yr. 4	
Categories of Accomplishments	4/1/2012 through 06/30/2013 : (Number/Amount; numbers only)
Student Enrollment in COE Programs:	
Traditional undergraduate and graduate students attending classes	188
Students registered in on-line or other distance learning courses	0
Homeland security professionals attending courses	0
COE Funded Students	70
Papers	294
Software Products Developed	16
New Courses Developed	0
New Certificates or Degree Programs Developed:	
New Degree Programs	1
New Certificates	0
New private or public licencees/partners using coursework licensed by the COE	0
Patent Applications	1
Patents Awarded	0
Requests for assistance or advice from DHS (# of different DHS contacts/projects/requests)	24
Requests for assistance or advice from Federal, State, Local Government	31
Follow-on funding from other sources	611190
Presentations	61
Congressional Testimonies	0
Projects Completed	13
Collaborative Projects	

Totals - Yr. 5	
Categories of Accomplishments	7/1/2013 through 06/30/2014 : (Number/Amount; numbers only)
Student Enrollment in COE Programs:	
Traditional undergraduate and graduate students attending classes	2281
Students registered in on-line or other distance learning courses	
Homeland security professionals attending courses	
COE Funded Students	66
Papers	61
Software Products Developed	27
New Courses Developed	2
New Certificates or Degree Programs Developed:	
New Degree Programs	7
New Certificates	1
New private or public licencees/partners using coursework licensed by the COE	0
Patent Applications	0
Patents Awarded	2
Requests for assistance or advice from DHS (# of different DHS contacts/projects/requests)	44
Requests for assistance or advice from Federal, State, Local Government	442
Follow-on funding from other sources	1418104
Presentations	76
Congressional Testimonies	0
Projects Completed	7
Collaborative Projects	3

Totals - Yr. 6	
Categories of Accomplishments	7/1/2014 through 06/30/2015 : (Number/Amount; numbers only)
Student Enrollment in COE Programs:	
Traditional undergraduate and graduate students attending classes	495
Students registered in on-line or other distance learning courses	
Homeland security professionals attending courses	
COE Funded Students	37
Papers	41
Software Products Developed	17
New Courses Developed	
New Certificates or Degree Programs Developed:	
New Degree Programs	1
New Certificates	
New private or public licencees/partners using coursework licensed by the COE	
Patent Applications	2
Patents Awarded	6
Requests for assistance or advice from DHS (# of different DHS contacts/projects/requests)	5
Requests for assistance or advice from Federal, State, Local Government	50
Follow-on funding from other sources	759336
Presentations	34
Congressional Testimonies	
Projects Completed	7
Collaborative Projects	

Totals - Yr. 7	
Categories of Accomplishments	7/1/2015 through 06/30/2016 : (Number/Amount; numbers only)
Student Enrollment in COE Programs:	
Traditional undergraduate and graduate students attending classes	612
Students registered in on-line or other distance learning courses	0
Homeland security professionals attending courses	0
COE Funded Students	44
Papers	19
Software Products Developed	8
New Courses Developed	1
New Certificates or Degree Programs Developed:	
New Degree Programs	0
New Certificates	0
New private or public licencees/partners using coursework licensed by the COE	0
Patent Applications	1
Patents Awarded	0
Requests for assistance or advice from DHS (# of different DHS contacts/projects/requests)	6
Requests for assistance or advice from Federal, State, Local Government	26
Follow-on funding from other sources	70000
Presentations	19
Congressional Testimonies	0
Projects Completed	3
Collaborative Projects	1

Totals - Yrs. 8	
Categories of Accomplishments	7/1/2009 through 06/30/2017 : (Number/Amount; numbers only)
Student Enrollment in COE Programs:	
Traditional undergraduate and graduate students attending classes	
Students registered in on-line or other distance learning courses	
Homeland security professionals attending courses	
COE Funded Students	20
Papers	
Software Products Developed	
New Courses Developed	
New Certificates or Degree Programs Developed:	
New Degree Programs	
New Certificates	
New private or public licencees/partners using coursework licensed by the COE	
Patent Applications	
Patents Awarded	
Requests for assistance or advice from DHS (# of different DHS contacts/projects/requests)	
Requests for assistance or advice from Federal, State, Local Government	
Follow-on funding from other sources	
Presentations	
Congressional Testimonies	
Projects Completed	
Collaborative Projects	

VIII. List of All Funded Projects

Proj Title (P/R)	Theme	Start Date	Start Year	End Date (P/R)	End Year	Abstract (P/R)	Status (R)	Theme (P)	Proj Type (P/R)	Awd Amt (P/R)	Awd No. (P)	Compliance (R)
Plugfest	Resource Allocation	2016/09	2016	2017/06	2017	Entered	In Progress			150000	2009-ST-061-CI001	No
VBOLO	Law Enforcement	2016/08	2016	2017/06	2017	Entered	In Progress	Visual Analytics of Unstructured and Streaming Data	Research	120000	2009-st-061-ci001	No
success visualization project	Education	2016/07	2016	2017/06	2017	Entered	In Progress	Information-driven Visualization, Modeling and Simulation of Data		0	N/A	No
Crisis Informatics Course Development	Education	2015/12	2015	2016/06	2016	Entered	Complete	Big Data Visual Analytics	Workforce Development/Education	38750	2009-ST-061-CI001	No
Geographic Network Analytics Correlations for VALET	Law Enforcement	2015/11	2015	2017/07	2017	Entered	In Progress	Data-driven Decision Support	Research	50000	2009-ST-061-CI001	No
Safety in View: A Public Safety Visual Analytics Tool Based on CCTV Camera Angles of View	Law Enforcement	2015/06	2015	2015/07	2015	Entered	Complete		Research	0	2009-ST-061-CI001	No
Officer Performance Visualization System	Law Enforcement	2015/05	2015	2017/07	2017	Entered	In Progress		Research	0	2009-ST-061-CI001	No
Chicago LTE Project	Law Enforcement	2015/05	2015	2016/02	2016	Entered	Complete		Research	220293	2009-ST-061-CI001	No
Context-Driven Visual Analytics for Cyber Defensive Operations - Oak Ridge N Lab	Social Media Tools	2015/01	2015	2016/07	2016	Entered	Complete	Information-driven Visualization, Modeling and Simulation of Data		820000	2009-ST-061-CI001	No
SMART: Social Media Analytics and Reporting Toolkit	Social Media Tools	2014/07	2014	2017/07	2017	Entered	In Progress		Research	10000	2009-ST-061-CI001	No
Analyzing High-dimensional Multivariate Network Links with Integrated Anomaly Detection, Highlighting and Exploration	Resource Allocation	2014/07	2014	2015/06	2015	Entered	Complete		Research	0	2009-ST-061-CI001	No
Social Media and Healthcare Analytics for Identification of Emerging Health Threats	Disease Surveillance	2014/07	2014	2015/06	2015	Entered	Complete		Research	0	2009-ST-061-CI001	No
Mobile Application Communication	Social Media Tools	2014/07	2014	2015/06	2015	Entered	Complete		Research	504901	2009-ST-061-CI001	No
Explore Impact of Visualization on Predictive Analysis	Social Media Tools	2014/07	2014	2017/06	2017	Entered	In Progress	Data-driven Decision Support	Research	193686	2009-ST-061-CI001	No
Exascale Data Visualization: Information-assisted data analysis and visualization	Resource Allocation	2014/07	2014	2015/06	2015	Entered	Complete		Research	0	2009-ST-061-CI001	No
Critical Infrastructure in Large Scale Emergencies	Resource Allocation	2014/07	2014	2015/06	2015	Entered	Complete			0	2009-ST-061-CI001	No
Multimedia Analytics for Open Source Media	Social Media Tools	2014/07	2014	2016/06	2016	Entered	Complete			0	2009-ST-061-CI001	No
Parallelizing Video Algorithms for Public Safety Applications	Law Enforcement	2014/07	2014	2015/06	2015		Complete		Research	0	2009-ST-061-CI001	No
RISK VA	Financial Flows Tools	2014/07	2014	2016/12	2016	Entered	Complete		Research	0	2009-ST-061-CI001	No
Multimedia Visual Analytics for News, Blogs, RSS Feeds and other Streaming Data	Social Media Tools	2014/07	2014	2016/06	2016		Complete		Research	0	2009-ST-061-CI001	No
SmartGridVis Project	Resource Allocation	2014/07	2014	2015/06	2015	Entered	Complete		Research	0	2009-ST-061-CI001	No
SP 14 Task 5: Visual Analytics for Security Applications - VASA	Resource Allocation	2014/07	2014	2015/06	2015	Entered	Complete		Research	25000	2009-ST-061-CI001	No
WDYTYA: The Uncertainty of Identity	Law Enforcement	2013/07	2013	2016/12	2016	Entered	Complete		Research	199006	2009-ST-061-CI001	No
GIS Implementations	Disease Surveillance	2013/07	2013	2014/06	2014	Entered	Complete		Research	0	2009-ST-061-CI001	No
Flight Delay Data Exploration System for Analyzing Spatiotemporal Multivariate Data	Resource Allocation	2013/07	2013	2014/06	2014	Entered	Complete			0	2009-ST-061-CI001	No
SEED 1: Investigation of the Impacts of Visualization Literacy on the Performance of Visual Analysis; International Collaborations	Education	2013/07	2013	2014/06	2014	Entered	Complete		Research	0	2009-ST-061-CI001	No
ORAM	Resource Allocation	2013/07	2013	2016/06	2016	Entered	Complete		Research	0	2009-ST-061-CI001	No
UKVAC Joint Research Project		2013/07	2013	2014/06	2014	Entered	Complete			0	2009-ST-061-CI001	No
Visual Analytics of Microblog Data for Public Response Behavioral Analysis in Disaster Events	Social Media Tools	2013/07	2013	2016/06	2016	Entered	Complete		Research	0	2009-ST-061-CI001	No
Visual Analytics Environment for Public Health Surveillance	Disease Surveillance	2013/07	2013	2014/06	2014	Entered	Complete		Research	0	2009-ST-061-CI001	No
SP 14 Task 2: Public Safety Consortium	Education	2013/07	2013	2015/06	2015	Entered	Complete		Seminar/Symposium/Workshop	30804	2009-ST-061-CI001	No
Mobile 3D Routing and Emergency Evacuation in Dense Urban Environments	Resource Allocation	2013/06	2013	2015/07	2015	Entered	Complete		Research	0	2009-ST-061-CI001	No

Proj Title (P/R)	Data Collection Method	Is Deleted	Other Project Type	Primary End User	PI (P/R)	PI Organization (P/R)	MSIs (P)	States (P)	Collab COEs (P)	Users (P/R)	Primary End User
Plugfest		FALSE			David Ebert	Purdue University		IN	Center for Visual Analytics for Command, Control, and Interoperability Environments		
VBOLO	Field Monitors	FALSE			Edward Delp; Edward Delp	Purdue University; Purdue University		IN; OH	Center for Visual Analytics for Command, Control, and Interoperability Environments; Northeastern University	State and Local Transportation	
success visualization project		FALSE			David Ebert	Purdue University		IN	Center for Visual Analytics for Command, Control, and Interoperability Environments	Other DHS	
Crisis Informatics Course Development	Compiling and Sorting Database	FALSE			Louis Ngamassi	Prairie View A & M University	Prairie View A&M University	TX		Academic Community	
Geographic Network Analytics Correlations for VALET	Data Mining	FALSE			Ross Maciejwski; Ross Maciejewski	Arizona State University; Arizona State University		AZ; IN	Center for Visual Analytics for Command, Control, and Interoperability Environments	Academic Community	
Safety in View: A Public Safety Visual Analytics Tool Based on CCTV Camera Angles of View	Expert Consultation	FALSE			David Ebert	Purdue University		IN		State and Local First Responders	
Officer Performance Visualization System	Compiling and Sorting Database	FALSE			David Ebert	Purdue University		IN		State and Local First Responders	
Chicago LTE Project	Field Monitors	FALSE			Edward Delp; Edward Delp	Purdue University; Purdue University		IN; IL		Private Sector Other; State and Local First Responders	
Context-Driven Visual Analytics for Cyber Defensive Operations - Oak Ridge N Lab	Data Mining	FALSE			Bobby Bridges			IN; TN		Academic Community; DHS Science and Technology Directorate; Other Industry	
SMART: Social Media Analytics and Reporting Toolkit	Data Mining	FALSE			David Ebert	Purdue University		IN; TN		DHS Federal Emergency Management Agency; DHS U.S. Coast Guard; State and Local First Responders	
Analyzing High-dimensional Multivariate Network Links with Integrated Anomaly Detection, Highlighting and Exploration	Compiling and Sorting Database	FALSE			David Ebert	Purdue University		IN			
Social Media and Healthcare Analytics for Identification of Emerging Health Threats	Compiling and Sorting Database	FALSE			David Ebert	Purdue University		AZ; IN			
Mobile Application Communication		FALSE						VA			
Explore Impact of Visualization on Predictive Analysis	Bench Tests	FALSE			Ross Maciejwski; Ross Maciejewski	Arizona State University; Arizona State University		AZ		Academic Community	
Exascale Data Visualization: Information-assisted data analysis and visualization		FALSE			Kelly Gaither	University of Texas		TX			
Critical Infrastructure in Large Scale Emergencies		FALSE			William Ribarsky	University of North Carolina at Charlotte		NC		Department of Energy National Labs; Private Sector Other	
Multimedia Analytics for Open Source Media		FALSE			William Ribarsky; William Ribarsky	University of North Carolina-Charlotte; University of North Carolina at Charlotte		NC		DHS Labs	
Parallelizing Video Algorithms for Public Safety Applications	Compiling and Sorting Database	FALSE			Kelly Gaither	University of Texas, Austin		IN; TX			
RISK VA		FALSE			William Ribarsky; William Ribarsky	University of North Carolina-Charlotte; University of North Carolina at Charlotte		NC		Academic Community; Banking Industry; Insurance Industry; Policymakers	
Multimedia Visual Analytics for News, Blogs, RSS Feeds and other Streaming Data		FALSE			William Ribarsky	University of North Carolina at Charlotte		NC			
SmartGridVis Project		FALSE			William Ribarsky	University of North Carolina at Charlotte		IN; NC			
SP 14 Task 5: Visual Analytics for Security Applications - VASA	Compiling and Sorting Database	FALSE			William Ribarsky; William Ribarsky	University of North Carolina-Charlotte; University of North Carolina at Charlotte		NC			
WDYTYA: The Uncertainty of Identity	Compiling and Sorting Database	FALSE			Ross Maciejwski; Ross Maciejewski	Arizona State University; Arizona State University		AZ	Center for Visual Analytics for Command, Control, and Interoperability Environments	Academic Community	
GIS Implementations	Compiling and Sorting Database	FALSE			Richard Aló; Richard Alo	University of Houston-Downtown; Jackson State University		IN; MS			
Flight Delay Data Exploration System for Analyzing Spatiotemporal Multivariate Data		FALSE			Min Chen, David Ebert						
SEED 1: Investigation of the Impacts of Visualization Literacy on the Performance of Visual Analysis; International Collaborations	Survey	FALSE			David Ebert	Purdue University		IN		State and Local First Responders	
ORAM		FALSE			David Ebert	Purdue University					
UKVAC Joint Research Project		FALSE			Min Chen						
Visual Analytics of Microblog Data for Public Response Behavioral Analysis in Disaster Events	Compiling and Sorting Database	FALSE			David Ebert; Tom Ertl	Purdue University;		IN			
Visual Analytics Environment for Public Health Surveillance		FALSE			David Ebert	Purdue University		AZ; IN			
SP 14 Task 2: Public Safety Consortium		FALSE						FL; IN; NC; OH		State and Local First Responders	
Mobile 3D Routing and Emergency Evacuation in Dense Urban Environments		FALSE			William Ribarsky	University of North Carolina at Charlotte		NC			

Proj Title (P/R)	Exec Summ (P/R)	Prog/Final Rpt	Research Areas	Completed Challenges	Analytic Methods Utilized	Academic Disciplines	Stages of Transition	Resulting Output Type	Output Description & Final Report	Peer-reviewed Journ	Other Publications	Student Theses	Presentations	Invention disclosures and Patents
Plugfest	2016				Modeling		Pilot/Field Testing and Evaluation in an Operational Environment	Event	Plugfest allows providers of sensors, analysis, decision support tools, and information sharing capabilities to show their products in real time during on-water simulations of different scenarios. A booth with DHS S&T was setup, cgSARVA was demonstrated, a modified version for VALET and a short talk on visual analytic systems. Positive feedback was received and other vendors with graphical user interfaces have shown interest in the systems.					
VBOLO	2016		Emergency Preparedness and Response; Transportation Security	Data Collection/Generation	Qualitative Analysis	Engineering - Electrical; Mathematics	Pilot/Field Testing and Evaluation in an Operational Environment	Tool	The vBOLO system had successful tests. Improvements are expected to be completed. Additional funds are needed for system integration and deployment.	4 journal articles - See Journal Tab for more detailed information.			4 presentations - See Presentations Tab for more detailed information.	
success visualization project	2016						Basic Research, Operational Use, Prototype Demonstration	Tool	SuccessViz was created to show Visualization of COE success and impact and will be placed on website as a timeline. It will include key pieces of information in presentations, iPad demos, etc. by VACCINE as well as any DHS staff when communicating about the work of the center.					
Crisis Informatics Course Development		06/2016	Advanced Data Analysis and Visualization; Emergency Preparedness and Response; Human Factors Aspects of Technology	Low Risk	Qualitative Analysis	Classroom Education; Exercise; Online Education; Information Science; Information systems; Risk management/assessment; Security Informatics	Pilot/Field Testing and Evaluation in an Operational Environment	Course	The Crisis Informatics Course has been developed and has been offered once a year at the graduate level since Fall 2015. The course includes a visual analytics component which is mainly constituted of hands-on class activities involving the use of visual analytic toolkits (NODEXL, SMART) to explore	1 journal article - See Journal Tab for more detailed information.				
Geographic Network Analytics Correlations for VALET	2016		Advanced Data Analysis and Visualization; Emergency Preparedness and Response; Social, Behavioral, and Economic Sciences		Case Studies; Statistical Analysis	Geographic information sciences; Geography; Information Science; Information systems; Computer Science; Criminology	Basic Research	Deployment	An online service for creating network density estimate models was created. These features are in the process of being ported to other systems for deployment. The expected impact is improved data analytics for law enforcement as well as serving as a basis for improved network based modeling of crime and crime hotspots.	2 journal articles - See Journal Tab for more detailed information.			2 presentations - See Presentations Tab for more detailed information.	
Safety in View: A Public Safety Visual Analytics Tool Based on CCTV Camera Angles of View					Case Studies	Computer Science		Published	Journal articles were created.	2 journal articles - See Journal Tab for more detailed information.				
Officer Performance Visualization System	2016		Communications and Interoperability; Social, Behavioral, and Economic Sciences		Modeling; Statistical Analysis	Computer Science	Pilot/Field Testing and Evaluation in an Operational Environment	Tool	MetricVis was created and a prototype was delivered. To the Lafayette Police Department in Aug 2016.		1 other publication - See Other Publications Tab for more information.			
Chicago LTE Project	2015	08/2015						Test Report including Lessons Learned and recommendations for future deployments	A subjective assessment of RTVI was conducted at CPD. This project invoked investigating the delivery of real-time video delivery to police vehicles. The major effort was the work of Motorola in setting up a Public Service LTE cell site for the Chicago Police, which was used for video testing. Chicago LTE Pilot Project Final Report	1 journal article - See Journal Tab for more detailed information.	1 other publication - See Other Publications Tab for more information.		2 presentations - See Presentations Tab for more detailed information.	
Context-Driven Visual Analytics for Cyber Defensive Operations - Oak Ridge N Lab			Advanced Data Analysis and Visualization		Modeling; Statistical Analysis	Mathematical and Computational Modeling	Basic Research	Tool	GraphPrints was created, a graph analytic approach for detecting anomalies in network flow data. Initial testing has been completed.		1 other publication - See Other Publications Tab for more information.			
SMART: Social Media Analytics and Reporting Toolkit	2016				Case Studies; Modeling; Sampling; Statistical Analysis			Tool	SMART has been licensed by Purdue in 2015 to be used exclusively by Davista Technologies, LLC. Davista is a start-up company created by current and former members of VACCINE who were integral to the development of the technology.	10 journal articles - See Journal Tab for more detailed information.	1 other publication - See Other Publications Tab for more information.			
Analyzing High-dimensional Multivariate Network Links with Integrated Anomaly Detection, Highlighting and Exploration					Case Studies; Statistical Analysis			Published	Journal article was created.	1 journal article - See Journal Tab for more detailed information.				
Social Media and Healthcare Analytics for Identification of Emerging Health Threats					Modeling; Statistical Analysis	Biostatistics and bioinformatics; Computer Science								
Mobile Application Communication									The constant internet connectivity of smart devices coupled with their					
Explore Impact of Visualization on Predictive Analysis	2016		Advanced Data Analysis and Visualization; Human Factors Aspects of Technology; Social, Behavioral, and Economic Sciences	Data Collection/Generation	Case Studies		Laboratory Testing and Evaluation		Given the conflicting demands of model accuracy, comprehensibility and trustworthiness, the question of how much human knowledge and interaction is needed or warranted in relation to the model becomes a critical question for predictive visual analytics. How much of the human do we want in the loop of model prediction? Are humans able to					
Exascale Data Visualization: Information-assisted data analysis and visualization														
Critical Infrastructure in Large Scale Emergencies														
Multimedia Analytics for Open Source Media														
Parallelizing Video Algorithms for Public Safety Applications					Case Studies; Modeling; Sampling; Statistical Analysis									
RISK VA	2016				Case Studies; Statistical Analysis			Tool/Technology/Deployed	Work was with managers at Bank of America and was made available to BoA financial analysts. A version can be made available for government agencies to assist in the investigation of					
Multimedia Visual Analytics for News, Blogs, RSS Feeds and other Streaming Data														
SmartGridVis Project								Tool?/Technology	Foundation for VASA					
SP 14 Task 5: Visual Analytics for Security Applications - VASA					Case Studies; Modeling; Sampling; Statistical Analysis				Hypothetical stores in North Carolina damaged by Hurricane Irene were looked at. In our visual analytics					
WDYTYA: The Uncertainty of Identity	2016		Advanced Data Analysis and Visualization; Human Factors Aspects of Technology; Social, Behavioral, and Economic Sciences	Applied Known	Sampling; Statistical Analysis	Computer Science	Basic Research	Published & Patents	Journal articles and presentations were created. Patents were awarded.	10 journal articles - See Journal Tab for more detailed information.			9 presentations - See Presentations Tab for more detailed information.	3 patents - See Patent Tab for more detailed information.
GIS Implementations					Modeling; Sampling; Statistical Analysis			Published	Journal articles were created.	7 journal articles - See Journal Tab for more detailed information.				
Flight Delay Data Exploration System for Analyzing Spatiotemporal Multivariate Data														
SEED 1: Investigation of the Impacts of Visualization Literacy on the Performance of Visual Analysis; International Collaborations	2010							Published	This project began a collaboration which resulted in one journal article during the project and several others after the project concluded. This line of inquiry also contributed to a successful 3 year NSERC Strategic Partnership	1 journal article - See Journal Tab for more detailed information.				
ORAM									System was developed and provided to					
UKVAC Joint Research Project									In collaboration with the Purdue team, we integrated anomaly analysis capacity (Oxford) with a flight data	1 journal article - See Journal Tab for more detailed information.				
Visual Analytics of Microblog Data for Public Response Behavioral Analysis in Disaster Events					Modeling; Sampling; Statistical Analysis				Became SMART					
Visual Analytics Environment for Public Health Surveillance									Software product that enables analysis to understand the characteristics of					
SP 14 Task 2: Public Safety Consortium									Process to engage First Responders used by VACCINE.					
Mobile 3D Routing and Emergency Evacuation in Dense Urban Environments	2011							Tools	The University of North Carolina at Charlotte has delivered an evacuation decision support system and Urban Emergency Response search and command center tools to the UNC Charlotte Police and Public Safety Department. The tools have been used in the Canada-US Experiment Resiliency Environment demonstration in Seattle at which DHS managers were					

UKVAC II	Resource Allocation	2012/10	2012	2013/12	2013	Entered	Complete		Research	0	2009-ST-061-CI001	No		FALSE			Min Chen			IN				2015				Statistical Analysis	Computer Science	Pilot/Field Testing and Evaluation in an Operational Environment	Published	An information-theoretic framework for anomaly detection was formulated. A study on visual representations was conducted. With the help of Purdue, a prototype demonstration system for illustrating the potential us of information theoretic quantities in the visual analytics process for handling the FD data was delivered. And a high-level visual analytics cycle was formulated by dividing visual analytics tasks into three groups, monitoring, analysis and model refinement.	1 journal article - See Journal Tab for more detailed information.			5 presentations - See Presentations Tab for more detailed information.	
(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Law Enforcement	2012/07	2012	2017/08	2017	Entered	In Progress	Dynamic, On-demand Data Analysis and Visualizatio...	Research	190380	2009-ST-061-CI001	No	Data Mining	FALSE			David Ebert	Purdue University	Morgan State University	IL; IN; NY; OH		State and Local Emergency Managers; State and Local First Responders		2015		Emergency Preparedness and Response; Risk and Decision Sciences		Case Studies; Risk Assessment; Statistical Analysis	Geographic information sciences; Information Science; Computer Science; Criminology; Biostatistics and bioinformatics	Pilot/Field Testing and Evaluation in an Operational Environment	Tool	The VALET application has been deployed to several law enforcement agencies. It is licensed by Purdue in 2015 to be used exclusively by Davista Technologies, LLC.	3 journal articles - See Journal Tab for more detailed information.	4 other publications - See Other Publications Tab for more information.	1 student thesis - See Theses Tab for more detailed information.	29 Presentations - See Presentations Tab.	2 patents - See Patent Tab for more detailed information.
(MADIS) A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi Agency, Multi-Partner Multimedia Data	Resource Allocation	2012/07	2012	2015/07	2015	Entered	Complete		Research	318125	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			Shu-Ching Chen; Shu-Ching Chen	Florida International University; Florida International University		FL; IN		State and Local Emergency Managers		2016		Advanced Data Analysis and Visualization; Emergency Preparedness and Response; Risk and Decision ...		Case Studies; Modeling; Risk Assessment; Sampling; Statistical Analysis	Preparedness training; Computer Science; Risk management/assessment	Pilot/Field Testing and Evaluation in an Operational Environment	Tool	MADIS is in use/tested by Miami-Dade Department of Emergency Management.	15 journal articles - See Journal Tab.				
(iLEAPS) iLaw Enforcement Apps Assistance Program for Students	Resource Allocation	2012/07	2012	2014/12	2014	Entered	Complete		Research	118496	2009-ST-061-CI001	No	Survey	FALSE			Tim Akers	Morgan State University	Morgan State University	MD		State and Local Emergency Managers; State and Local First Responders		2015	06/2016	Advanced Data Analysis and Visualization; Emergency Preparedness and Response		Case Studies; Risk Assessment	Computer Science	Pilot/Field Testing and Evaluation in an Operational Environment	Tool	It was demonstrated to Morgan State University Police Chief Hatcher, and he called for meeting to introduce iLEAPS to the entire police force. Five additional students have been trained to conduct mobile, specifically to continue the development using the Android Software Development kit, and Xcode for iOS development. New capabilities to extend the utility of iLeaps have been added, including native notifications, ability to send pictures, and for dispatch to see the location for all officers on campus.				3 presentations - See Presentations Tab for more information	
(GARI) Gang Graffiti Recognition and Analysis	Law Enforcement	2012/07	2012	2017/06	2017	Entered	In Progress		Research	107941	2009-ST-061-CI001	No	Expert Consultation	FALSE			Edward Delp; Ed Delp	Purdue University; Purdue University	Navajo Technical University	IN; CA; AZ; IL	Center for Visual Analytics for Command, Control, and Interoperability Environments	State and Local Emergency Managers; State and Local First Responders		2016		Advanced Data Analysis and Visualization; Risk and Decision Sciences		Case Studies; Modeling; Qualitative Analysis; Risk Assessment; Statistical Analysis	Geographic information sciences; Information systems; Computer Science; Criminology	Operational Use	Tool	GARI was deployed to the Indianapolis Metropolitan Police, Indiana Intelligence Fusion Center Gang Task Force, INGang, program, Cook County Sherriff's Department, Navajo Nation, and the Illinois State Police. Additionally, a number of other law enforcement entities (approximately 400) have expressed interest in using and deploying the tool. A community version was developed, but not deployed due to privacy reasons.	14 journal articles - See Journal Tab for more detailed information.		2 student theses - See Theses Tab for more detailed information.	5 presentations - See Presentations Tab for more detailed information.	
COAST: Coastal Operations and Analysis Suite of Tools	Resource Allocation	2012/07	2012	2014/06	2014	Entered	Complete		Research	0	2009-ST-061-CI001	No	Data Mining	FALSE			David Ebert	Purdue University		IN		DHS U.S. Coast Guard		2015				Modeling; Sampling; Statistical Analysis	Computer Science	Verification & Validation	Tool	Coast Guard Headquarters (CG-771) utilizes the COAST software to generate images used in the reports used for operations planning				10 presentations - See Presentations Tab for more detailed information.	
Multimedia, Social Media, Text, and Emergency Response Analytics	Social Media Tools	2012/07	2012	2016/12	2016	Entered	Complete		Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			David Ebert; William Ribarsky	Purdue University; University of North Carolina at Charlotte		IN; MN; NC; SC; TX; MD		Banking Industry; DHS Labs; State and Local Emergency Managers; State and Local First Responders; Other State or Local		2016		Advanced Data Analysis and Visualization; Social, Behavioral, and Economic Sciences		Case Studies; Modeling; Statistical Analysis	Computer Science; Sociology	Adopted by End User, Operational Use, Pilot/Field Testing and Evaluation in an Operational Environment	Tool	A stand-alone version of the critical infrastructure modeling system plus the collection of cascading breakdown results for a large ensemble of hurricane paths has been deployed. The visualization interface is accessible as a web service by a range of devices anywhere on the internet. Case studies are being ran for Charlotte Mecklenburg EMS and NC Public Health and Preparedness. The partnership with the Electric Power Research Institute (EPRI) continues. A prototype to respond to the effects of large storms as they develop is being set up. Funding from the Department of Energy and other sources is being sought.	34 journal articles - See Journal Tab for more detailed information.		2 student theses - See Theses Tab for more detailed information.	9 presentations - See Presentations Tab for more detailed information.	
Spatiotemporal Social Media Analytics for Abnormal Event Detection	Social Media Tools	2012/07	2012	2013/06	2013	Entered	Complete			0	2009-ST-061-CI001	No		FALSE			Tom Ertl															Abnormal event detection feature added to SMART.					
(GeoTxt) E2E: GeoTxt API	Social Media Tools	2012/06	2012	2017/06	2017	Entered	In Progress		Research	155665	2009-ST-061-CI001	No	Data Mining	FALSE			Alan MacEachren; Alan MacEachren	Pennsylvania State University; Pennsylvania State University		PA		Academic Community; State and Local First Responders		2016		Advanced Data Analysis and Visualization; Communications and Interoperability		Case Studies; Modeling; Sampling; Statistical Analysis	Information systems; Computer Science; Geography	Laboratory Testing and Evaluation	Tool	The throughput of GeoTxt was improved substantially by reengineering the system to take full advantage of both advanced text indexing methods and high-performance computing. The first Gold Standard corpus of geolocated places in tweets was produced that can be used to test and train any geoparsing tools. A geovisual analytics application has been developed to support building geolocation corpra. GeoTxt has been integrated as the backend geographic entity recognition, disambiguation, and co-coding systems to support SensePlace 2, our spatial-temporal twitter analytics environment. The early stages of SensePlace 2 (and its precursor SensePlace) were funded through VACCINE. GeoTxt has been made available to other VACCINE partners. We have worked actively with partners at both Purdue and UNCC to test use of the GeoTxt API from software applications under development by those teams.	6 journal articles - See Journal Tab for more detailed information.	1 other publication - See Other Publications Tab for more information.	4 student theses - See Theses Tab for more detailed information.	8 presentations - See Presentations Tab for more detailed information.	
Symbology Standardization Support	Law Enforcement	2012/06	2012	2014/07	2014	Entered	Complete		Research	972488	2009-ST-061-CI001	No	Expert Consultation	FALSE			Alan MacEachren	Pennsylvania State University		PA		DHS Federal Emergency Management Agency; DHS U.S. Customs and Border Protection; Food and Drug Administration; Other Industry		2013	06/2013	Advanced Data Analysis and Visualization		Case Studies; Sampling; Statistical Analysis	Geographic information sciences; Information Science; Communication (risk, scientific, technical)	Operational Use	Tool	Development of a revised Symbol Store, featuring a new interface design, improved symbol uploading workflow, new downloadable formats, and integration with Drupal to support interactive refinement of user-contributed symbol sets. Provision of these improvements in a public-facing Symbol Store. Presented Symbol Store to DHS and other Federal Stakeholders in an in-person workshop and an online webcast to encourage adoption and solicit feedback.	4 journal articles - See Journal Tab for more detailed information.	5 other publications - See Other Publications Tab for more information.		17 presentations - See Presentations Tab for more detailed information.	
(VASA) – Visual Analytics for Security Applications	Resource Allocation	2012/06	2012	2014/11	2014	Entered	Complete		Research	1185816	2009-ST-061-CI001	Yes	Data Mining	FALSE	Public Safety Coalition Project		David Ebert, Isaac Cho	Purdue University		IN; MN; NC; TX	Food Protection and Defense Institute	State and Local Emergency Managers; State and Local First Responders		2015	05/2016	Advanced Data Analysis and Visualization; Infrastructure Protection		Case Studies; Modeling; Risk Assessment; Sampling; Statistical Analysis	Engineering; Computer Science; Risk management/assessment	Pilot/Field Testing and Evaluation in an Operational Environment	Tool	VASA is a visual analytics platform targeting this setting and consists of a desktop application, a component model, and a suite of distributed simulation components for modeling the impact of societal threats such as weather, food contamination, and traffic on critical infrastructure such as supply chains, road networks, and power grids. Each component encapsulates high-fidelity simulation models that together form an asynchronous simulation pipeline: a system of systems of individual simulations with a common data and parameter exchange format.	2 journal articles - See Journal Tab for more detailed information.			3 presentations - See Presentations Tab for more information	
MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	Law Enforcement	2012/06	2012	2014/07	2014	Entered	Complete		Research	32170	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			David Ebert, Nicklas Elmqvist	Purdue University		CA; GA; IL; NJ; IN	Center for Command, Control, and Interoperability Center for Advanced Data Analysis	Academic Community; DHS Labs; DHS Science and Technology Directorate; Media; U.S. Department of Commerce		2013		Advanced Data Analysis and Visualization		Case Studies; Sampling; Statistical Analysis	Computer Science	Operational Use, Pilot/Field Testing and Evaluation in an Operational Environment	Tool	The COE Explorer project was delivered and in use. This is 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 capabilities, and the data it is visualizing. Furthermore, the tool has also been highly successful with its intended audience: investigators, program officers, and policymakers.	2 journal articles - See Journal Tab for more detailed information.	4 other publications - See Other Publications Tab for more information.	1 student thesis - See Theses Tab for more detailed information.	6 presentations - See Presentations Tab for more detailed information.	1 patent - See Patent Tab for more detailed information.
MDRP 6: Video Surveillance Visual Analytics	Resource Allocation	2012/06	2012	2014/07	2014	Entered	Complete		Research	24874	2009-ST-061-CI001	No	Expert Consultation	FALSE			Brian Fisher			IN; NC		State and Local Emergency Managers		2013		Advanced Data Analysis and Visualization; Border Security; Emergency Preparedness and Response		Case Studies; Modeling; Risk Assessment; Sampling; Statistical Analysis	Geographic information sciences; Computer Science; Sociology	Pilot/Field Testing and Evaluation in an Operational Environment, Prototype Demonstration	Research	There has been successful work in translating the work done in the lab to practices in emergency management in the City of Richmond. Our researchers consult on policy decisions with the Richmond emergency manager. Approval has been gained 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 to work with us on our projects, enabling us to build effective participatory design with end users, with should support buy-in and real-world success for our VEOC.	21 journal articles - See Journal Tab for more detailed information.	5 other publications - See Other Publications Tab for more information.	1 student thesis - See Theses Tab for more detailed information.	2 presentations - See Presentations Tab for more detailed information.	
(Crowdsourcing) Combining Crowdsourcing technology with machine learning to do visual analytics on big qualitative data (video datasets).	Law Enforcement	2012/06	2012	2014/07	2014	Entered	Complete		Research	139700	2009-ST-061-CI001	No	Expert Consultation	FALSE			David Kirsh	University of California San Diego		CA; IN		State and Local Emergency Managers; State and Local First Responders		2014		Communications and Interoperability; Emergency Preparedness and Response; Human Factors Aspects of Technology		Case Studies; Sampling; Statistical Analysis	Computer Science	Laboratory Testing and Evaluation	Tool	A user friendly system that is easy to manage at the back-end and easy to work in on the client side was created. Pilot work has shown that students find it natural to work in the client. The system is currently being re-implemented to increase robustness and to accommodate user feedback. More research is needed to better determent the cost structure of scaling up to larger video sets and to real-time analysis and reporting. The practical value of this system depends on the reason a group might want it. Police need to review video to document reports and provide evidence. Crowd sourcing can save time in that task. Our original goal remains to provide real time assistance for monitoring thousands of video in real-time. That application is of value in hundreds of scenarios, including police surveillance, search and rescue and border crossing.					

Bristle Maps - A Multivariate Abstraction Technique for	Law Enforcement	2012/06	2012	2014/07	2014	Entered	Complete		Research	0	2009-ST-061-CI001	No		FALSE			David Ebert	Purdue University		AZ; IN											Tool	Prototyped and evaluated in VALET system.	1 journal article - See Journal Tab for more detailed information.			1 presentation - See Presentations Tab for more detailed information.	
iOPAR - Operational Performance Assessment	Resource Allocation	2012/06	2012	2013/07	2013	Entered	Complete		Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			David Ebert	Purdue University		AK; AZ; NY; IN		DHS U.S. Coast Guard		2015				Sampling; Statistical Analysis	Computer Science		Tool	Delivered and in use; the prototype is being evaluated.				1 presentation - See Presentations Tab for more detailed information.	
Mobile 3D Routing, Emergency Evacuation, and In-Field Criminal Investigative Analytics	Law Enforcement	2012/06	2012	2013/09	2013	Entered	Complete		Research	0	2009-ST-061-CI001	No		FALSE			William Ribarsky; William Ribarsky	University of North Carolina-Charlotte; University of North Carolina at Charlotte		NC											Tool	A mobile application was developed with graphs for all the academic buildings on the UNC Charlotte campus and embedded them in the street network. We participated in the DHS Canada-US Experiment (CAUSE-ERE) based in Seattle for response to a Northwestern earthquake and will participate in follow-up activities. We are also working with the Charlotte-Mecklenburg Police Department (CMPD) to develop a training exercises using this environment. The improved system will be tested with other police departments and is being deployed with UNC Charlotte Police, CMPD, and others.					
Personal Visual Analytics	Education	2012/03	2012	2012/06	2012		Complete		Seminar/Sympo	12000	2009-ST-061-	No		FALSE			Melanie	University of Victoria		PA					06/2016						Workshop Created	Personal Visual Analytic Workshop					
Banff Workshop	Education	2011/09	2011	2011/09	2011	Entered	Complete		Seminar/Symposium/Workshop	30000	2009-ST-061-CI001	No		FALSE										2011								Workshops created					
(MERGE) Mobile Emergency Response Guide	Law Enforcement	2011/08	2011	2014/08	2014	Entered	Complete		Research	41643	2009-ST-061-CI001	No	Field Monitors	FALSE			Edward Delp; Ed Delp	Purdue University; Purdue University		IN; CA; OH		State and Local Emergency Managers; State and Local First Responders; Other DHS		2014		Emergency Preparedness and Response; Explosives Detection, Mitigation and Response	Data Collection/Generation	Case Studies; Modeling; Sampling; Statistical Analysis	Engineering; Computer Science	Operational Use	Tool	MERGE has been deployed to several law first responders groups and it has received very positive responses from our targeted user groups which include: the Lafayette, West Lafayette, Indianapolis, and St. Clair, MI Fire Department. MERGE was recently demonstrated to a manufacturer of detection sensors, who is interested in licensing the MERGE source code.	7 journal articles - See Journal Tab for more detailed information.		2 student theses - See Theses Tab for more detailed information.		
SP 10: Physical Extraction & Reconstruction of Evidence from Mobile Phones Using JTAG Test Ports	Law Enforcement	2011/07	2011	2012/06	2012	Entered	Complete		Research	198565	2009-ST-061-CI001	No		FALSE																							
Coast Guard Swimmer Deaths	Resource Allocation	2011/07	2011	2012/06	2012	Entered	Complete		Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			David Ebert	Purdue University		IN; MI				2011							Research	Analysis was completed on the frequency of swimmer deaths, the time-of-day and location. Analysis was also completed for boating deaths. The findings were summarized and the Coast Guard used these results in their operational planning for fiscal year 2011 and also in designing the public service message campaigns. There was a drop of almost 37% in swimmer deaths in 2011. Finished.				4 presentations - See Presentations Tab for more detailed information.	
LAHVA: Linked Animal-Human Health Visual	Disease Surveillance	2011/07	2011	2012/06	2012	Entered	Complete		Research	0	2009-ST-061-CI001	Yes	Compiling and Sorting Database	FALSE			David Ebert	Purdue University		NC; IN				2012				Statistical Analysis		Basic Research	Research	Software product that linked animal and human health records from the state				2 presentations - See Presentations Tab for more detailed information.	
High Risk Alcohol Behavior Analysis	Law Enforcement	2011/07	2011	2012/06	2012	Entered	Complete		Research	0	2009-ST-061-CI001	Yes	Compiling and Sorting Database	FALSE			David Ebert	Purdue University		IN		State and Local First Responders		2011				Statistical Analysis	Computer Science			The output of the analysis was used to create an awareness presentation for Purdue students, guide intervention activities and to develop intervention					
iVALET - Mobile Visual Analytics Law Enforcement Toolkit	Law Enforcement	2011/07	2011	2017/06	2017	Entered	Complete		Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			David Ebert	Purdue University	Morgan State University	IN	Center for Visual Analytics for Command, Control, and Interoperability Environments	State and Local First Responders		2016				Modeling; Sampling; Statistical Analysis	Computer Science	Operational Use	Tool	The mobile version of VALET (iVALET) continues to be a popular option for law enforcement officers depending upon their roles and responsibilities. VALET has been utilized to devise novel data guided patrolling strategies and has led to a paradigm operational shift at several police departments. VALET has also supported investigative analysis tasks at the departments who utilize the system. In keeping with the goal of transitioning this software, we have licensed the technology to a startup company called Davista Technologies, LLC that was born out of the VACCINE center.				5 presentations - See Presentations Tab for more detailed information.	
NHANES Exploration	Financial Flows Tools	2011/07	2011	2016/07	2016	Entered	Complete		Research	0	2009-ST-061-CI001	No		FALSE			David Ebert;	Purdue University;														Delivered to nutrition researcher.					
Visual Analytics Decision Support Environment for Epidemic Modeling and Response Evaluation; Public Safety Coalition Projects	Disease Surveillance	2011/07	2011	2012/06	2012	Entered	Complete		Other (enter short description)	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			David Ebert	Purdue University		AZ; IN				2010				Modeling; Sampling; Statistical Analysis			Tool	There are two software products to date from this project. The first system enables visual analytic decision making and evaluation of interdiction measures for Rift Valley fever (RVF), a zoonotic disease that could have a devastating impact on the US cattle industry. The second system allows visual analytic decision making to respond to and curtail the spread of pandemic influenza. This project has shown the potential of integrated simulation, visual analysis, and linked interactive spatiotemporal displays with decision space displays for evaluating and optimizing multiple interdiction strategies. RVF: Partnered with DHS					
SP 14 Task 1 - Extend	Education	2011/07	2011	2012/06	2012	Entered	Complete		Research	62466	2009-ST-061-	No		FALSE			Niklas	Purdue University														Multimodal graph visualization is an					
Cyber Education	Education	2011/06	2011	2014/07	2014	Entered	Complete			100000	2009-ST-061-CI001	No		FALSE			Niklas Elmqvist	Purdue University													Course	A graduate course was created.		1 other publication - See Other Publications Tab for		1 presentation - See Presentations Tab for more detailed information.	
Coast Guard PROTECT Visualization	Resource Allocation	2011/06	2011	2013/07	2013	Entered	Complete		Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			David Ebert	Purdue University		AZ; IN	Center for Risk and Economic Analysis of Terrorism Events	DHS U.S. Coast Guard		2011				Case Studies; Modeling; Sampling; Statistical Analysis	Geography	Prototype Demonstration	Prototype	VACCINE, in conjunction with the CREATE Center, analyzed the PROTECT model for security patrols in Boston and made recommendations for improvements for deployment in New York City. Summary of Transition and Deployment - PROTECT - Port Resilience Operational / Tactical Enforcement to Combat Terrorism • Collaboration with CREATE • Prototype July 26, 2011. Completed.	1 journal article - See Journal Tab for more detailed information.			2 presentations - See Presentations Tab for more detailed information.	
MarketAnalyzer: An Interactive Visual Analytics System for Analyzing Competitive Advantage Using Point of Sale Data	Financial Flows Tools	2011/06	2011	2013/07	2013	Entered	Complete		Research	0	2009-ST-061-CI001	No		FALSE			David Ebert	Purdue University		IN; AZ											Research	Delivered to corporate partner.	1 journal article - See Journal Tab for more detailed information.				
SP 8: Disposable Cell	Law Enforcement	2010/10	2010	2012/03	2012	Entered	Complete		Research	149811	2009-ST-061-	No		FALSE			David	Purdue University														A final report was submitted to DHS					
Justice Institute of British Columbia and VACCINE	Education	2010/09	2010	2010/09	2010		Complete		Seminar/Symposium/Workshop	46000	2009-ST-061-CI001	No		FALSE																		Workshops were created					
SP 2: CCC Tech Support	Law Enforcement	2010/07	2010	2011/06	2011	Entered	Complete		Research	98660	2009-ST-061-CI001	No		FALSE			Alan MacEachren; Alan MacEachr	Pennsylvania State University; Pennsylvania State University		PA; IN												Tech Support Provided					
SP 7: User Adoption Learning Tool (Ulearning)	Education	2010/07	2010	2011/06	2011	Entered	Complete			83829	2009-ST-061-CI001	No		FALSE			David Ebert			IN				2011							Tool	Based on availability of funding, the plan was to target the state of Indiana as a large pilot project and give those first responders supported access to the uLearning Platform in exchange for feedback to further the development of the Platform. First responders were interviewed and their input was recorded by Captico. However, in the summer of 2011 the project was postponed due to lack of funding. Summary of Transition and Deployment: Ulearning (Captico)-Training portal for S&T and COE Technologies • Deployed for Test &					
Analytical Visualization of the Port Arthur, TX Economic Impact Study	Resource Allocation	2010/07	2010	2011/06	2011	Entered	Complete		Research	0	2009-ST-061-CI001	No	Expert Consultation	FALSE			David Ebert	Purdue University		AZ; IN	Center for Risk and Economic Analysis of Terrorism Events	DHS U.S. Coast Guard		2011				Case Studies; Modeling; Sampling; Statistical Analysis		Operational Use	Tool	VACCINE personnel have developed a visual analytics environment for the analysis, exploration and decision making of the effects of a port closure in Port Arthur, TX. The tools created run on Windows PCs and provide users with a graphical user interface with which to explore the economic impact data by market sector and by mitigation					
PlumeViz	Law Enforcement	2010/07	2010	2011/06	2011	Entered	Complete		Research	0	2009-ST-061-	No		FALSE			David	Purdue University		IN												Completed live demonstration in					
Symbology Map Transition	Resource Allocation	2010/07	2010	2016/07	2016	Entered	Complete		Research	0	2009-ST-061-CI001	No	Survey	FALSE			Alan MacEachren; Alan MacEachren	Pennsylvania State University; Pennsylvania State University		IN; PA		DHS Federal Emergency Management Agency; DHS Transportation Security Administration; DHS U.S. Coast Guard; State and Local First Responders; Other Federal Agency		2014	06/2013			Case Studies	Geography	Pilot/Field Testing and Evaluation in an Operational Environment	Tool	Multiple improvements to the Symbol Store application have been made due to feedback from work with users. Additionally, the Symbol Store API has been enhanced and simplified to allow a developer to easily search and access symbols in the Symbol Store.	3 journal articles - See Journal Tab for more detailed information.	1 other publication - See Other Publications Tab for more information.		2 presentations - See Presentations Tab for more detailed information.	
Video Surveillance Project	Law Enforcement	2010/07	2010	2011/06	2011	Entered	Complete		Research	0	2009-ST-061-	No		FALSE			David	Purdue University		IN																	
Seed 3: Uncertainty in Video Visual Analytics	Law Enforcement	2010/07	2010	2012/06	2012	Entered	Complete			0	2009-ST-061-CI001	No	Field Monitors	FALSE			David Ebert	Purdue University		IN				2010				Sampling			Method?	We have developed a real-time method for transforming video information in quasi-3D to spatial information in a 2D planar visualization, which acts as a live layer on top of a conventional satellite image-based mapping system. We have also developed several schemes for visually mapping information extracted from videos, including traffic speed and density, and uncertainty in illustration. This form of traffic video visualization can potentially reduce the need for specialized traffic sensory devices and infrastructure, and enable better utilization of the existing video-based traffic sensory network.	1 journal article - See Journal Tab for more detailed information.				
SP 15 Task 2: VASA	Resource Allocation	2010/07	2010	2011/06	2011	Entered	Complete			74918	2009-ST-061-CI001	No		FALSE			William Ribarsky,	Office of University Programs, Science &		CA; NC; PA; SC;				2010								Hypothetical stores in North Carolina damaged by Hurricane Irene were					
SP 16 - VASA	Resource Allocation	2010/07	2010	2011/06	2011	Entered	Complete		Research	1085896	2009-ST-061-	No		FALSE			William															Hypothetical stores in North Carolina					
(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Resource Allocation	2010/06	2010	2014/09	2014	Entered	Complete		Research	87600	2009-ST-061-CI001	No	Expert Consultation	FALSE			David Ebert	Purdue University		IN		DHS U.S. Coast Guard		2013		Advanced Data Analysis and Visualization; Risk and Decision Sciences		Case Studies; Modeling; Risk Assessment; Sampling; Statistical Analysis	Engineering; Geographic information sciences; Computer Science; Risk management/assessment; Biostatistics and bioinformatics	Operational Use	Tool	cgSARVA is deployed and in use by the United States Coast Guard.	2 journal articles - See Journal Tab for more detailed information.			13 presentations - See Presentations Tab for more detailed information.	

Hazmat Placards	Law Enforcement	2010/06	2010	2010/08	2010	Entered	Complete		Research	94139	2009-ST-061-CI001	No		FALSE			Edward Delp	Purdue University		IN											Research	Placards were created for research use with application				1 presentation - See Presentations Tab for more detailed information	
RECONNECT Workshop 2010 - Extracting and Visualizing Information from Natural Language Text	Education	2010/06	2010	2010/06	2010	Entered	Complete	Information-driven Visualization, Modeling and Simulation of Data	Seminar/Symposium/Workshop	0	200	No	Data Mining	FALSE			Eduard Hovy	University of Southern California		CA; NJ		Academic Community; Federal Bureau of Investigation; Intelligence Community; U.S. Department of Defense		2010	06/2010	Advanced Data Analysis and Visualization; Communications and Interoperability; Social, Behavioral, and Economic Sciences	Data Collection/Generation	Biometrics; Qualitative Analysis; Sampling	Information Science; Information systems; Mathematical and Computational Modeling; Rhetoric	Adopted by End User	Workshop	CCICADA/VACCINE taught the workshop. The workshop is listed in the final report in PRS.					
TRIP: Trip Response Investigative Profiler	Law Enforcement	2010/06	2010	2013/07	2013	Entered	Complete			0		No		FALSE			David Ebert	Purdue University		IN; CA	Center for Visual Analytics for Command, Control, and Interoperability Environments			2007							Tool	Collaboration with end-user; Delivered and in use. Delivered to Indiana Intelligence Fusion Center.					
A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi Agency, Multi-Partner Multimedia Data; Public Safety Coalition Projects	Resource Allocation	2010/04	2010	2011/03	2011	Entered	Complete		Research	0	2009-ST-061-CI001	No	Data Mining	FALSE			Shu-Ching Chen	Florida International University		FL; IN		DHS Federal Emergency Management Agency; State and Local First Responders		2014				Case Studies; Modeling; Sampling; Statistical Analysis	Computer Science	Pilot/Field Testing and Evaluation in an Operational Environment	Tool	A Disaster Multimedia Search Engine is developed as an iPad application and can be used for retrieving and visualizing the categorized disaster multimedia data. The underlying key techniques include various multimedia semantic analysis and retrieval methods developed by our group. We also develop web-based systems for storyline generation and disaster susceptibility comparisons among cities based on text mining and visualization techniques. The developed methods will greatly improve situation awareness during or after disasters.	12 journal articles - See Journal Tab for more detailed information.			3 presentations - See Presentations Tab for more information	
SP 15-Task 3: Event Evacuation Planning; Public Safety Coalition Projects	Resource Allocation	2010/04	2010	2011/03	2011	Entered	Complete		Research	23748	2009-ST-061-CI001	No		FALSE			William Ribarsky; William Ribarsky	University of North Carolina-Charlotte; University of North Carolina at Charlotte		NC		State and Local First Responders		2010						Operational Use	Planning and Exercise	Situationally-aware evacuation model with several building examples and ability to expand to new buildings. The model is available for use by DHS S&T stakeholders, customers, and to partners such as PNNL. We have begun to prepare for an evacuation exercise built around a scenario of a nuclear emergency at the McGuire Nuclear Power station, about 15 miles from the UNC Charlotte campus. Emergency planners and responders, including UNCC Police, Charlotte Mecklenburg Emergency Management, and FEMA observers, will use the on-campus field house as an evacuation site. The exercise will take place in Summer, 2011, and we will provide a report of results to DHS.				1 presentation - See Presentations Tab for more detailed information.	
SP 14 Task 3: Technical Integration into ExPOD at JIBC	Education	2010/04	2010	2011/03	2011	Entered	Complete		Research	5000	2009-ST-061-CI001	No		FALSE			David Ebert; Alan MacEachren	Purdue University; Pennsylvania State University		PA; IN												Completed					
Visual Analytics Law Enforcement Technology; Public Safety Coalition Projects	Law Enforcement	2010/01	2010	2017/06	2017	Entered	In Progress			0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			David Ebert	Purdue University		AZ; IN		State and Local First Responders		2016				Modeling; Sampling; Statistical Analysis	Biostatistics and bioinformatics; Computer Science	Operational Use	Tool	On Friday, September 30, a demonstration of two new enhancements to the Visual Analytics Law Enforcement Toolkit (VALET) was provided to the Lafayette Police Department, West Lafayette PD and others. This presentation showcased how VALET filters through crime-related activities within various areas of our community and selects officers to be sent to the corresponding locations based upon their performance ranking. In general, these luncheons provided a	2 journal articles - See Journal Tab for more detailed information.			3 presentations - See Presentations Tab for more information	1 patent - See Patent Tab for more information.
MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Law Enforcement	2009/07	2009	2013/06	2013	Entered	Complete		Research	229728	2009-ST-061-CI001	No	Data Mining	FALSE			David Ebert, Alan MacEachren	Purdue University		IN; PA; VA; NJ		Academic Community; Center for Disease Control and Prevention; DHS Labs; DHS Science and Technology Directorate; State and Local First Responders		2013		Advanced Data Analysis and Visualization; Biological Threats and Countermeasures; Social, Behavioral, and Economic Sciences		Case Studies; Econometrics; Modeling; Molecular Biology/Genomics; Risk Assessment; Sampling; Statistical Analysis	Preparedness training; Computer Science; Risk management/assessment; Geography; Information Science	Operational Use	Tool	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).	21 journal articles - See Journal Tab for more detailed information.	2 other publications - See Other Publications Tab for more information.	3 student theses - See Theses Tab for more detailed information.	30 presentations - See Presentations Tab for more detailed information.	
MDRP 5: Cybersecurity Visual Analytics	Law Enforcement	2009/07	2009	2010/03	2010	Entered	Complete			308619	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			David Ebert	Purdue University		CA; IN		Academic Community; Critical Infrastructure Owners and Operators; DHS Labs; Intelligence Community		2010		Advanced Data Analysis and Visualization; Infrastructure Protection; Risk and Decision Sciences		Case Studies; Modeling; Statistical Analysis	Biostatistics and bioinformatics; Computer Science	Laboratory Testing and Evaluation	Tool	The two principal accomplishments have been (1) transfer of the Isis forensic tool to a pilot study with the US-CERT Enhanced Analytic Database Capability, and (2) incorporation of our SSH keystroke detection algorithm into Argus Release 3.0.4				8 presentations - See Presentations Tab for more detailed information.	
MDRP 7: Introducing Sustainable Visual Analytics into Command Center Environments	Law Enforcement	2009/07	2009	2013/06	2013	Entered	Complete		Research	5080	2009-ST-061-CI001	No	Expert Consultation	FALSE			David Ebert	Purdue University		IN; TX; WA		Center for Disease Control and Prevention; Critical Infrastructure Owners and Operators; DHS U.S. Coast Guard; Federal Bureau of Investigation; State and Local First Responders		2010		Communications and Interoperability; Emergency Preparedness and Response; Human Factors Aspects of Technology		Case Studies; Modeling; Sampling; Statistical Analysis			Modeling	Under an SBIR led by Truestone, Inc., we teamed with FAZD (Texas A&M) and VACCINE (Purdue) to deliver and assess the second iteration of a next-generation CCI system. Thanks to our ongoing collaboration with the Puget Sound Port Readiness Committee (PRC), we were able to plan and conduct a computer supported "worst-case" table-top exercise in the Fall using a "Truevue dashboard" to present the scenario and share information among the participants. There was general agreement within the PRC that there would be significant benefit from such an exercise, especially considering that there would be a change of command within the Army's 833rd Transportation Battalion during the summer. Completed.	1 journal article - See Journal Tab for more detailed information.	2 other publications - See Other Publications Tab for more information.	1 student thesis - See Theses Tab for more detailed information.	4 presentations - See Presentations Tab for more detailed information.	
MDRP 9: (Rosetta Phone) Mobile Imaging, Rosetta Phone, and Light-Weight Visual Analytics for In-Field Analytics	Resource Allocation	2009/07	2009	2013/06	2013	Entered	Complete		Research	0	2009-ST-061-CI001	No	Bench Tests	FALSE			David Ebert	Purdue University		IN		Academic Community; Center for Disease Control and Prevention; Critical Infrastructure Owners and Operators; DHS U.S. Coast Guard; DHS U.S. Customs and Border Protection		2012		Advanced Data Analysis and Visualization; Biological Threats and Countermeasures; Border Security		Biometrics; Case Studies; Econometrics; Genomic Testing; Modeling; Molecular Biology/Genomics; Risk Assessment; Sampling; Statistical Analysis			Report	The project resulted in the DHS report we wrote that is available at: https://www.dhs.gov/publication/chicago-lte-video-pilot-report. Completed.					
MDRP 11: Financial Fraud Visual Analytics	Financial Flows Tools	2009/07	2009	2014/06	2014	Entered	Complete		Research	417775	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			William Ribarsky	University of North Carolina at Charlotte		IN; NC; MA		Academic Community; Consumers; Critical Infrastructure Owners and Operators; Federal Bureau of Investigation; Intelligence Community		2010		Advanced Data Analysis and Visualization; Infrastructure Protection; Social, Behavioral, and Economic Sciences		Case Studies; Econometrics; Modeling; Risk Assessment; Statistical Analysis	Computer Science		Tool	A procedure for creating simulated bank transaction datasets has been developed. The WireVis tool for analyzing bank transactions over extended periods of time is available to DHS partners and customers. We are expanding its capabilities to analyze the unstructured text fields that accompany transactions and that describe the purpose of a transaction, identify payees, and give other information. There are currently no automated methods to study these fields and connect them to the transactional	4 journal articles - See Journal Tab for more detailed information.		2 student theses - See Theses Tab for more detailed information.	2 presentations - See Presentations Tab for more detailed information.	
MDRP 12: Foreign Animal and Zoonotic Disease Visual Analytics	Disease Surveillance	2009/07	2009	2013/06	2013	Entered	Complete		Research	19320	2009-ST-061-CI001	Yes	Compiling and Sorting Database	FALSE			David Ebert	Purdue University		TX; IN; PA		Academic Community; Center for Disease Control and Prevention; Critical Infrastructure Owners and Operators; Food and Agriculture Industries; State and Local Transportation		2009		Advanced Data Analysis and Visualization; Biological Threats and Countermeasures; Risk and Decision Sciences		Biometrics; Case Studies; Econometrics; Genomic Testing; Modeling; Molecular Biology/Genomics; Risk Assessment; Sampling; Statistical Analysis	Risk management/assessment	Operational Use	Tool	The team has developed a new strategy for visualization coordination through the combination of several recent advances in software engineering: automatic introspection of objects, software design patterns, and reflective invocation of methods. This strategy is called Introspective Observer Coordination and demonstrates how this method can allow end users to create their own visualization toolkits on the fly, solve challenges associated with coupling spatial analysis methods to geovisualization methods, and make geovisualization applications sharable between users.	1 journal article - See Journal Tab for more detailed information.	10 other publications - See Other Publications Tab for more information.	1 student thesis - See Theses Tab for more detailed information.	3 presentations - See Presentations Tab for more information	
MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Law Enforcement	2009/07	2009	2013/03	2013	Entered	Complete		Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			David Ebert, Alan MacEachren	Purdue University		IN; CA; PA	Center for Command, Control, and Interoperability Center for Advanced Data Analysis	U.S. Army Corps of Engineers		2011				Case Studies; Sampling; Statistical Analysis	Computer Science	Laboratory Testing and Evaluation	Tool	1. Scalable visual analytic toolkit SensePlace2. a. Scalability ensured by innovative database design, indexing that allows large-scale storage and retrieval of social text streams such as those obtained Twitter. b. Improved algorithms to geo-code mentions of location names in social text streams in the presence of limited contextual information. 2. Timeline functionality that allows for range queries for temporal attributes. 3. Improved user interaction functionality 4. Clustering of similar tweets in order to enable improved examination of topics being tweeted. 5. With complementary funding from USACE, we developed methods to flexibly access geographic information using the standard Geonames hierarchy of place names for the world.	7 journal articles - See Journal Tab for more detailed information.	7 other publications - See Other Publications Tab for more information.	2 student theses - See Theses Tab for more detailed information.	4 presentations - See Presentations Tab for more detailed information.	
MDRP 14: Multimedia Visual Analytics for Investigative Analysis	Law Enforcement	2009/07	2009	2014/06	2014	Entered	Complete		Research	0	2009-ST-061-CI001	No	Data Mining	FALSE			David Ebert	Purdue University		IN; NC		Academic Community; DHS Labs; DHS Science and Technology Directorate; Federal Bureau of Investigation; Intelligence Community		2010		Advanced Data Analysis and Visualization; Biological Threats and Countermeasures; Border Security		Case Studies; Modeling; Sampling; Statistical Analysis	Computer Science		Tool	Our image analytics and exploration tools and source code are released to users at PNNL. They are available to customers in DHS S&T, if desired. Our automatic object detection and classification tools and source code are released to Vufind.com. They are available to customers in DHS S&T, if desired. Our multimedia analytics tools including StreamIt, Newdle, and PIWI are available to DHS S&T stakeholders and customers. Our systems on multimedia analytics have been demonstrated at multiple leading	29 journal articles - See Journal Tab for more detailed information.	11 other publications - See Other Publications Tab for more information.		6 presentations - See Presentations Tab for more detailed information.	
MDRP 18: Visual Analytics for the DHS Centers of Excellence	Resource Allocation	2009/07	2009	2012/06	2012	Entered	Complete		Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			David Ebert	Purdue University		CA; IL; IN; GA; NJ		Academic Community		2010				Case Studies; Statistical Analysis			Research	Journal articles and presentations were completed.	3 journal articles - See Journal Tab for more detailed information.			2 presentations - See Presentations Tab for more detailed information.	1 patent - See Patent Tab for more detailed information.

MDRP 17: START Center Visual Analytics	Law Enforcement	2009/07	2009	2010/03	2010	Entered	Withdrawn		Research	5429	2009-ST-061-CI001	No	Bench Tests	FALSE			David Ebert	Purdue University		MD; NC; IN; NJ	National Consortium for the Study of Terrorism and Responses to Terrorism	Academic Community; DHS Labs; DHS Science and Technology Directorate; DHS U.S. Customs and Border Protection; Federal Bureau of Investigation		2009		Advanced Data Analysis and Visualization; Human Factors Aspects of Technology; Social, Behavioral, and Economic		Case Studies; Modeling; Statistical Analysis	Computer Science		Withdrawn	Demonstrated collaboration between COEs. Journal articles were completed.	2 journal articles - See Journal Tab for more detailed information.				
EP 1: Leadership and Coordination	Education	2009/07	2009	2014/06	2014	Entered	Complete		Research	0	2009-ST-061-CI001	No	Bench Tests	FALSE			David Ebert	Purdue University		NJ; GA; IN; MS; TX				2009		Advanced Data Analysis and Visualization; Biological Threats and Countermeasures; Border Security		Biometrics; Case Studies; Econometrics; Genomic Testing; Modeling; Molecular Biology/Genomics; Risk Assessment; Sampling	Computer Science		Groups, Panel?	1. The Project PI and support faculty member visited Purdue University in November to work on the Education Plan. 2. The Project PI and support faculty member participated in monthly education conference calls as well as the collaboration calls with Rutgers University. 3. The 2010 ADMI/A4RC conference was held on April 8-11, 2010 in Jackson, MS. VACCINE was spotlighted in two conference sessions and the evening Social Networking	5 journal articles - See Journal Tab for more detailed information.			1 presentation - See Presentations Tab for more detailed information.	
EP 2: MSI Collaboration	Education	2009/07	2009	2016/06	2016	Entered	Complete	Big Data Visual Analytics	Research	264029	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			David Ebert	Purdue University	Bethune-Cookman College; Jackson State University; Morgan State University	FL; MD; MS; IN; NJ; TX; CA		Critical Infrastructure Owners and Operators; Department of Energy National Labs; Federal Bureau of Investigation; Food and Agriculture Industries; State and Local First Responders		2015		Advanced Data Analysis and Visualization; Biological Threats and Countermeasures; Chemical Threats and Countermeasures		Biometrics; Case Studies; Econometrics; Genomic Testing; Modeling; Molecular Biology/Genomics; Risk Assessment; Sampling; Statistical Analysis	Computer Science		Workshop	2015 Visual Analytics Faculty Workshop - Bethune-Cookman University - June 18, 2015 - June 19, 2015 - MSI Summer Research Workshop for Morgan State University undergrads - July 19, 2015 to July 25, 2015 - VACCINE center was host to six undergraduate students from MSI partner Morgan State University (MSU). The students were housed on-campus at Purdue University and engaged in activities and presentations that helped them to better understand visual analytics and its real-world applications. DHS - Summer Research Team (SRT) for Minority Serving Institutions (MSI). - May 25, 2015 - July 31, 2015 - Dr. Louis Ngamassi, a College of Business professor at Prairie View A&M University, successfully completed the SRT Program in the summer of 2015. With the support of the VACCINE Center, Ngamassi is incorporating visual analytics into a new course he is developing entitled "Crisis Informatics."		7 other publications - See Other Publications Tab for more information.		5 presentations - See Presentations Tab for more detailed information.	
EP 4: SURF Program (Summer Undergraduate Research Fellowships)	Education	2009/07	2009	2016/06	2016	Entered	Complete	Big Data Visual Analytics		183686	2009-ST-061-CI001	No		FALSE			David Ebert	Purdue University	Jackson State University	MS; IN		Academic Community		2015		Advanced Data Analysis and Visualization			Classroom Education								
EP 5: Graduate Programs	Education	2009/07	2009	2015/12	2015	Entered	Complete		Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			David Ebert	Purdue University		GA; IN		Academic Community		2009		Advanced Data Analysis and Visualization		Case Studies	Computer Science								
EP 6: HS-STEM Career Development Program	Education	2009/07	2009	2017/07	2017	Entered	In Progress		Research	431090	2009-ST-061-CI001	No		FALSE			David Ebert	Purdue University		IN	Center for Visual Analytics for Command, Control, and Interoperability Environments	Academic Community		2016		Advanced Data Analysis and Visualization; Biological Threats and Countermeasures; Border Security			Classroom Education	Basic Research	Development	Development of 26 STEM Students. Please see Education initiatives and student successes for more information.					
EP 7: Professional Development	Education	2009/07	2009	2017/06	2017	Entered	In Progress	Big Data Visual Analytics	Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			David Ebert	Purdue University	Jackson State University; University of Houston-Downtown; Bethune-Cookman College	IN; NJ; GA		State and Local First Responders; State and Local Public Health Agencies		2015		Advanced Data Analysis and Visualization		Case Studies; Qualitative Analysis; Risk Assessment	Classroom Education	Basic Research	Workshop	The workshop had over 500 registrants.					
EP 8: (VADL) Educational Materials	Education	2009/07	2009	2010/12	2010	Entered	Complete		Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			David Ebert	Purdue University		GA; IN		Academic Community		2010		Advanced Data Analysis and Visualization		Statistical Analysis	Classroom Education		Education Materials	The Visual Analytics Digital Library (VADL) provided a website that contained a variety of resources for the visual analytics education community including class syllabi, sample exams, video lectures, lecture notes and so on. The project helped boot-strap a variety of educational program efforts across different universities by providing a shared resource repository that could be tapped for assistance. As the area matured and more information about visual analytics became prevalent across the web, the need for the VADL lessened, and we eventually stopped updating and supporting the site.					
Video Surveillance Visual Analytics	Law Enforcement	2009/07	2009	2012/06	2012	Entered	Complete			0	2009-ST-061-CI001	No		FALSE			Ed Delp	Purdue University		IN																	
MDRP 1: Geovisual Analytics	Law Enforcement	2009/07	2009	2010/03	2010	Entered	Complete		Research	399808	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			John Stasko	Georgia Institute of Technology		GA; IN; PA; CA						Advanced Data Analysis and Visualization; Human Factors Aspects of Technology		Case Studies; Sampling; Statistical Analysis			Tool	The team developed techniques and tools for investigative analysis on large collections of documents including both unstructured text and structured documents (e.g., spreadsheets). They developed systems that use interactive visualizations to help analysts with performing exploration, sense-making, and understanding tasks. If they could help analysts determine which documents to read first and to also find important, connected documents, then they could help them to make timelier and accurate assessments of the situations described within those documents. The project builds upon the Jigsaw system, and explores how new capabilities can be added to it. They also planned to disseminate the system for use by real clients, people, and organizations in various domains.	2 journal articles - See Journal Tab for more detailed information.				
ISIS - Infovis System for Investigating Intrusions	Law Enforcement	2009/07	2009	2011/06	2011	Entered	Complete	Information-driven Visualization, Modeling and Simulation of Data	Research	0	2009-ST-061-CI001	No		FALSE			Patrick Hanrahan; Pat Hanrahan	Office of University Programs, Science & Technology Directorate		CA				2011							Tool	Awaiting deployment to US CERT A California-based proof of concept application of the TransNIEMO modeling approach was prompted by interest from the California Department of Transportation in concert with the National Center for Metropolitan Transportation Research (METRANS).					
VACCINE Affinity Research Groups	Education	2009/07	2009	2012/06	2012	Entered	Complete		Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			Richard Aló; Richard Alo	University of Houston-Downtown; University of Houston-Downtown	University of Houston-Downtown	IN; TX; CA				2011				Statistical Analysis	Biostatistics and bioinformatics; Computer Science; Mathematics		Research Groups	Twenty-six undergraduate students, including 14 supported students, from Univ. of Houston-Downtown, Navajo Tech and Cal State-Dominguez Hills participated in the VACCINE Affinity Research Groups organized by Richard Alo. These were students from a combination of statistics, math and computer science. As a result of participation in this project, students gained research and collaboration experience and submitted posters and publications for the Student Research Day Conference at Cal State-Dominguez Hills.			2 student theses - See Theses Tab for more detailed information.		
Developing a Sustainable Visual Analytics for Command Center Environments	Resource Allocation	2009/07	2009	2011/03	2011	Entered	Complete		Research	0	2009-ST-061-CI001	No		FALSE			Mark Haselkorn; Mark Haselkorn	University of Washington; University of Washington		WA																	
Enhancing Interactive Visual Analysis and Decision Making Environments	Resource Allocation	2009/07	2009	2010/06	2010	Entered	Complete		Research	0	2009-ST-061-CI001	No	Expert Consultation	FALSE			Mark Haselkorn	University of Washington		WA		DHS U.S. Coast Guard		2011				Modeling	Engineering		Tool	We have successfully modeled workflow in a clinical environment and used that to work with practitioners in the design and development of a mobile application that enhances communication between patients and healthcare providers. That application, called Priority Contact, is being piloted in the sandbox environment of the Veterans Healthcare Administration.	2 journal articles - See Journal Tab for more detailed information.			4 presentations - See Presentations Tab for more detailed information.	2 patents - See Patent Tab for more detailed information.
PanViz	Disease Surveillance	2009/07	2009	2011/06	2011	Entered	Complete		Research	0	2009-ST-061-CI001	No		FALSE			David Ebert	Purdue University		IN; NC; PA; WA				2011								VACCINE developed an interactive pandemic preparedness, surveillance					
PURVAC RVF	Education	2009/07	2009	2011/06	2011		Complete		Research	0	2009-ST-061-CI001	No		FALSE			David Ebert	Purdue University																			
MDRP 2: Integrate Automated Analytical Reasoning into Jigsaw	Law Enforcement	2009/07	2009	2010/06	2010	Entered	Complete		Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			John Stasko	Georgia Institute of Technology		GA		Academic Community; DHS Science and Technology Directorate; Federal Bureau of Investigation; Intelligence Community		2009		Advanced Data Analysis and Visualization		Case Studies; Sampling	Computer Science			This project produced a system prototype that combined the Jigsaw system with capabilities from the STAB system. We experimented with this					
SP 1: Improving Query Performance in Large Scale Analytic Databases	Law Enforcement	2009/07	2009	2011/06	2011	Entered	Complete		Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			Patrick Hanrahan; Pat Hanrahan	Stanford University; Stanford University		CA		DHS National Protection & Programs Directorate; DHS U.S. Coast Guard		2009		Advanced Data Analysis and Visualization; Border Security; Maritime and Port Security		Case Studies	Computer Science								
Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Law Enforcement	2009/07	2009	2010/03	2010	Entered	Complete		Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			William Ribarsky	University of North Carolina at Charlotte		NC; IN; NJ; PA; VA		State and Local First Responders		2010				Biometrics; Case Studies; Econometrics; Modeling; Molecular Biology/Genomics; Risk Assessment; Sampling; Statistical Analysis	Geography; Information Science		Demonstration	The urban routing and emergency response system was incorporated into the Canada- US Experiment Emergency Resiliency Environment (CAUSE –ERE) scenario set for demonstration at the end of June. DHS managers were in attendance for the experiment. The initial experiment involved an earthquake in the Pacific Northwest spanning the U.S.-Canada border. The system will be used for mobile emergency routing and situational awareness in a downtown	1 journal article - See Journal Tab for more detailed information.		2 student theses - See Theses Tab for more detailed information.	1 presentation - See Presentations Tab for more detailed information.	

(Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Law Enforcement	2009/06	2009	2017/06	2017	Entered	In Progress		Research	637772	2009-ST-061-CI001	No	Expert Consultation	FALSE			John Stasko	Georgia Institute of Technology		GA; IN; PA	Center for Visual Analytics for Command, Control, and Interoperability Environments	State and Local First Responders; Other State or Local		2016		Advanced Data Analysis and Visualization; Risk and Decision Sciences		Case Studies; Sampling; Statistical Analysis	Information Science; Communication (risk, scientific, technical); Computer Science	Operational Use	Tool	Jigsaw is a large Java-based desktop application system. It contains just under 100,000 lines of code. The system is available for anyone to download via http://www.cc.gatech.edu/gvu/ii/jigsaw. Jigsaw was used by the Indianapolis Police Department, West Lafayette Police Department, Rock Hill Police Department (SC), and the Lafayette Police Department. It is being used in various university classes on visual analytics and intelligence analysis and has been downloaded by a wide variety of organizations in government and industry. There have been approximately 8000 downloads of the Jigsaw system in its history. Examples of organizations that have downloaded JIGSAW are; Air Force Intelligence, AFRL Wright Patterson, Army Counterintelligence, Boeing Deloitte, Naval Research Lab, National Crime Information Center, PayPal, Thomson Reuters, United Nations Investigators Office, US Attorney's Office Organized Crime Taskforce, as well as numerous newspapers and police departments. The research team published 11 full papers and 5 abstracts about the project. Additionally, Dr. Stasko	18 journal articles - See Journal Tab for more detailed information.	5 other publications - See Other Publications Tab for more information.	2 student theses - See Theses Tab for more detailed information.	37 presentations - See Presentations Tab for more detailed information.	
MDRP 13: (SensePlace 2) Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Resource Allocation	2009/06	2009	2010/06	2010	Entered	Complete		Research	100000	2009-ST-061-CI001	No	Data Mining	FALSE			Alan MacEachren; Alan MacEachren	Pennsylvania State University; Pennsylvania State University		PA		State and Local First Responders		2016		Advanced Data Analysis and Visualization; Communications and Interoperability; Emergency Preparedness and Response		Case Studies; Risk Assessment; Statistical Analysis	Geographic information sciences; Computer Science	Pilot/Field Testing and Evaluation in an Operational Environment	Tool	GeoTxt has been integrated as the backend geographic entity recognition, disambiguation, and co-coding systems to support SensePlace 2, our spatial-temporal twitter analytics environment. The early stages of SensePlace 2 (and its precursor SensePlace) were funded through VACCINE.	3 journal articles - See Journal Tab for more detailed information.			10 presentations - See Presentations Tab for more detailed information.	
EP 3: K-12 Programs	Education	2009/02	2009	2013/09	2013	Entered	Complete		Research	0	2009-ST-061-CI001	No		FALSE			David Ebert	Purdue University		NJ; IN		Academic Community; Consumers; DHS Science and Technology Directorate; Media		2011		Advanced Data Analysis and Visualization			Classroom Education		Classroom Education	VACCINE limited its interaction in K-12 activities at the suggestion of DHS at the end of Year 2. Students from the HS-STEM program visited Principles of Engineering classes at a local high school and presented information on their research, visual analytics and connections to homeland security. As a follow-up, 30 students from the school came to campus for half a day to tour our visual analytics labs and learn about the research taking place through VACCINE. The teacher was very impressed.				8 presentations - See Presentations Tab for more detailed information.	
Scatterblogs	Resource Allocation								Research	0		No		FALSE																	Tool	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.					
Measuring & Visualizing Information Trustworthiness Using Visual Analytics	Law Enforcement					Entered				113750	2009-ST-061-CI001	No		FALSE																		Generated a report					
Malware on Smartphones: Collection, Analysis and Defensive Measures	Law Enforcement					Entered			Research	0	2009-ST-061-CI001	No		FALSE						CA; IN																	
Co-Located Collaborative Analysis on Large, High-Resolution Displays using Multiple Input Devices; Public Safety Coalition Projects	Law Enforcement					Entered	Complete		Research	0	2009-ST-061-CI001	No	Survey	FALSE			Chris North	Virginia Tech University		GA; VA		State and Local First Responders		2011				Case Studies; Statistical Analysis	Computer Science		Research	Virginia Tech's project on —Collocated Collaborative Visual Analytics involved two undergraduate female and one graduate female computer science students who were involved with the research on the project. As a result, the two undergraduates plan to pursue graduate 27 research opportunities and the graduate students received an offer for a summer internship at PNNL to continue research related to the project.	3 journal articles - See Journal Tab for more detailed information.	3 other publications - See Other Publications Tab for more information.		4 presentations - See Presentations Tab for more detailed information.	
Navajo Nation Graffiti Project	Law Enforcement					Entered	Withdrawn		Research	0	2009-ST-061-CI001	No	Field Monitors	FALSE			Mark Trebian	Navajo Technical University		NM; UT; IN; AZ		DHS Federal Emergency Management Agency; DHS Transportation Security Administration; DHS U.S. Coast Guard; State and Local First Responders		2014				Modeling; Sampling	Geography; Computer Science; Mathematics; Sociology; Information systems								
Critical Infrastructure Integration Modeling and Simulation Project	Resource Allocation								Research	0	2009-ST-061-CI001	No		FALSE			William Ribarsky	University of North Carolina at Charlotte		NC																	

code	first_name	last_name	email	project_title	role	institution_names	status
11	Shehzad	Afzal	safzal@purdue.edu	(MERGE) Mobile Emergency Response Guide	Graduate Student-Doctorate	Purdue University	Complete
12	Shehzad	Afzal	safzal@purdue.edu	(VASA) – Visual Analytics for Security Applications	Graduate Student-Doctorate	Purdue University	Complete
49	Shehzad	Afzal	safzal@purdue.edu	Coast Guard PROTECT Visualization	Graduate Student-Doctorate	Purdue University	Complete
89	Shehzad	Afzal	safzal@purdue.edu	Parallelizing Video Algorithms for Real-Time/Near-Real-Time Public Safety Applications; Public Safety Coaltion Project	Graduate Student-Masters	Purdue University	
17	Shehzad	Afzal	safzal@purdue.edu	SMART: Social Media Analytics and Reporting Toolkit	Graduate Student-Doctorate	Purdue University	In Progress
22	Shehzad	Afzal	safzal@purdue.edu	Safety in View: A Public Safety Visual Analytics Tool Based on CCTV Camera Angles of View	Graduate Student-Doctorate	Purdue University	Complete
23	Shehzad	Afzal	safzal@purdue.edu	Social Media and Healthcare Analytics for Identification of Emerging Health Threats	Graduate Student-Doctorate	Purdue University	Complete
75	Shehzad	Afzal	safzal@purdue.edu	iVALET - Mobile Visual Analytics Law Enforcement Toolkit	Graduate Student-Doctorate	Purdue University	Complete
106	shehzad	Afzal	safzal@purdue.edu	Visual Analytics Law Enforcement Technology; Public Safety Coalition Projects	Graduate Student-Masters	Purdue University	In Progress
5	Tim	Akers	timothy.akers@morgan.edu	(iLEAPS) iLaw Enforcement Apps Assistance Program for Students	Principal Investigator	Morgan State University	Complete
	Richard	Alo	alor@dt.uh.edu	EP 1: Leadership and Coordination	Co-Principal Investigator	University of Houston-Downtown	Complete
	Richard	Alo	alor@dt.uh.edu	EP 2: MSI Collaboration	Co-Principal Investigator	University of Houston-Downtown	Complete

72	Richard	Alo	richard.a.alo@jsums.edu	GIS Implementations	Principal Investigator	Jackson State University	Complete
65	Richard	Alo	richard.a.alo@jsums.edu	VACCINE Affinity Research Groups	Principal Investigator	University of Houston-Downtown	Complete
72	Richard	Aló	alor@dt.uh.edu	GIS Implementations	Principal Investigator	University of Houston-Downtown	Complete
65	Richard	Aló	alor@dt.uh.edu	VACCINE Affinity Research Groups	Principal Investigator	University of Houston-Downtown	Complete
14	Richard	Arias hernandez		MDRP 6: Video Surveillance Visual Analytics	Post-Doctorate		Complete
7	Siddhartha	Banerjee		(GeoTxt) E2E: GeoTxt API	Other	Pennsylvania State University	In Progress
7	Siddhartha	Banerjee		(GeoTxt) E2E: GeoTxt API	Other	Pennsylvania State University	In Progress
	Scott	Barlowe		MDRP 14: Multimedia Visual Analytics for Investigative Analysis	Other	University of North Carolina at Charlotte	Complete
	Christopher	Barrett	cbarrett@vbi.vt.edu	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Co-Principal Investigator	Virginia State University	Complete
65	Mohsen	Beheshti	MBeheshti@csudh.edu	VACCINE Affinity Research Groups	Co-Principal Investigator	California State University-Dominguez Hills	Complete
	Ishan	Behoora		MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Other	Pennsylvania State University	Complete
	Alena	Benson		MDRP 7: Introducing Sustainable Visual Analytics into Command Center Environments	Graduate Student-Masters	University of Washington	Complete
8	Raechel	Bianchetti		Symbology Standardization Support	Other	Pennsylvania State University	Complete

	Maureen	Biggers	biggers@indiana.edu	EP 1: Leadership and Coordination	Co-Principal Investigator	Indiana University School of Medicine	Complete
	Maureen	Biggers	biggers@indiana.edu	EP 2: MSI Collaboration	Co-Principal Investigator	Indiana University School of Medicine	Complete
100	Ann	Blandford		UKVAC II	Collaborator-unpaid		Complete
114	Mimi	Boutin	mboutin@purdue.edu	Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Co-Principal Investigator	Purdue University	Complete
	Mireille	Boutin	mboutin@purdue.edu	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Co-Principal Investigator	Purdue University	Complete
	Mireille	Boutin	mboutin@purdue.edu	MDRP 9: (Rosetta Phone) Mobile Imaging, Rosetta Phone, and Light-Weight Visual Analytics for In-Field Analytics	Co-Principal Investigator	Purdue University	Complete
77	Lauren	Bradel	lbradel1@vt.edu	Co-Located Collaborative Analysis on Large, High-Resolution Displays using Multiple Input Devices; Public Safety Coalition Projects	Graduate Student-Masters	Virginia Tech University	Complete
128	Robert	Bridges	bridgesra@ornl.gov	Context-Driven Visual Analytics for Cyber Defensive Operations - Oak Ridge N Lab	Co-Principal Investigator		Complete
	Marti	Burns	mhburns@purdue.edu	EP 1: Leadership and Coordination	Co-Principal Investigator	Purdue University	Complete
	Marti	Burns		EP 2: MSI Collaboration	Co-Principal Investigator	Purdue University	Complete
107	Marti	Burns	mhburns@purdue.edu	EP 3: K-12 Programs	Co-Principal Investigator	Purdue University	Complete

	Marti	Burns	mhburns@purdue.edu	EP 4: SURF Program (Summer Undergraduate Research Fellowships)	Co-Principal Investigator	Purdue University	Complete
	Marti	Burns	mhburns@purdue.edu	EP 7: Professional Development	Co-Principal Investigator	Purdue University	In Progress
	Marti	Burns	mhburns@purdue.edu	K-12 Programs	Co-Principal Investigator	Purdue University	In Progress
14	Nadya	Calderon Romero Alexandra		MDRP 6: Video Surveillance Visual Analytics	Graduate Student-Doctorate		Complete
80	Winston	Cambridge		Navajo Nation Graffiti Project	Undergraduate Student	Navajo Technical University	Withdrawn
6	Alice	Carron		(GARI) Navajo Nation Graffiti Project	Principal Investigator		Withdrawn
80	Alice	Carron	alicemcarron@gmail.com	Navajo Nation Graffiti Project	Co-Principal Investigator	Navajo Technical University	Withdrawn
11	Junghoon	Chae	jchae@purdue.edu	(MERGE) Mobile Emergency Response Guide	Graduate Student-Masters	Purdue University	Complete
17	Junghoon	Chae	jchae@purdue.edu	SMART: Social Media Analytics and Reporting Toolkit	Graduate Student-Doctorate	Purdue University	In Progress
29	Junghoon	Chae	jchae@purdue.edu	TRIP: Trip Response Investigative Profiler	Graduate Student-Doctorate	Purdue University	
	Remco	Chang	remco@cs.tufts.edu	MDRP 11: Financial Fraud Visual Analytics	Co-Principal Investigator	Tufts University	Complete
21	Min	Chen	min.chen@oerc.ox.ac.uk	Analyzing High-dimensional Multivariate Network Links with Integrated Anomaly Detection, Highlighting and Exploration	Co-Principal Investigator		In Progress
19	Min	Chen	min.chen@oerc.ox.ac.uk	Analyzing High-dimensional Multivariate Network Links with Integrated Anomaly Detection, Highlighting and Exploration	Co-Principal Investigator	University of Oxford	Complete

113	Min	Chen	min.chen@oerc.ox.ac.uk	Seed 3: Uncertainty in Video Visual Analytics	Co-Principal Investigator		Complete
100	Min	Chen	min.chen@oerc.ox.ac.uk	UKVAC II	Principal Investigator		Complete
99	Min	Chen	min.chen@oerc.ox.ac.uk	UKVAC Joint Research Project	Principal Investigator		Complete
103	Min	Chen	min.chen@oerc.ox.ac.uk	Video Surveillance Project	Co-Principal Investigator		Complete
	Ping	Chen		EP 1: Leadership and Coordination	Co-Principal Investigator	University of Houston-Downtown	Complete
65	Ping	Chen		VACCINE Affinity Research Groups	Co-Principal Investigator	University of Houston-Downtown	Complete
4	Shu-Ching	Chen	chens@cs.fiu.edu	(MADIS) A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data	Principal Investigator	Florida International University	Complete
4	Shu-Ching	Chen	chens@cs.fiu.edu	(MADIS) A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data	Principal Investigator	Florida International University	Complete
58	Shu-Ching	Chen	chens@cs.fiu.edu	A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data; Public Safety Coalition Projects	Principal Investigator	Florida International University	Complete
	Shu-Ching	Chen	chens@cs.fiu.edu	EP 2: MSI Collaboration	Co-Principal Investigator	Florida International University	Complete

3	Siqiao	Chen	chen1722@purdue.edu	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Graduate Student-Masters	Purdue University	In Progress
	Yang	Chen		MDRP 14: Multimedia Visual Analytics for Investigative Analysis	Other	University of North Carolina at Charlotte	Complete
24	Yang	Chen		Multimedia, Social Media, Text, and Emergency Response Analytics	Other	University of North Carolina at Charlotte	Complete
	Ying	Chen		MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Other	Pennsylvania State University	Complete
	Jen	Christopher	christ81@purdue.edu	EP 6: HS-STEM Career Development Program	Staff	Purdue University	In Progress
	Newville	Clark		MDRP 12: Foreign Animal and Zoonotic Disease Visual Analytics	Co-Principal Investigator	Texas A & M University	Complete
115	Seth	Clark		SP 15-Task 3: Event Evacuation Planning; Public Safety Coalition Projects	Graduate Student-Masters	University of North Carolina at Charlotte	Complete
	William	Cleveland	wsc@purdue.edu	MDRP 12: Foreign Animal and Zoonotic Disease Visual Analytics	Co-Principal Investigator	Purdue University	Complete
	William	Cleveland	wsc@purdue.edu	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Co-Principal Investigator	Purdue University	Complete
	William	Cleveland	wsc@purdue.edu	MDRP 5: Cybersecurity Visual Analytics	Co-Principal Investigator	Purdue University	Complete
114	William	Cleveland	wsc@stat.purdue.edu	Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Co-Principal Investigator	Purdue University	Complete

61	Tim	Collins		Analytical Visualization of the Port Arthur, TX Economic Impact Study	Co-Principal Investigator	Purdue University	Complete
	Tim	Collins		EP 7: Professional Development	Co-Principal Investigator	Purdue University	In Progress
	Tim	Collins	tfcollin@purdue.edu	MDRP 16: (VALET) Context-aware Mobile Visual Analytics for Emergency Response	Co-Principal Investigator	Purdue University	Complete
	Tim	Collins	tfcollin@purdue.edu	MDRP 7: Introducing Sustainable Visual Analytics into Command Center Environments	Co-Principal Investigator	Purdue University	Complete
118	Tim	Collins		SP 14 Task 3: Technical Integration into ExPOD at JIBC	Co-Principal Investigator	Purdue University	Complete
114	Tim	Collins		Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Co-Principal Investigator	Purdue University	Complete
29	Tim	Collins		TRIP: Trip Response Investigative Profiler	Co-Principal Investigator	Purdue University	
106	Tim	Collins	tfcollins@purdue.edu	Visual Analytics Law Enforcement Technology; Public Safety Coalition Projects	Co-Principal Investigator	Purdue University	In Progress
75	Tim	Collins		iVALET - Mobile Visual Analytics Law Enforcement Toolkit	Co-Principal Investigator	Purdue University	Complete
	Midge	Cozzens	midge6930@comcast.net	EP 1: Leadership and Coordination	Co-Principal Investigator	Rutgers University	Complete
	Midge	Cozzens	midge6930@comcast.net	EP 2: MSI Collaboration	Co-Principal Investigator	Rutgers University	Complete
107	Midge	Cozzens	midgec@dimacs.rutgers.edu	EP 3: K-12 Programs	Co-Principal Investigator	Rutgers University	Complete

	Midge	Cozzens	midge6930@comcast.net	EP 7: Professional Development	Co-Principal Investigator	Rutgers University	In Progress
	Midge	Cozzens	midge6930@Comcast.net	K-12 Programs	Co-Principal Investigator	Rutgers University	In Progress
116	Midge	Cozzens	midgec@dimacs.rutgers.edu	RECONNECT Workshop 2010 - Extracting and Visualizing Information from Natural Language Text	Co-Principal Investigator	Rutgers University	Complete
	Daniel	Dailey	dan@its.washington.edu	MDRP 7: Introducing Sustainable Visual Analytics into Command Center Environments	Co-Principal Investigator	University of Washington	Complete
65	Tom	Davis	tdavis@navajotech.edu	VACCINE Affinity Research Groups	Co-Principal Investigator	Navajo Technical University	Complete
118	Murray	Day		SP 14 Task 3: Technical Integration into ExPOD at JIBC	Co-Principal Investigator	Justice Institute of British Columbia	Complete
24	Jeffrey	Delawder		Multimedia, Social Media, Text, and Emergency Response Analytics	Other	University of North Carolina at Charlotte	Complete
15	Ed	Delp	ace@ecn.purdue.edu	(Crowdsourcing) Combining Crowdsourcing technology with machine learning to do visual analytics on big qualitative data (video datasets).	Co-Principal Investigator	Purdue University	Complete
10	Ed	Delp	ace@ecn.purdue.edu	(GARI) Gang Graffiti Recognition and Analysis	Principal Investigator	Purdue University	In Progress
11	Ed	Delp	ace@ecn.purdue.edu	(MERGE) Mobile Emergency Response Guide	Principal Investigator	Purdue University	Complete
88	Ed	Delp	ace@ecn.purdue.edu	Parallelizing Video Algorithms for Public Safety Applications	Co-Principal Investigator	Purdue University	Complete

114	Ed	Delp	ace@ecn.purdue.edu	Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Co-Principal Investigator	Purdue University	Complete
2	Ed	Delp		Video Surveillance Visual Analytics	Principal Investigator	Purdue University	Complete
10	Edward	Delp	ace@purdue.edu	(GARI) Gang Graffiti Recognition and Analysis	Principal Investigator	Purdue University	In Progress
11	Edward	Delp	ace@purdue.edu	(MERGE) Mobile Emergency Response Guide	Principal Investigator	Purdue University	Complete
25	Edward	Delp	ace@ecn.purdue.edu	Chicago LTE Project	Principal Investigator	Purdue University	Complete
25	Edward	Delp	ace@purdue.edu	Chicago LTE Project	Principal Investigator	Purdue University	Complete
33	Edward	Delp	ace@purdue.edu	Hazmat Placards	Principal Investigator	Purdue University	Complete
	Edward	Delp	ace@purdue.edu	MDRP 14: Multimedia Visual Analytics for Investigative Analysis	Co-Principal Investigator	Purdue University	Complete
	Edward	Delp	ace@purdue.edu	MDRP 16: (VALET) Context-aware Mobile Visual Analytics for Emergency Response	Co-Principal Investigator	Purdue University	Complete
	Edward	Delp	ace@purdue.edu	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Co-Principal Investigator	Purdue University	Complete
14	Edward	Delp	ace@ecn.purdue.edu	MDRP 6: Video Surveillance Visual Analytics	Co-Principal Investigator	Purdue University	Complete
	Edward	Delp	ace@purdue.edu	MDRP 9: (Rosetta Phone) Mobile Imaging, Rosetta Phone, and Light-Weight Visual Analytics for In-Field Analytics	Co-Principal Investigator	Purdue University	Complete
89	Edward	Delp	ace@ecn.purdue.edu	Parallelizing Video Algorithms for Real-Time/Near-Real-Time Public Safety Applications; Public Safety Coaltion Project	Co-Principal Investigator	Purdue University	

26	Edward	Delp	ace@ecn.purdue.edu	VBOLO	Principal Investigator	Purdue University	In Progress
26	Edward	Delp	ace@purdue.edu	VBOLO	Principal Investigator	Purdue University	In Progress
	Edward	Delp	ace@purdue.edu	Video Surveillance Visual Analytics	Co-Principal Investigator	Purdue University	In Progress
12	Khaldoon	Dhou		(VASA) – Visual Analytics for Security Applications	Other	University of North Carolina at Charlotte	Complete
120	Khaldoon	Dhou		SP 14 Task 5: Visual Analytics for Security Applications - VASA	Other	University of North Carolina at Charlotte	Complete
13	John	Dill	dill@cs.sfu.ca	MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	Co-Principal Investigator	Simon Fraser University	Complete
	John	Dill	dill@cs.sfu.ca	MDRP 18: Visual Analytics for the DHS Centers of Excellence	Co-Principal Investigator	Simon Fraser University	Complete
24	Douglas	Dorr	ddorr@epri.com	Multimedia, Social Media, Text, and Emergency Response Analytics	Co-Principal Investigator		Complete
24	Wenwen	Dou		Multimedia, Social Media, Text, and Emergency Response Analytics	Other	University of North Carolina at Charlotte	Complete
24	Todd	Eaglin		Multimedia, Social Media, Text, and Emergency Response Analytics	Other	University of North Carolina at Charlotte	Complete
16	David	Ebert	ebertd@ecn.purdue.edu	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Principal Investigator	Purdue University	Complete
3	David	Ebert	ebertd@ecn.purdue.edu	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Principal Investigator	Purdue University	In Progress
12	David	Ebert	ebertd@ecn.purdue.edu	(VASA) – Visual Analytics for Security Applications	Principal Investigator	Purdue University	Complete

61	David	Ebert	ebertd@ecn.purdue.edu	Analytical Visualization of the Port Arthur, TX Economic Impact Study	Principal Investigator	Purdue University	Complete
19	David	Ebert	ebertd@ecn.purdue.edu	Analyzing High-dimensional Multivariate Network Links with Integrated Anomaly Detection, Highlighting and Exploration	Principal Investigator	Purdue University	Complete
60	David	Ebert	ebertd@ecn.purdue.edu	Bristle Maps - A Multivariate Abstraction Technique for Geovisualization	Principal Investigator	Purdue University	Complete
42	David	Ebert	ebertd@ecn.purdue.edu	CES: Student Travel	Principal Investigator	Purdue University	Complete
18	David	Ebert	ebertd@ecn.purdue.edu	COAST: Coastal Operations and Analysis Suite of Tools	Principal Investigator	Purdue University	Complete
30	David	Ebert	ebertd@ecn.purdue.edu	CVADA	Principal Investigator	Purdue University	
49	David	Ebert	ebertd@ecn.purdue.edu	Coast Guard PROTECT Visualization	Principal Investigator	Purdue University	Complete
62	David	Ebert	ebertd@ecn.purdue.edu	Coast Guard Swimmer Deaths	Principal Investigator	Purdue University	Complete
	David	Ebert	ebertd@ecn.purdue.edu	EP 1: Leadership and Coordination	Principal Investigator	Purdue University	Complete
	David	Ebert	ebertd@ecn.purdue.edu	EP 2: MSI Collaboration	Principal Investigator	Purdue University	Complete
107	David	Ebert	ebertd@ecn.purdue.edu	EP 3: K-12 Programs	Principal Investigator	Purdue University	Complete
	David	Ebert	ebertd@ecn.purdue.edu	EP 4: SURF Program (Summer Undergraduate Research Fellowships)	Principal Investigator	Purdue University	Complete
	David	Ebert	ebertd@ecn.purdue.edu	EP 5: Graduate Programs	Principal Investigator	Purdue University	Complete
	David	Ebert	ebertd@ecn.purdue.edu	EP 6: HS-STEM Career Development Program	Principal Investigator	Purdue University	In Progress
	David	Ebert	ebertd@ecn.purdue.edu	EP 7: Professional Development	Principal Investigator	Purdue University	In Progress
	David	Ebert	ebertd@ecn.purdue.edu	EP 8: (VADL) Educational Materials	Principal Investigator	Purdue University	Complete

68	David	Ebert	ebertd@ecn.purdue.edu	High Risk Alcohol Behavior Analysis	Principal Investigator	Purdue University	Complete
	David	Ebert	ebertd@ecn.purdue.edu	K-12 Programs	Principal Investigator	Purdue University	In Progress
67	David	Ebert	ebertd@ecn.purdue.edu	LAHVA: Linked Animal-Human Health Visual Analytics	Principal Investigator	Purdue University	Complete
	David	Ebert	ebertd@ecn.purdue.edu	MDRP 12: Foreign Animal and Zoonotic Disease Visual Analytics	Principal Investigator	Purdue University	Complete
	David	Ebert	ebertd@ecn.purdue.edu	MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Principal Investigator	Purdue University	Complete
	David	Ebert	ebertd@ecn.purdue.edu	MDRP 14: Multimedia Visual Analytics for Investigative Analysis	Principal Investigator	Purdue University	Complete
	David	Ebert	ebertd@ecn.purdue.edu	MDRP 16: (VALET) Context-aware Mobile Visual Analytics for Emergency Response	Principal Investigator	Purdue University	Complete
	David	Ebert	ebertd@ecn.purdue.edu	MDRP 17: START Center Visual Analytics	Principal Investigator	Purdue University	Withdrawn
13	David	Ebert	ebertd@ecn.purdue.edu	MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	Principal Investigator	Purdue University	Complete
	David	Ebert	ebertd@ecn.purdue.edu	MDRP 18: Visual Analytics for the DHS Centers of Excellence	Principal Investigator	Purdue University	Complete
	David	Ebert	ebertd@ecn.purdue.edu	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Principal Investigator	Purdue University	Complete
	David	Ebert	ebertd@ecn.purdue.edu	MDRP 5: Cybersecurity Visual Analytics	Principal Investigator	Purdue University	Complete
	David	Ebert	ebertd@ecn.purdue.edu	MDRP 7: Introducing Sustainable Visual Analytics into Command Center Environments	Principal Investigator	Purdue University	Complete

	David	Ebert	ebertd@ecn.purdue.edu	MDRP 9: (Rosetta Phone) Mobile Imaging, Rosetta Phone, and Light-Weight Visual Analytics for In-Field Analytics	Principal Investigator	Purdue University	Complete
66	David	Ebert	ebertd@ecn.purdue.edu	MarketAnalyzer: An Interactive Visual Analytics System for Analyzing Competitive Advantage Using Point of Sale Data	Principal Investigator	Purdue University	Complete
24	David	Ebert	ebertd@ecn.purdue.edu	Multimedia, Social Media, Text, and Emergency Response Analytics	Principal Investigator	Purdue University	Complete
24	David	Ebert	ebertd@purdue.edu	Multimedia, Social Media, Text, and Emergency Response Analytics	Co-Principal Investigator	Purdue University	Complete
93	David	Ebert	ebertd@ecn.purdue.edu	NHANES Exploration	Principal Investigator	Purdue University	Complete
90	David	Ebert	ebertd@ecn.purdue.edu	ORAM	Principal Investigator	Purdue University	Complete
20	David	Ebert	ebertd@ecn.purdue.edu	Officer Performance Visualization System	Principal Investigator	Purdue University	In Progress
91	David	Ebert	ebertd@ecn.purdue.edu	PURVAC RVF	Principal Investigator	Purdue University	Complete
86	David	Ebert	ebertd@ecn.purdue.edu	PanViz	Principal Investigator	Purdue University	Complete
40	David	Ebert	ebertd@ecn.purdue.edu	Plugfest	Principal Investigator	Purdue University	In Progress
87	David	Ebert	ebertd@ecn.purdue.edu	PlumeViz	Principal Investigator	Purdue University	Complete
84	David	Ebert	ebertd@ecn.purdue.edu	SEED 1: Investigation of the Impacts of Visualization Literacy on the Performance of Visual Analysis; International Collaborations	Principal Investigator	Purdue University	Complete
17	David	Ebert	ebertd@ecn.purdue.edu	SMART: Social Media Analytics and Reporting Toolkit	Principal Investigator	Purdue University	In Progress

118	David	Ebert	ebertd@ecn.purdue.edu	SP 14 Task 3: Technical Integration into ExPOD at JIBC	Principal Investigator	Purdue University	Complete
121	David	Ebert	ebertd@ecn.purdue.edu	SP 15 Task 1: Enterprise Resiliency Environments	Principal Investigator	Purdue University	Complete
59	David	Ebert	ebertd@ecn.purdue.edu	SP 17: Distributed Rendering for Web-Enabling the Stadium Evacuation Planning Tool	Principal Investigator	Purdue University	Complete
54	David	Ebert	ebertd@ecn.purdue.edu	SP 8: Disposable Cell Phone Analysis	Principal Investigator	Purdue University	Complete
22	David	Ebert	ebertd@ecn.purdue.edu	Safety in View: A Public Safety Visual Analytics Tool Based on CCTV Camera Angles of View	Principal Investigator	Purdue University	Complete
113	David	Ebert	ebertd@ecn.purdue.edu	Seed 3: Uncertainty in Video Visual Analytics	Principal Investigator	Purdue University	Complete
114	David	Ebert	ebertd@purdue.edu	Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Co-Principal Investigator	Purdue University	Complete
23	David	Ebert	ebertd@ecn.purdue.edu	Social Media and Healthcare Analytics for Identification of Emerging Health Threats	Principal Investigator	Purdue University	Complete
29	David	Ebert	ebertd@ecn.purdue.edu	TRIP: Trip Response Investigative Profiler	Co-Principal Investigator	Purdue University	
130	David	Ebert	ebertd@ecn.purdue.edu	TRIP: Trip Response Investigative Profiler	Principal Investigator	Purdue University	Complete
103	David	Ebert	ebertd@ecn.purdue.edu	Video Surveillance Project	Principal Investigator	Purdue University	Complete
	David	Ebert	ebertd@ecn.purdue.edu	Video Surveillance Visual Analytics	Principal Investigator	Purdue University	In Progress
101	David	Ebert	ebertd@ecn.purdue.edu	Visual Analytics Decision Support Environment for Epidemic Modeling and Response Evaluation; Public Safety Coalition Projects	Principal Investigator	Purdue University	Complete

105	David	Ebert	ebertd@ecn.purdue.edu	Visual Analytics Environment for Public Health Surveillance	Principal Investigator	Purdue University	Complete
106	David	Ebert	ebertd@ecn.purdue.edu	Visual Analytics Law Enforcement Technology; Public Safety Coalition Projects	Principal Investigator	Purdue University	In Progress
104	David	Ebert	ebertd@ecn.purdue.edu	Visual Analytics of Microblog Data for Public Response Behavioral Analysis in Disaster Events	Principal Investigator	Purdue University	Complete
126	David	Ebert	ebertd@ecn.purdue.edu	Visualization and Policy Making: Theoretical and Empirical Explorations Workshop	Principal Investigator	Purdue University	Complete
64	David	Ebert	ebertd@ecn.purdue.edu	iOPAR - Operational Performance Assessment Reports	Principal Investigator	Purdue University	Complete
75	David	Ebert	ebertd@ecn.purdue.edu	iVALET - Mobile Visual Analytics Law Enforcement Toolkit	Principal Investigator	Purdue University	Complete
131	David	Ebert	ebertd@ecn.purdue.edu	success visualization project	Principal Investigator	Purdue University	In Progress
107	Steve	Elder		EP 3: K-12 Programs	Co-Principal Investigator		Complete
12	Niklas	Elmqvist	elm@umd.edu	(VASA) – Visual Analytics for Security Applications	Co-Principal Investigator	University of Maryland	Complete
34	Niklas	Elmqvist	elm@purdue.edu	Cyber Education	Principal Investigator	Purdue University	Complete
	Niklas	Elmqvist	elm@umd.edu	MDRP 11: Financial Fraud Visual Analytics	Co-Principal Investigator	Purdue University	Complete
	Niklas	Elmqvist	elm@umd.edu	MDRP 17: START Center Visual Analytics	Co-Principal Investigator	Purdue University	Withdrawn
13	Niklas	Elmqvist	elm@umd.edu	MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	Co-Principal Investigator	Purdue University	Complete

	Niklas	Elmqvist	elm@umd.edu	MDRP 18: Visual Analytics for the DHS Centers of Excellence	Co-Principal Investigator	Purdue University	Complete
24	Niklas	Elmqvist	elm@umd.edu	Multimedia, Social Media, Text, and Emergency Response Analytics	Co-Principal Investigator	University of Maryland	Complete
119	Niklas	Elmqvist	elm@purdue.edu	SP 14 Task 1 - Extend COE Explorer	Principal Investigator	Purdue University	Complete
59	Niklas	Elmqvist	elm@umd.edu	SP 17: Distributed Rendering for Web-Enabling the Stadium Evacuation Planning Tool	Co-Principal Investigator	Purdue University	Complete
	Alex	Endert	endert@gatech.edu	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Co-Principal Investigator	Georgia Institute of Technology	In Progress
24	Thomas	Ertl	Thomas.Ertl@vis.uni-stuttgart.de	Multimedia, Social Media, Text, and Emergency Response Analytics	Co-Principal Investigator		Complete
12	Tom	Ertl	Thomas.Ertl@vis.uni-stuttgart.de	(VASA) – Visual Analytics for Security Applications	Co-Principal Investigator		Complete
	Tom	Ertl	Thomas.Ertl@vis.uni-stuttgart.de	MDRP 16: (VALET) Context-aware Mobile Visual Analytics for Emergency Response	Co-Principal Investigator		Complete
93	Tom	Ertl	Thomas.Ertl@vis.uni-stuttgart.de	NHANES Exploration	Principal Investigator		Complete
96	Tom	Ertl	Thomas.Ertl@vis.uni-stuttgart.de	Spatiotemporal Social Media Analytics for Abnormal Event Detection	Principal Investigator		Complete
104	Tom	Ertl	Thomas.Ertl@vis.uni-stuttgart.de	Visual Analytics of Microblog Data for Public Response Behavioral Analysis in Disaster Events	Principal Investigator		Complete
	Stephen	Eubank	seubank@vbi.vt.edu	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Co-Principal Investigator	Virginia State University	Complete

114	Stephen	Eubank		Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Investigator		Complete
	Jianping	Fan	jfan@uncc.edu	MDRP 14: Multimedia Visual Analytics for Investigative Analysis	Co-Principal Investigator	University of North Carolina at Charlotte	Complete
14	Jianping	Fan	jfan@uncc.edu	MDRP 6: Video Surveillance Visual Analytics	Co-Principal Investigator	University of North Carolina at Charlotte	Complete
79	Jianping	Fan	JFan@uncc.edu	Multimedia Analytics for Open Source Media	Co-Principal Investigator	University of North Carolina at Charlotte	Complete
114	Jianping	Fan	jfan@uncc.edu	Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Co-Principal Investigator	University of North Carolina at Charlotte	Complete
	Jianping	Fan	jfan@uncc.edu	Video Surveillance Visual Analytics	Co-Principal Investigator	University of North Carolina-Charlotte	In Progress
13	Brian	Fisher	bfisher@sfu.ca	MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	Co-Principal Investigator	Simon Fraser University	Complete
28	Brian	Fisher	bfisher@sfu.ca	MDRP 1: Geovisual Analytics	Co-Principal Investigator	Simon Fraser University	Complete
14	Brian	Fisher	bfisher@sfu.ca	MDRP 6: Video Surveillance Visual Analytics	Principal Investigator		Complete
84	Brian	Fisher	bfisher@sfu.ca	SEED 1: Investigation of the Impacts of Visualization Literacy on the Performance of Visual Analysis; International Collaborations	Co-Principal Investigator	Simon Fraser University	Complete
15	Daniel	Frysinger		(Crowdsourcing) Combining Crowdsourcing technology with machine learning to do visual analytics on big qualitative data (video datasets).	Other	University of California San Diego	Complete

15	Neeraj	Gadgil		(Crowdsourcing) Combining Crowdsourcing technology with machine learning to do visual analytics on big qualitative data (video datasets).	Other	Purdue University	Complete
12	Kelly	Gaither	kelly@tacc.utexas.edu	(VASA) – Visual Analytics for Security Applications	Investigator	University of Texas	Complete
76	Kelly	Gaither	kelly@tacc.utexas.edu	Exascale Data Visualization: Information-assisted data analysis and visualization	Principal Investigator	University of Texas	Complete
24	Kelly	Gaither	kelly@tacc.utexas.edu	Multimedia, Social Media, Text, and Emergency Response Analytics	Co-Principal Investigator	University of Texas, Austin	Complete
88	Kelly	Gaither	kelly@tacc.utexas.edu	Parallelizing Video Algorithms for Public Safety Applications	Principal Investigator	University of Texas, Austin	Complete
89	Kelly	Gaither	kelly@tacc.utexas.edu	Parallelizing Video Algorithms for Real-Time/Near-Real-Time Public Safety Applications; Public Safety Coaltion Project	Principal Investigator	University of Texas, Austin	
	John	Gerth	gerth@stanford.edu	MDRP 5: Cybersecurity Visual Analytics	Co-Principal Investigator	Stanford University	Complete
13	Sohaib	Ghani		MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	Graduate Student-Doctorate	Purdue University	Complete
	Sohaib	Ghani		MDRP 18: Visual Analytics for the DHS Centers of Excellence	Other	Purdue University	Complete
	Alex	Godwin		MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Graduate Student-Masters	Georgia Institute of Technology	In Progress
111	Ashok	Goel		MDRP 2: Integrate Automated Analytical Reasoning into Jigsaw	Investigator	Georgia Institute of Technology	Complete

	Sujatha	Gollapalli		MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Other	Pennsylvania State University	Complete
7	Sujatha Das	Gollapalli		(GeoTxt) E2E: GeoTxt API	Other	Pennsylvania State University	In Progress
	Sujatha Das	Gollapalli		MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Other	Pennsylvania State University	Complete
128	John	Goodall		Context-Driven Visual Analytics for Cyber Defensive Operations - Oak Ridge N Lab	Co-Principal Investigator		Complete
115	Jack	Guest		SP 15-Task 3: Event Evacuation Planning; Public Safety Coalition Projects	Graduate Student-Masters	University of North Carolina at Charlotte	Complete
114	Jack	Guest		Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Other	University of North Carolina at Charlotte	Complete
8	Elaine	Guidero		Symbology Standardization Support	Other	Pennsylvania State University	Complete
11	Andrew	Haddad		(MERGE) Mobile Emergency Response Guide	Other	Purdue University	Complete
100	Chris	Hankins		UKVAC II	Collaborator-unpaid		Complete
112	Pat	Hanrahan	hanrahan@cs.stanford.edu	SP 1: Improving Query Performance in Large Scale Analytic Databases	Principal Investigator	Stanford University	Complete
	Patrick	Hanrahan	hanrahan@cs.stanford.edu	MDRP 5: Cybersecurity Visual Analytics	Co-Principal Investigator	Stanford University	Complete
112	Patrick	Hanrahan	hanrahan@cs.stanford.edu	SP 1: Improving Query Performance in Large Scale Analytic Databases	Principal Investigator	Stanford University	Complete
	Frank	Hardisty	hardisty@psu.edu	MDRP 12: Foreign Animal and Zoonotic Disease Visual Analytics	Co-Principal Investigator	Pennsylvania State University	Complete

	Frank	Hardisty	hardisty@psu.edu	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Co-Principal Investigator	Pennsylvania State University	Complete
114	Frank	Hardisty		Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Co-Principal Investigator	Purdue University	Complete
128	Chris	Harshaw		Context-Driven Visual Analytics for Cyber Defensive Operations - Oak Ridge N Lab	Undergraduate Student		Complete
	David	Hartley		MDRP 12: Foreign Animal and Zoonotic Disease Visual Analytics	Co-Principal Investigator	Texas A & M University	Complete
81	Mark	Haselkorn	markh@u.washington.edu	Developing a Sustainable Visual Analytics for Command Center Environments	Principal Investigator	University of Washington	Complete
81	Mark	Haselkorn	markh@u.washington.edu	Developing a Sustainable Visual Analytics for Command Center Environments	Principal Investigator	University of Washington	Complete
82	Mark	Haselkorn	markh@u.washington.edu	Enhancing Interactive Visual Analysis and Decision Making Environments	Principal Investigator	University of Washington	Complete
	Mark	Haselkorn	markh@u.washington.edu	MDRP 7: Introducing Sustainable Visual Analytics into Command Center Environments	Co-Principal Investigator	University of Washington	Complete
14	Sabrina	Hauser		MDRP 6: Video Surveillance Visual Analytics	Graduate Student-Doctorate		Complete
	Matthew	Hawkins		MDRP 11: Financial Fraud Visual Analytics	Graduate Student-Doctorate	University of North Carolina at Charlotte	Complete
24	Bob	Hay	hayrw@epb.net	Multimedia, Social Media, Text, and Emergency Response Analytics	Co-Principal Investigator		Complete
24	Hossein	Hematialam		Multimedia, Social Media, Text, and Emergency Response Analytics	Other	University of North Carolina at Charlotte	Complete
	Hooman	Hemmati		EP 2: MSI Collaboration	Investigator	University of Houston-Downtown	Complete

	Erin	Hodgess	hodgesse@zeus.dt.uh.edu	EP 1: Leadership and Coordination	Co-Principal Investigator	University of Houston-Downtown	Complete
	Erin	Hodgess	hodgesse@zeus.dt.uh.edu	MDRP 16: (VALET) Context-aware Mobile Visual Analytics for Emergency Response	Co-Principal Investigator	University of Houston-Downtown	Complete
13	Ed	Hovy	hovy@cmu.edu	MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	Co-Principal Investigator	University of Southern California	Complete
	Eduard	Hovy	hovy@isi.edu	MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Co-Principal Investigator	University of Southern California	Complete
	Eduard	Hovy	hovy@isi.edu	MDRP 18: Visual Analytics for the DHS Centers of Excellence	Co-Principal Investigator	University of Southern California	Complete
28	Eduard	Hovy	hovy@cmu.edu	MDRP 1: Geovisual Analytics	Co-Principal Investigator	Carnegie Mellon University	Complete
116	Eduard	Hovy	hovy@cmu.edu	RECONNECT Workshop 2010 - Extracting and Visualizing Information from Natural Language Text	Principal Investigator	University of Southern California	Complete
107	James	Howard		EP 3: K-12 Programs	Co-Principal Investigator		Complete
	Mengdie	Hu		MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Other	Georgia Institute of Technology	In Progress
7	Wenyi	Huang		(GeoTxt) E2E: GeoTxt API	Other	Pennsylvania State University	In Progress
67	Whitney	Huang	huang251@purdue.edu	LAHVA: Linked Animal-Human Health Visual Analytics	Graduate Student-Doctorate	Purdue University	Complete
80	Aaron	Huber		Navajo Nation Graffiti Project	Undergraduate Student	Navajo Technical University	Withdrawn

60	Tobias	Isenberg	tobias.isenberg@inria.fr	Bristle Maps - A Multivariate Abstraction Technique for Geovisualization	Co-Principal Investigator		Complete
	Jacqueline	Jackson	jacqueline.m.jackson@jsums.edu	EP 1: Leadership and Coordination	Co-Principal Investigator	Jackson State University	Complete
	Jacqueline	Jackson	jacqueline.m.jackson@jsums.edu	EP 2: MSI Collaboration	Co-Principal Investigator	Jackson State University	Complete
	Jacqueline	Jackson	jacqueline.m.jackson@jsums.edu	EP 4: SURF Program (Summer Undergraduate Research Fellowships)	Co-Principal Investigator	Jackson State University	Complete
	Jacqueline	Jackson	jacqueline.m.jackson@jsums.edu	MDRP 16: (VALET) Context-aware Mobile Visual Analytics for Emergency Response	Co-Principal Investigator	Jackson State University	Complete
	Anuj	Jaiswal		MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Other	Pennsylvania State University	Complete
128	Jessie	Jamieson		Context-Driven Visual Analytics for Cyber Defensive Operations - Oak Ridge N Lab	Graduate Student-Masters		Complete
19	Yun	Jang	jangy@sejong.edu	Analyzing High-dimensional Multivariate Network Links with Integrated Anomaly Detection, Highlighting and Exploration	Co-Principal Investigator		Complete
21	Yun	Jang	jangy@sejong.ecu	Analyzing High-dimensional Multivariate Network Links with Integrated Anomaly Detection, Highlighting and Exploration	Co-Principal Investigator		In Progress
60	Yun	Jang	jangy@sejong.edu	Bristle Maps - A Multivariate Abstraction Technique for Geovisualization	Co-Principal Investigator		Complete
66	Yun	Jang	jangy@sejong.edu	MarketAnalyzer: An Interactive Visual Analytics System for Analyzing Competitive Advantage Using Point of Sale Data	Co-Principal Investigator		Complete

	Wall	Jim		MDRP 7: Introducing Sustainable Visual Analytics into Command Center Environments	Graduate Student-Masters	University of Washington	Complete
59	Jenish	Joseph		SP 17: Distributed Rendering for Web-Enabling the Stadium Evacuation Planning Tool	Co-Principal Investigator		Complete
106	Shantanu	Joshi		Visual Analytics Law Enforcement Technology; Public Safety Coalition Projects	Undergraduate Student	Purdue University	In Progress
8	Stevens	Joshua		Symbology Standardization Support	Other	Pennsylvania State University	Complete
84	Linda	Kaastra		SEED 1: Investigation of the Impacts of Visualization Literacy on the Performance of Visual Analysis; International Collaborations	Co-Principal Investigator	Simon Fraser University	Complete
	Youn-ah	Kang		MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Other	Georgia Institute of Technology	In Progress
7	Morteza	Karimzadeh		(GeoTxt) E2E: GeoTxt API	Other	Pennsylvania State University	In Progress
7	Morteza	Karimzadeh		(GeoTxt) E2E: GeoTxt API	Other	Pennsylvania State University	In Progress
12	Daniel	Keim	Daniel.Keim@uni-konstanz.de	(VASA) – Visual Analytics for Security Applications	Co-Principal Investigator		Complete
24	Daniel	Keim	keim@uni-konstanz.de	Multimedia, Social Media, Text, and Emergency Response Analytics	Co-Principal Investigator		Complete
12	Shaun	Kennedy	kenne108@umn.edu	(VASA) – Visual Analytics for Security Applications	Co-Principal Investigator	University of Minnesota	Complete
24	Shaun	Kennedy	Shaun.Kennedy@ncfpd.umn.edu	Multimedia, Social Media, Text, and Emergency Response Analytics	Co-Principal Investigator	University of Minnesota	Complete

132	Joe	Kielman	joseph.kielman@dhs.gov	Crime Maps	Principal Investigator	Office of University Programs, Science & Technology Directorate	Complete
63	Joe	Kielman	joseph.kielman@dhs.gov	ISIS - Infovis System for Investigating Intrusions	Principal Investigator	Office of University Programs, Science & Technology Directorate	Complete
122	Joe	Kielman	joseph.kielman@dhs.gov	SP 15 Task 2: VASA	Principal Investigator	Office of University Programs, Science & Technology Directorate	Complete
	Eun-Kyeong	Kim		MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Other	Pennsylvania State University	Complete
8	Eun-Kyeong	Kim		Symbology Standardization Support	Other	Pennsylvania State University	Complete
10	Joonoo	Kim		(GARI) Gang Graffiti Recognition and Analysis	Graduate Student-Doctorate	Purdue University	In Progress
11	Joonoo	Kim		(MERGE) Mobile Emergency Response Guide	Other	Purdue University	Complete
84	Sung-Hee	Kim		SEED 1: Investigation of the Impacts of Visualization Literacy on the Performance of Visual Analysis; International Collaborations	Co-Principal Investigator	Purdue University	Complete
60	SungYe	Kim		Bristle Maps - A Multivariate Abstraction Technique for Geovisualization	Co-Principal Investigator	Purdue University	Complete

106	SungYe	Kim		Visual Analytics Law Enforcement Technology; Public Safety Coalition Projects	Graduate Student-Masters	Purdue University	In Progress
15	David	Kirsh	kirsh@ucsd.edu	(Crowdsourcing) Combining Crowdsourcing technology with machine learning to do visual analytics on big qualitative data (video datasets).	Principal Investigator	University of California San Diego	Complete
11	Sungahn	Ko	ko@purdue.edu	(MERGE) Mobile Emergency Response Guide	Graduate Student-Doctorate	Purdue University	Complete
12	Sungahn	Ko	ko@purdue.edu	(VASA) – Visual Analytics for Security Applications	Graduate Student-Doctorate	Purdue University	Complete
18	Sungahn	Ko	ko@purdue.edu	COAST: Coastal Operations and Analysis Suite of Tools	Graduate Student-Doctorate	Purdue University	Complete
66	Sungahn	Ko	ko@purdue.edu	MarketAnalyzer: An Interactive Visual Analytics System for Analyzing Competitive Advantage Using Point of Sale Data	Co-Principal Investigator	Purdue University	Complete
106	Sungahn	Ko	ko@purdue.edu	Visual Analytics Law Enforcement Technology; Public Safety Coalition Projects	Graduate Student-Masters	Purdue University	In Progress
16	Sunghan	Ko	ko@purdue.edu	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Graduate Student-Doctorate	Purdue University	Complete
8	Peter	Koby		Symbology Standardization Support	Other	Pennsylvania State University	Complete
	Robert	Kosara		MDRP 11: Financial Fraud Visual Analytics	Co-Principal Investigator	University of North Carolina at Charlotte	Complete
	Robert	Kosara	rkosara@uncc.edu	MDRP 17: START Center Visual Analytics	Co-Principal Investigator	University of North Carolina at Charlotte	Withdrawn

116	Zornitsa	Kozareva	kozareva@isi.edu	RECONNECT Workshop 2010 - Extracting and Visualizing Information from Natural Language Text	Co-Principal Investigator	University of Southern California	Complete
24	Thomas	Kraft		Multimedia, Social Media, Text, and Emergency Response Analytics	Other	University of North Carolina at Charlotte	Complete
84	Bum chul	Kwon		SEED 1: Investigation of the Impacts of Visualization Literacy on the Performance of Visual Analysis; International Collaborations	Investigator	Purdue University	Complete
24	Justin	LaRoche	Justin.LaRoche@duke-energy.com	Multimedia, Social Media, Text, and Emergency Response Analytics	Consultant		Complete
128	Michael	Lannacone		Context-Driven Visual Analytics for Cyber Defensive Operations - Oak Ridge N Lab	Co-Principal Investigator		Complete
108	Victoria	Lemieux	v.lemieux@ubc.ca	Personal Visual Analytics Workshop	Co-Principal Investigator	University of British Columbia	Complete
106	Jing	Li		Visual Analytics Law Enforcement Technology; Public Safety Coalition Projects	Undergraduate Student	Purdue University	In Progress
4	Tao	Li		(MADIS) A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data	Co-Principal Investigator	Florida International University	Complete
58	Tao	Li	taoli@cs.fiu.edu	A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data; Public Safety Coalition Projects	Co-Principal Investigator	Florida International University	Complete

65	Hong	Lin		VACCINE Affinity Research Groups	Co-Principal Investigator	University of Houston-Downtown	Complete
108	Evert	Lindquist	evert.lindquist@anu.edu.au	Personal Visual Analytics Workshop	Co-Principal Investigator		Complete
	Dongning	Liu		MDRP 14: Multimedia Visual Analytics for Investigative Analysis	Other	University of North Carolina at Charlotte	Complete
	Yujie	Liu		MDRP 14: Multimedia Visual Analytics for Investigative Analysis	Other	University of North Carolina at Charlotte	Complete
24	Yujie	Liu		Multimedia, Social Media, Text, and Emergency Response Analytics	Other	University of North Carolina at Charlotte	Complete
	Zhicheng	Liu		MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Other	Georgia Institute of Technology	In Progress
27	Yafeng	Lu		WDYTYA: The Uncertainty of Identity	Other	Arizona State University	Complete
4	Steven	Luis		(MADIS) A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data	Investigator	Florida International University	Complete
58	Steven	Luis	luiss@cis.fiu.edu	A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data; Public Safety Coalition Projects	Investigator	Florida International University	Complete
7	Alan	MacEachren	maceachren@psu.edu	(GeoTxt) E2E: GeoTxt API	Principal Investigator	Pennsylvania State University	In Progress
7	Alan	MacEachren	maceachren@psu.edu	(GeoTxt) E2E: GeoTxt API	Principal Investigator	Pennsylvania State University	In Progress

	Alan	MacEachren	maceachren@psu.edu	MDRP 12: Foreign Animal and Zoonotic Disease Visual Analytics	Co-Principal Investigator	Pennsylvania State University	Complete
9	Alan	MacEachren	maceachren@psu.edu	MDRP 13: (SensePlace 2) Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Principal Investigator	Pennsylvania State University	Complete
9	Alan	MacEachren	maceachren@psu.edu	MDRP 13: (SensePlace 2) Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Principal Investigator	Pennsylvania State University	Complete
	Alan	MacEachren	maceachren@psu.edu	MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Co-Principal Investigator	Pennsylvania State University	Complete
	Alan	MacEachren	maceachren@psu.edu	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Co-Principal Investigator	Pennsylvania State University	In Progress
28	Alan	MacEachren	maceachren@psu.edu	MDRP 1: Geovisual Analytics	Co-Principal Investigator	Pennsylvania State University	Complete
	Alan	MacEachren	maceachren@psu.edu	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Co-Principal Investigator	Pennsylvania State University	Complete
118	Alan	MacEachren	maceachren@psu.edu	SP 14 Task 3: Technical Integration into ExPOD at JIBC	Principal Investigator	Pennsylvania State University	Complete
46	Alan	MacEachren	maceachren@psu.edu	SP 2: CCC Tech Support	Principal Investigator	Pennsylvania State University	Complete
46	Alan	MacEachren	maceachren@psu.edu	SP 2: CCC Tech Support	Principal Investigator	Pennsylvania State University	Complete

114	Alan	MacEachren	maceachren@psu.edu	Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Co-Principal Investigator	Pennsylvania State University	Complete
98	Alan	MacEachren	maceachren@psu.edu	Symbology Map Transition	Principal Investigator	Pennsylvania State University	Complete
98	Alan	MacEachren	maceachren@psu.edu	Symbology Map Transition	Principal Investigator	Pennsylvania State University	Complete
8	Alan	MacEachren	maceachren@psu.edu	Symbology Standardization Support	Principal Investigator	Pennsylvania State University	Complete
16	Ross	Maciejewski	rmacieje@asu.edu	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Co-Principal Investigator	Purdue University	Complete
3	Ross	Maciejewski	rmacieje@asu.edu	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Co-Principal Investigator	Arizona State University	In Progress
61	Ross	Maciejewski	rmacieje@asu.edu	Analytical Visualization of the Port Arthur, TX Economic Impact Study	Co-Principal Investigator	Arizona State University	Complete
60	Ross	Maciejewski	rmacieje@asu.edu	Bristle Maps - A Multivariate Abstraction Technique for Geovisualization	Co-Principal Investigator	Arizona State University	Complete
49	Ross	Maciejewski	rmacieje@asu.edu	Coast Guard PROTECT Visualization	Co-Principal Investigator	Arizona State University	Complete
	Ross	Maciejewski	rmacieje@asu.edu	EP 4: SURF Program (Summer Undergraduate Research Fellowships)	Co-Principal Investigator	Arizona State University	Complete
41	Ross	Maciejewski	rmacieje@asu.edu	Explore Impact of Visualization on Predictive Analysis	Principal Investigator	Arizona State University	In Progress
129	Ross	Maciejewski	rmacieje@asu.edu	Geographic Network Analytics Correlations for VALET	Principal Investigator	Arizona State University	In Progress
	Ross	Maciejewski	rmacieje@asu.edu	MDRP 16: (VALET) Context-aware Mobile Visual Analytics for Emergency Response	Co-Principal Investigator	Arizona State University	Complete

66	Ross	Maciejewski	rmacieje@asu.edu	MarketAnalyzer: An Interactive Visual Analytics System for Analyzing Competitive Advantage Using Point of Sale Data	Co-Principal Investigator	Arizona State University	Complete
59	Ross	Maciejewski	rmacieje@asu.edu	SP 17: Distributed Rendering for Web-Enabling the Stadium Evacuation Planning Tool	Co-Principal Investigator	Purdue University	Complete
101	Ross	Maciejewski	rmacieje@asu.edu	Visual Analytics Decision Support Environment for Epidemic Modeling and Response Evaluation; Public Safety Coalition Projects	Co-Principal Investigator	Arizona State University	Complete
105	Ross	Maciejewski	rmacieje@asu.edu	Visual Analytics Environment for Public Health Surveillance	Co-Principal Investigator	Arizona State University	Complete
106	Ross	Maciejewski	rmacieje@asu.edu	Visual Analytics Law Enforcement Technology; Public Safety Coalition Projects	Co-Principal Investigator	Arizona State University	In Progress
27	Ross	Maciejewski	rmacieje@asu.edu	WDYTYA: The Uncertainty of Identity	Principal Investigator	Arizona State University	Complete
41	Ross	Maciejwski	rmacieje@asu.edu	Explore Impact of Visualization on Predictive Analysis	Principal Investigator	Arizona State University	In Progress
129	Ross	Maciejwski	rmacieje@asu.edu	Geographic Network Analytics Correlations for VALET	Principal Investigator	Arizona State University	In Progress
27	Ross	Maciejwski	rmacieje@asu.edu	WDYTYA: The Uncertainty of Identity	Principal Investigator	Arizona State University	Complete
16	Abish	Malik	amalik@purdue.edu	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Graduate Student-Doctorate	Purdue University	Complete
11	Abish	Malik	amalik@purdue.edu	(MERGE) Mobile Emergency Response Guide	Graduate Student-Doctorate	Purdue University	Complete
3	Abish	Malik	amalik@purdue.edu	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Co-Principal Investigator	Purdue University	In Progress

60	Abish	Malik	amalik@purdue.edu	Bristle Maps - A Multivariate Abstraction Technique for Geovisualization	Co-Principal Investigator	Purdue University	Complete
18	Abish	Malik	amalik@purdue.edu	COAST: Coastal Operations and Analysis Suite of Tools	Graduate Student-Doctorate	Purdue University	Complete
68	Abish	Malik	amalik@purdue.edu	High Risk Alcohol Behavior Analysis	Graduate Student-Doctorate	Purdue University	Complete
22	Abish	Malik	amalik@purdue.edu	Safety in View: A Public Safety Visual Analytics Tool Based on CCTV Camera Angles of View	Graduate Student-Doctorate	Purdue University	Complete
106	Abish	Malik	amalik@purdue.edu	Visual Analytics Law Enforcement Technology; Public Safety Coalition Projects	Graduate Student-Masters	Purdue University	In Progress
75	Abish	Malik	amalik@purdue.edu	iVALET - Mobile Visual Analytics Law Enforcement Toolkit	Graduate Student-Doctorate	Purdue University	Complete
	Madhav	Marathe	mmarathe@vbi.vt.edu	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Co-Principal Investigator	Virginia State University	Complete
114	Madhav	Marathe		Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Investigator		Complete
82	Robin	Mays		Enhancing Interactive Visual Analysis and Decision Making Environments	Graduate Student-Doctorate	University of Washington	Complete
	Robin	Mays		MDRP 7: Introducing Sustainable Visual Analytics into Command Center Environments	Graduate Student-Doctorate	University of Washington	Complete
114	John	Merritt		Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Other	University of North Carolina at Charlotte	Complete
107	Kent	Mikel		EP 3: K-12 Programs	Co-Principal Investigator		Complete

	Prasenjit	Mitra	pmitra@ist.psu.edu	MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Co-Principal Investigator	Pennsylvania State University	Complete
	Prasenjit	Mitra	pmitra@ist.psu.edu	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Co-Principal Investigator	Pennsylvania State University	In Progress
28	Prasenjit	Mitra	pmitra@ist.psu.edu	MDRP 1: Geovisual Analytics	Co-Principal Investigator	Pennsylvania State University	Complete
	Prasenjit	Mitra	pmitra@ist.psu.edu	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Co-Principal Investigator	Pennsylvania State University	Complete
114	Prasenjit	Mitra	pmitra@ist.psu.edu	Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Co-Principal Investigator	Pennsylvania State University	Complete
	Loretta	Moore	loretta.a.moore@jsums.edu	EP 1: Leadership and Coordination	Co-Principal Investigator	Jackson State University	Complete
	Loretta	Moore	loretta.a.moore@jsums.edu	EP 2: MSI Collaboration	Co-Principal Investigator	Jackson State University	Complete
16	Daudi	Muhamed		(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Undergraduate Student	Purdue University	Complete
	Ryan	Mullins		MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Other	Pennsylvania State University	Complete
98	Ryan	Mullins		Symbology Map Transition	Other	Pennsylvania State University	Complete
8	Ryan	Mullins		Symbology Standardization Support	Other	Pennsylvania State University	Complete
14	Ka Ki	Ng		MDRP 6: Video Surveillance Visual Analytics	Graduate Student-Masters	Purdue University	Complete

36	Louis	Ngamassi	longamassi@pvamu.edu	Crisis Informatics Course Development	Principal Investigator	Prairie View A & M University	Complete
	Nathan	Nikotan		EP 2: MSI Collaboration	Investigator	California State University-Dominguez Hills	Complete
77	Chris	North	north@cs.vt.edu	Co-Located Collaborative Analysis on Large, High-Resolution Displays using Multiple Input Devices; Public Safety Coalition Projects	Principal Investigator	Virginia Tech University	Complete
69	Chris	North	north@cs.vt.edu	Collaborative Sensemaking on Large, High-Resolution Displays			Complete
5	Kofi	Nyarko	kofi.nyarko@morgan.edu	(iLEAPS) iLaw Enforcement Apps Assistance Program for Students	Co-Principal Investigator	Morgan State University	Complete
114	Onyewuchi	Obirieze		Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Other	University of North Carolina at Charlotte	Complete
16	Silvia	Oliveros	solivero@purdue.edu	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Graduate Student-Doctorate	Purdue University	Complete
18	Silvia	Oliveros-Torres	solivero@purdue.edu	COAST: Coastal Operations and Analysis Suite of Tools	Graduate Student-Doctorate	Purdue University	Complete
106	Silvia	Oliveros-Torres	solivero@purdue.edu	Visual Analytics Law Enforcement Technology; Public Safety Coalition Projects	Graduate Student-Masters	Purdue University	In Progress
12	Osarieme	Omokaro		(VASA) – Visual Analytics for Security Applications	Other	University of North Carolina at Charlotte	Complete
120	Osarieme	Omokaro		SP 14 Task 5: Visual Analytics for Security Applications - VASA	Other	University of North Carolina at Charlotte	Complete
10	Albert	Parra		(GARI) Gang Graffiti Recognition and Analysis	Graduate Student-Doctorate	Purdue University	In Progress

11	Albert	Parra Pozo		(MERGE) Mobile Emergency Response Guide	Graduate Student-Doctorate	Purdue University	Complete
106	Kushal	Patel		Visual Analytics Law Enforcement Technology; Public Safety Coalition Projects	Undergraduate Student	Purdue University	In Progress
80	Dustin	Perry		Navajo Nation Graffiti Project	Undergraduate Student	Navajo Technical University	Withdrawn
80	Myron	Peters		Navajo Nation Graffiti Project	Undergraduate Student	Navajo Technical University	Withdrawn
	Hannah	Pileggi		MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Other	Georgia Institute of Technology	In Progress
	Bill	Pottenger	billp@dimacs.rutgers.edu	MDRP 17: START Center Visual Analytics	Co-Principal Investigator	Rutgers University	Withdrawn
	Sakshi	Pratap		MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Graduate Student-Masters	Georgia Institute of Technology	In Progress
68	Ahmad	Razip		High Risk Alcohol Behavior Analysis	Graduate Student-Doctorate	Purdue University	Complete
106	Ahmad	Razip		Visual Analytics Law Enforcement Technology; Public Safety Coalition Projects	Undergraduate Student	Purdue University	In Progress
75	Ahmad Mujahid Mohammed	Razip		iVALET - Mobile Visual Analytics Law Enforcement Toolkit	Graduate Student-Doctorate	Purdue University	Complete
128	Joel	Reed		Context-Driven Visual Analytics for Cyber Defensive Operations - Oak Ridge N Lab	Co-Principal Investigator		Complete
12	Bill	Ribarsky	ribarsky@uncc.edu	(VASA) – Visual Analytics for Security Applications	Co-Principal Investigator	University of North Carolina-Charlotte	Complete
85	William	Ribarsky	ribarsky@uncc.edu	Critical Infrastructure Integration Modeling and Simulation Project	Principal Investigator	University of North Carolina at Charlotte	

78	William	Ribarsky	ribarsky@uncc.edu	Critical Infrastructure in Large Scale Emergencies	Principal Investigator	University of North Carolina at Charlotte	Complete
	William	Ribarsky	ribarsky@uncc.edu	MDRP 11: Financial Fraud Visual Analytics	Principal Investigator	University of North Carolina at Charlotte	Complete
	William	Ribarsky	ribarsky@uncc.edu	MDRP 14: Multimedia Visual Analytics for Investigative Analysis	Co-Principal Investigator	University of North Carolina at Charlotte	Complete
14	William	Ribarsky	ribarsky@uncc.edu	MDRP 6: Video Surveillance Visual Analytics	Co-Principal Investigator	University of North Carolina at Charlotte	Complete
71	William	Ribarsky	ribarsky@uncc.edu	Mobile 3D Routing and Emergency Evacuation in Dense Urban Environments	Principal Investigator	University of North Carolina at Charlotte	Complete
70	William	Ribarsky	ribarsky@uncc.edu	Mobile 3D Routing, Emergency Evacuation, and In-Field Criminal Investigative Analytics	Principal Investigator	University of North Carolina-Charlotte	Complete
70	William	Ribarsky	ribarsky@uncc.edu	Mobile 3D Routing, Emergency Evacuation, and In-Field Criminal Investigative Analytics	Principal Investigator	University of North Carolina at Charlotte	Complete
79	William	Ribarsky	ribarsky@uncc.edu	Multimedia Analytics for Open Source Media	Principal Investigator	University of North Carolina-Charlotte	Complete
79	William	Ribarsky	ribarsky@uncc.edu	Multimedia Analytics for Open Source Media	Principal Investigator	University of North Carolina at Charlotte	Complete
94	William	Ribarsky	ribarsky@uncc.edu	Multimedia Visual Analytics for News, Blogs, RSS Feeds and other Streaming Data	Principal Investigator	University of North Carolina at Charlotte	Complete
24	William	Ribarsky	ribarsky@uncc.edu	Multimedia, Social Media, Text, and Emergency Response Analytics	Principal Investigator	University of North Carolina at Charlotte	Complete
24	William	Ribarsky	ribarsky@uncc.edu	Multimedia, Social Media, Text, and Emergency Response Analytics	Co-Principal Investigator	University of North Carolina-Charlotte	Complete
92	William	Ribarsky	ribarsky@uncc.edu	RISK VA	Principal Investigator	University of North Carolina-Charlotte	Complete

92	William	Ribarsky	ribarsky@uncc.edu	RISK VA	Principal Investigator	University of North Carolina at Charlotte	Complete
120	William	Ribarsky	ribarsky@uncc.edu	SP 14 Task 5: Visual Analytics for Security Applications - VASA	Principal Investigator	University of North Carolina-Charlotte	Complete
120	William	Ribarsky	ribarsky@uncc.edu	SP 14 Task 5: Visual Analytics for Security Applications - VASA	Principal Investigator	University of North Carolina at Charlotte	Complete
123	William	Ribarsky	ribarsky@uncc.edu	SP 15 Task 3: Event Evacuation Planning	Principal Investigator	University of North Carolina at Charlotte	Complete
115	William	Ribarsky	ribarsky@uncc.edu	SP 15-Task 3: Event Evacuation Planning; Public Safety Coalition Projects	Principal Investigator	University of North Carolina at Charlotte	Complete
115	William	Ribarsky	ribarsky@uncc.edu	SP 15-Task 3: Event Evacuation Planning; Public Safety Coalition Projects	Principal Investigator	University of North Carolina-Charlotte	Complete
114	William	Ribarsky	ribarsky@uncc.edu	Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Principal Investigator	University of North Carolina at Charlotte	Complete
97	William	Ribarsky	ribarsky@uncc.edu	SmartGridVis Project	Principal Investigator	University of North Carolina at Charlotte	Complete
	William	Ribarsky	ribarsky@uncc.edu	Video Surveillance Visual Analytics	Co-Principal Investigator	University of North Carolina-Charlotte	In Progress
	Fred	Roberts	froberts@dimacs.rutgers.edu	MDRP 17: START Center Visual Analytics	Co-Principal Investigator	Rutgers University	Withdrawn
13	Fred	Roberts	froberts@dimacs.rutgers.edu	MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	Co-Principal Investigator	Rutgers University	Complete
	Fred	Roberts	froberts@dimacs.rutgers.edu	MDRP 18: Visual Analytics for the DHS Centers of Excellence	Co-Principal Investigator	Rutgers University	Complete

	Fred	Roberts	froberts@dimacs.rutgers.edu	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Co-Principal Investigator	Rutgers University	Complete
114	Fred	Roberts	froberts@dimacs.rutgers.edu	Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Co-Principal Investigator	Rutgers University	Complete
100	Jonathan	Roberts		UKVAC II	Collaborator-unpaid		Complete
8	Anthony	Robinson	arobinson@psu.edu	Symbology Standardization Support	Co-Principal Investigator	Pennsylvania State University	Complete
13	Dan	Roth		MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	Co-Principal Investigator	University of Illinois - Urbana/Champaign	Complete
	Dan	Roth	danr@uiuc.edu	MDRP 18: Visual Analytics for the DHS Centers of Excellence	Co-Principal Investigator	University of Illinois - Urbana/Champaign	Complete
	Robert	Roth	rer5286@psu.edu	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Investigator	Pennsylvania State University	Complete
8	Robert	Roth		Symbology Standardization Support	Other	Pennsylvania State University	Complete
	Anand	Sainath		MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Other	Georgia Institute of Technology	In Progress
	Alexander	Savelyev		MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Other	Pennsylvania State University	Complete
	Alexander	Savelyey		MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Other	Pennsylvania State University	Complete

24	Chris	Sechrest	Chris.Sechrest@duke-energy.com	Multimedia, Social Media, Text, and Emergency Response Analytics	Co-Principal Investigator		Complete
58	Chao	Shen		A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data; Public Safety Coalition Projects	Graduate Student-Doctorate	Florida International University	Complete
	Yi	Shen		MDRP 14: Multimedia Visual Analytics for Investigative Analysis	Other	University of North Carolina at Charlotte	Complete
24	Yi	Shen		Multimedia, Social Media, Text, and Emergency Response Analytics	Other	University of North Carolina at Charlotte	Complete
65	Ongard	Sirisaengtaksin		VACCINE Affinity Research Groups	Co-Principal Investigator	University of Houston-Downtown	Complete
	Kathy	Smarick		MDRP 17: START Center Visual Analytics	Co-Principal Investigator	University of Maryland	Withdrawn
8	Jennifer	Smith		Symbology Standardization Support	Other	Pennsylvania State University	Complete
	John	Stasko	stasko@cc.gatech.edu	(Jigsaw) Integrate Automated Analytical Reasoning into Jigsaw	Co-Principal Investigator	Georgia Institute of Technology	Complete
	John	Stasko	stasko@cc.gatech.edu	(Jigsaw) Integrate Automated Analytical Reasoning into Jigsaw	Principal Investigator	Georgia Institute of Technology	Complete
77	John	Stasko	stasko@cc.gatech.edu	Co-Located Collaborative Analysis on Large, High-Resolution Displays using Multiple Input Devices; Public Safety Coalition Projects	Co-Principal Investigator	Georgia Institute of Technology	Complete
	John	Stasko	stasko@cc.gatech.edu	EP 1: Leadership and Coordination	Co-Principal Investigator	Georgia Institute of Technology	Complete

	John	Stasko	stasko@cc.gatech.edu	EP 2: MSI Collaboration	Co-Principal Investigator	Georgia Institute of Technology	Complete
	John	Stasko	stasko@cc.gatech.edu	EP 5: Graduate Programs	Co-Principal Investigator	Georgia Institute of Technology	Complete
	John	Stasko	stasko@cc.gatech.edu	EP 7: Professional Development	Co-Principal Investigator	Georgia Institute of Technology	In Progress
	John	Stasko	stasko@cc.gatech.edu	EP 8: (VADL) Educational Materials	Co-Principal Investigator	Georgia Institute of Technology	Complete
13	John	Stasko	stasko@cc.gatech.edu	MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	Co-Principal Investigator	Georgia Institute of Technology	Complete
	John	Stasko	stasko@cc.gatech.edu	MDRP 18: Visual Analytics for the DHS Centers of Excellence	Co-Principal Investigator	Georgia Institute of Technology	Complete
	John	Stasko	stasko@cc.gatech.edu	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Co-Principal Investigator	Georgia Institute of Technology	In Progress
	John	Stasko	stasko@cc.gatech.edu	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Principal Investigator	Georgia Institute of Technology	In Progress
28	John	Stasko	stasko@cc.gatech.edu	MDRP 1: Geovisual Analytics	Principal Investigator	Georgia Institute of Technology	Complete
111	John	Stasko	stasko@cc.gatech.edu	MDRP 2: Integrate Automated Analytical Reasoning into Jigsaw	Principal Investigator	Georgia Institute of Technology	Complete
115	KR	Subramanian	krs@uncc.edu	SP 15-Task 3: Event Evacuation Planning; Public Safety Coalition Projects	Co-Principal Investigator	University of North Carolina at Charlotte	Complete
114	KR	Subramanian	krs@uncc.edu	Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Co-Principal Investigator	University of North Carolina at Charlotte	Complete

15	Khalid	Tahboub		(Crowdsourcing) Combining Crowdsourcing technology with machine learning to do visual analytics on big qualitative data (video datasets).	Other	Purdue University	Complete
25	Khalid	Tahboub	ktahboub@purdue.edu	Chicago LTE Project	Co-Principal Investigator	Purdue University	Complete
	Justin	Talbot		MDRP 5: Cybersecurity Visual Analytics	Graduate Student-Masters	Stanford University	Complete
80	Antwone	Temple		Navajo Nation Graffiti Project	Undergraduate Student	Navajo Technical University	Withdrawn
24	Ted	Thomas	Ted.Thomas@duke-energy.com	Multimedia, Social Media, Text, and Emergency Response Analytics	Consultant		Complete
12	William	Tolone	wjtolone@uncc.edu	(VASA) – Visual Analytics for Security Applications	Co-Principal Investigator	University of North Carolina-Charlotte	Complete
78	William	Tolone	wjtolone@uncc.edu	Critical Infrastructure in Large Scale Emergencies	Co-Principal Investigator	University of North Carolina at Charlotte	Complete
24	William	Tolone	wjtolone@uncc.edu	Multimedia, Social Media, Text, and Emergency Response Analytics	Co-Principal Investigator	University of North Carolina at Charlotte	Complete
120	William	Tolone	wjtolone@uncc.edu	SP 14 Task 5: Visual Analytics for Security Applications - VASA	Co-Principal Investigator	University of North Carolina at Charlotte	Complete
108	Melanie	Tory	mtory@cs.uvic.ca	Personal Visual Analytics Workshop	Principal Investigator	University of Victoria	Complete
23	Sherry	Towers	smtowers@asu.edu	Social Media and Healthcare Analytics for Identification of Emerging Health Threats	Co-Principal Investigator	Arizona State University	Complete
	Mark	Trebian	mtrebian@gmail.com	EP 2: MSI Collaboration	Co-Principal Investigator	Navajo Technical University	Complete

80	Mark	Trebian	mtrebian@gmail.com	Navajo Nation Graffiti Project	Principal Investigator	Navajo Technical University	Withdrawn
114	Praveen	Tripathi		Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Other	University of North Carolina at Charlotte	Complete
77	Katherine	Vogt		Co-Located Collaborative Analysis on Large, High-Resolution Displays using Multiple Input Devices; Public Safety Coalition Projects	Undergraduate Student		Complete
118	Bob	Walker		SP 14 Task 3: Technical Integration into ExPOD at JIBC	Co-Principal Investigator	Justice Institute of British Columbia	Complete
19	Simon	Walton	simon.walton@oerc.ox.ac.uk	Analyzing High-dimensional Multivariate Network Links with Integrated Anomaly Detection, Highlighting and Exploration	Co-Principal Investigator	University of Oxford	Complete
21	Simon	Walton	simon.walton@oerc.ox.ac.uk	Analyzing High-dimensional Multivariate Network Links with Integrated Anomaly Detection, Highlighting and Exploration	Co-Principal Investigator		In Progress
100	Simon	Walton		UKVAC II	Graduate Student-Doctorate		Complete
103	Simon	Walton	simon.walton@oerc.ox.ac.uk	Video Surveillance Project	Co-Principal Investigator		Complete
129	Feng	Wang	fwang25@asu.edu	Geographic Network Analytics Correlations for VALET	Investigator	Arizona State University	In Progress
27	Feng	Wang		WDYTYA: The Uncertainty of Identity	Other	Arizona State University	Complete
3	Guizhen	Wang	wang1908@purdue.edu	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Graduate Student-Masters	Purdue University	In Progress

18	Guizhen	Wang	wang1908@purdue.edu	COAST: Coastal Operations and Analysis Suite of Tools	Graduate Student-Doctorate	Purdue University	Complete
12	Xiao	Wang		(VASA) – Visual Analytics for Security Applications	Co-Principal Investigator	University of North Carolina at Charlotte	Complete
	Xiaoyu	Wang		MDRP 11: Financial Fraud Visual Analytics	Graduate Student-Doctorate	University of North Carolina at Charlotte	Complete
24	Xiaoyu	Wang		Multimedia, Social Media, Text, and Emergency Response Analytics	Co-Principal Investigator	University of North Carolina at Charlotte	Complete
	Daniel	Weiskopf	weiskopf@visus.uni-stuttgart.de	MDRP 16: (VALET) Context-aware Mobile Visual Analytics for Emergency Response	Co-Principal Investigator		Complete
3	David	Wiszowaty	dwiszowa@purdue.edu	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Graduate Student-Masters	Purdue University	In Progress
17	David	Wiszowaty	dwiszowa@purdue.edu	SMART: Social Media Analytics and Reporting Toolkit	Graduate Student-Masters	Purdue University	In Progress
100	B.L. William	Wong		UKVAC II	Collaborator-unpaid		Complete
3	Hanye	Xu	xu193@purdue.edu	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Graduate Student-Masters	Purdue University	In Progress
22	Hanye	Xu	xu193@purdue.edu	Safety in View: A Public Safety Visual Analytics Tool Based on CCTV Camera Angles of View	Graduate Student-Masters	Purdue University	Complete
	Chunlei	Yang		MDRP 14: Multimedia Visual Analytics for Investigative Analysis	Other	University of North Carolina at Charlotte	Complete
	Jing	Yang	jyang13@uncc.edu	MDRP 14: Multimedia Visual Analytics for Investigative Analysis	Co-Principal Investigator	University of North Carolina at Charlotte	Complete
79	Jing	Yang	Jing.Yang@uncc.edu	Multimedia Analytics for Open Source Media	Co-Principal Investigator	University of North Carolina at Charlotte	Complete

3	Calvin	Yau	yauc@purdue.edu	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Graduate Student-Masters	Purdue University	In Progress
20	Calvin	Yau	yauc@purdue.edu	Officer Performance Visualization System	Graduate Student-Doctorate	Purdue University	In Progress
84	Ji Soo	Yi		SEED 1: Investigation of the Impacts of Visualization Literacy on the Performance of Visual Analysis; International Collaborations	Co-Principal Investigator	Purdue University	Complete
17	Jiawei	Zhang	zhan1486@purdue.edu	SMART: Social Media Analytics and Reporting Toolkit	Graduate Student-Doctorate	Purdue University	In Progress
	Xiao	Zhang		MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Other	Pennsylvania State University	Complete
129	Yifan	Zhang	Yifan.Zhang@asu.edu	Geographic Network Analytics Correlations for VALET	Graduate Student-Doctorate	Arizona State University	In Progress
27	Yifan	Zhang		WDYTYA: The Uncertainty of Identity	Other	Arizona State University	Complete
10	Bin	Zhao		(GARI) Gang Graffiti Recognition and Analysis	Graduate Student-Doctorate	Purdue University	In Progress
11	Bin	Zhao		(MERGE) Mobile Emergency Response Guide	Other	Purdue University	Complete
12	Jieqiong	Zhao	jieqiongzhao@purdue.edu	(VASA) – Visual Analytics for Security Applications	Graduate Student-Doctorate	Purdue University	Complete
4	Li	Zheng		(MADIS) A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data	Graduate Student-Doctorate	Florida International University	Complete

58	Li	Zheng	A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data; Public Safety Coalition Projects	Graduate Student-Doctorate	Florida International University	Complete
7	Chong	Zhou	(GeoTxt) E2E: GeoTxt API	Other	Pennsylvania State University	In Progress
4	Wubai	Zhou	(MADIS) A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data	Graduate Student-Masters	Florida International University	Complete
34	david	ebert	Cyber Education	Co-Principal Investigator	Purdue University	Complete

Citation	Journal Date	Project	Journal Status	Center of Excellence
1. Ka Ki Ng and E. J. Delp, "New Models For Real-Time Tracking Using Particle Filtering," Proceedings of the SPIE/IS&T Conference on Visual Communications and Image Processing(VCIP), San Jose, CA, January 2009. 2. K. K. Ng and E. J. Delp, "Object Tracking Initialization Using Automatic Moving Object Detection," Proceedings of the SPIE/IS&T Conference on Visual Communications and Image Processing (VCIP), January 2010, San Jose, CA. 3. Z. Li, J. Fan, "Stochastic contour approach for automatic image segmentation", Journal of Electronic Imaging, vol.18, no.4, 2009. 4. Luo, Qingshan, Xiaodong Kong, Guihua Zeng, Jianping Fan: Human action detection via boosted local motion histograms. Mach. Vis. Appl. 21(3): 377-389 (2010).				
Benson, A.L., Biggers, K., Wall, J., and Haselkorn, M.P. (2010) "Adaptive Development of a Common Operating Environment for Crisis Response Management." In Proceedings of the 2010 International Conference on Information Systems for Crisis Response and Management (ISCRAM2010) [Fully-refereed, blind, 45% acceptance].	5/2010	MDRP 7: Introducing Sustainable Visual Analytics into Command Center Environments	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Chen, J., MacEachren, A.M. and Peuquet, D. 2009: Constructing overview + detail dendrogram-matrix views. IEEE Transactions on Visualization and Computer Graphics 15, 889-896. {joint research with MDRP 3}	11/2009	MDRP 12: Foreign Animal and Zoonotic Disease Visual Analytics	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Bezerianos, A., Chevalier, F., Dragicevic, P., Elmqvist, N., Fekete, J.-D. GraphDice: A System for Exploring Multivariate Social Networks. Computer Graphics Forum (IEEE EuroVis 2010 proceedings), to appear, 2010. http://engineering.purdue.edu/~elm/projects/graphdice/graphdice.pdf	7/2010	MDRP 17: START Center Visual Analytics	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
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.	7/2012	(MADIS) A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
A. M. M. Razip, A. Malik, S. Afzal, S. Joshi, R. Maciejewski, Y. Jang, N. Elmqvist, and D. S. Ebert. A Mobile Visual Analytics Approach for Situational Awareness and Risk Assessment. Proceedings of IEEE PacificVis,	3/2014	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Abish Malik, Ross Maciejewski, Sean McCullough, Sherry Towers, David S. Ebert. Proactive Spatiotemporal Resource Allocation and Predictive Visual Analytics for Community Policing and Law Enforcement.	12/2014	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Sungahnn Ko, Jieqiong Zhao, Jing Xia, Shehzad Afzal, Xiaoyu Wang, Greg Abram, Niklas Elmqvist,, Len Kne, David Van Riper, Kelly Gaither, Shaun Kennedy, William Tolone, William Ribarsky, David S. Ebert, "VASA: Interactive Computational Steering of Large Asynchronous Simulation Pipelines for Societal Infrastructure," IEEE Transactions on Visualization and Computer Graphics	12/2014	(VASA) – Visual Analytics for Security Applications	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Sungahnn Ko, Jieqiong Zhao, Jing Xia, Shehzad Afzal, Xiaoyu Wang, Greg Abram, Niklas Elmqvist,, Len Kne, David Van Riper, Kelly Gaither, Shaun Kennedy, William Tolone, William Ribarsky, David S. Ebert, "VASA: Interactive Computational Steering of Large Asynchronous Simulation Pipelines for Societal Infrastructure," IEEE Transactions on Visualization and Computer Graphics	12/2014	(VASA) – Visual Analytics for Security Applications	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Sungahnn Ko, Shehzad Afzal, Simon Walton, Yang Yang, Junghoon Chae, Abish Malik, Yun Jang, Min Chen and David Ebert, "Analyzing High-dimensional Multivariate Network Links with Integrated Anomaly Detection, Highlighting and Exploration," In Proceedings of IEEE Visual Analytics Science and Technology, p83-92	10/2014	Analyzing High-dimensional Multivariate Network Links with Integrated Anomaly Detection, Highlighting and Exploration	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Zhang, J., Afzal, S., Chae, J., Wang, G., Thom, D., Matei, S., Elmqvist, E., Ebert, D., "Visual Analytics of User influence based Dynamic Social Networks using Twitter Data", IEEE Visual Analytics Science and Technology (VAST) Conference.	10/2015	SMART: Social Media Analytics and Reporting Toolkit	In Review	Center for Visual Analytics for Command, Control, and Interoperability Environments
Chae, J., Cui, Y., Jang, Y., Wang, G., Malik, A., Ebert, D., "Trajectory-based Visual Analytics for Anomalous Human Movement Analysis using Social Media"	5/2015	SMART: Social Media Analytics and Reporting Toolkit	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Chae, J., Thom, D., Jang, Y., Kim, S., Ertl, T., Ebert, D., "Visual Analytics of Microblog Data for Public Behavior Response Analysis in Disaster Events", extended journal paper, Computers and Graphics.	6/2013	SMART: Social Media Analytics and Reporting Toolkit	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Chae, J., Thom, D., Jang, Y., Kim, S., Ertl, T., Ebert, D., "Visual Analytics of Microblog Data for Public Behavior Analysis in Disaster Events," Eurovis Workshop on Visual Analytics.	6/2013	SMART: Social Media Analytics and Reporting Toolkit	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Sungahnn Ko, Shehzad Afzal, Simon Walton, Yang Yang, Junghoon Chae, Abish Malik, Yun Jang, Min Chen and David Ebert, "Analyzing High-dimensional Multivariate Network Links with Integrated Anomaly Detection, Highlighting and Exploration," In Proceedings of IEEE Visual Analytics Science and Technology, p83-92			Published	
Hanye Xu; Tay, J.; Malik, A.; Afzal, S.; Ebert, D.S., "Safety in view: A public safety visual analytics tool based on CCTV camera angles of view," in Technologies for Homeland Security (HST), 2015 IEEE International Symposium on, vol., no., pp.1-6, 14-16	4/2015	Safety in View: A Public Safety Visual Analytics Tool Based on CCTV Camera Angles of View	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Shehzad Afzal, Isaac Cho, Calvin Yau, Junghoon Chae, Sungahn Ko, Abish Malik, Kaethe Beck, William Ribarsky, and David Ebert. Anomaly Exploration and Visual Analytics of Financial Data. Submitted to IEEE VAST	8/2014	Multimedia, Social Media, Text, and Emergency Response Analytics	In Review	Center for Visual Analytics for Command, Control, and Interoperability Environments
Todd Eaglin, Xiaoyu Wang, and William Ribarsky. Interactive Visual Analytics in Support of Image-Encoded LIDAR Analysis. Submitted to IEEE Symposium on Large Data Analysis and Visualization (LDAV	8/2015	Multimedia, Social Media, Text, and Emergency Response Analytics	In Review	Center for Visual Analytics for Command, Control, and Interoperability Environments
Shehzad Afzal, Isaac Cho, et al. A Survey of Visual Analysis Approaches for Financial Data Exploration. Submitted to IEEE Transaction on Visualization and Computer Graphics.	8/2013	Multimedia, Social Media, Text, and Emergency Response Analytics	In Review	Center for Visual Analytics for Command, Control, and Interoperability Environments
Sebastian Mittelstaedt, Xiaoyu Wang, Todd Eaglin, Dennis Thom, Daniel A. Keim, Thomas Ertl, William Tolone, and William Ribarsky. An Integrated In-Situ Approach to Impacts from Natural Disasters on Critical Infrastructures. Submitted to HICSS 2015.	1/2015	Multimedia, Social Media, Text, and Emergency Response Analytics	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Todd Eaglin, Xiaoyu Wang, William Ribarsky, and William Tolone. Ensemble Visual Analysis Architecture with High Mobility for Large-Scale Critical Infrastructure Simulations. IS&T/SPIE VDA 2015, Vol.9397-3, pp. 1-15.	2/2015	Multimedia, Social Media, Text, and Emergency Response Analytics	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Wenwen Dou, Li Yu, Thomas Kraft, William Ribarsky, and Xiaoyu Wang. DemographicVis: Analyzing Demographic Information based on User Generated Content. To be published. IEEE VAST 2015.	10/2015	Multimedia, Social Media, Text, and Emergency Response Analytics	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Sungahn Ko, Jieqiong Zhao, Jing Xia, Xiaoyu Wang, Greg Abram, Niklas Elmqvist, Shaun Kennedy, Kelly Gaither, William Tolone, William Ribarsky, and David S. Ebert. VASA: Interactive Computational Steering of Large Asynchronous Simulation Pipelines for Critical Infrastructure. IEEE Transactions on Visualization and Computer Graphics (IEEE VAST, November, 2014), 20(12), pp. 1853-1862	11/2014	Multimedia, Social Media, Text, and Emergency Response Analytics	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments

J. Ribera, K. Tahboub and E. J. Delp, “Automated crowd flow estimation enhanced by crowdsourcing,” Proceedings of the IEEE National Aerospace and Electronics Conference (NAECON), June 2014, Dayton, OH.	6/2014	(GARI) Gang Graffiti Recognition and Analysis	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
B. Delgado, K. Tahboub and E. J. Delp, “Automatic detection of abnormal human events of train platforms,” Proceedings of the IEEE National Aerospace and Electronics Conference (NAECON), June 2014, Dayton, OH.	6/2014	(GARI) Gang Graffiti Recognition and Analysis	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
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Mays, Robin E.; Zachry, Mark; Garrison-Laney, Carolyn; Murat, Alper; Haselkorn, Mark P. (2011) "Aligning Border Security Workflow and Decision Making with Support Information and Communications Systems." In Proceedings of the 2011 International Conference on Information Systems for Crisis Response and Management (ISCRAM2011) [Fully-refereed, blind, 45% acceptance].	5/2011	Enhancing Interactive Visual Analysis and Decision Making Environments	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
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Fan Yang, Xuan Li, Qianmu Li, and Tao Li. "Exploring the diversity in cluster ensemble generation: Random sampling and random projection." Expert Systems with Applications 41, no. 10 (2014): 4844-4866.	8/2014	A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data; Public Safety Coalition Projects	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
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Wubai Zhou, Chao Shen, Tao Li, Shu-Ching Chen, and Ning Xie. "Generating Textual Storyline to Improve Situation Awareness in Disaster Management," accepted for publication, The 15th IEEE International Conference on Inforamtion Reuse and Integration (IRI 2014), San Francisco, USA, August 13-15, 2014.	8/2014	A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data; Public Safety Coalition Projects	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Hsin-Yu Ha, Fausto C. Fleites, Shu-Ching Chen, and Min Chen, "Correlation-based Re-ranking for Semantic Concept Detection," accepted for publication, The 15th IEEE International Conference on Inforamtion Reuse and Integration (IRI 2014), San Francisco, USA, August 13-15, 2014.	8/2014	A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data; Public Safety Coalition Projects	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
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Yerramilli, Sudha., Fonesca, Duber Gomez "Assessing Geographical Inaccessibility to Health Care: Using GIS Network Based Methods." Public Health Research (Accepted, 2014)		GIS Implementations	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Invited Book Chapter: Yerramilli, Sudha. "GIS in monitoring of Hurricanes and Cyclones", Encyclopedia of Natural Hazards", Taylor and Francis Publication (Submitted and in review, 2014)		GIS Implementations	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
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William Ribarsky, Xiaoyu Wang, Wenwen Dou, and William Tolone. Towards a Visual Analytics Framework for Handling Complex Business Processes. HICSS 2014. pp. 1374 – 1383. DOI 10.1109/HICSS.2014.177.	1/2014	Multimedia, Social Media, Text, and Emergency Response Analytics	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
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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.	12/2012	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
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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).	10/2013	Multimedia, Social Media, Text, and Emergency Response Analytics	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Jack Guest, KR Subramanian, and William Ribarsky. Large Scale Situationally Aware Building Evacuation. To be published. Information Visualization Journal.	8/2013	Multimedia, Social Media, Text, and Emergency Response Analytics	In Review	Center for Visual Analytics for Command, Control, and Interoperability Environments
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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.	5/2013	Symbology Standardization Support	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Roth, R.E., Finch, B.G., Blanford, J.I., Klippel, A. Robinson, A.C. and MacEachren, A.M. (in press) Card sorting for cartographic research and practice. Cartography and Geographic Information Science 38(2).	3/2013	Symbology Standardization Support	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
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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.	5/2013	MDRP 13: (SensePlace 2) Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
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Liang Tang, Yexi Jiang, Lei Li, Chunqiu Zeng, and Tao Li. 2015. Personalized Recommendation via Parameter-Free Contextual Bandits. In Proceedings of the 38th International ACM SIGIR Conference on Research and Development in Information Retrieval (SIGIR '15).	10/2015	(MADIS) A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Wei Xue, Tao Li, Naphtali Rishe: Aspect and Ratings Inference with Aspect Ratings: Supervised Generative Models for Mining Hotel Reviews. WISE (2) 2015: 17-31	1/2015	(MADIS) A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
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Yilin Yan, Min Chen, Mei-Ling Shyu, and Shu-Ching Chen, "Deep Learning for Imbalanced Multimedia Data Classification," IEEE International Conference on Multimedia (ISM 2015), Miami, FL, pp. 483-488, December 14-16, 2015.	12/2015	(MADIS) A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
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Applied Curriculum Integration Overview - Crisis Informatics with NodeXL	5/2016	Crisis Informatics Course Development	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
GeoCorpora: Building a Corpus to Test and Train Microblog Geoparsers (submitted) International Journal of Geographical Information Science	1/2016	(GeoTxt) E2E: GeoTxt API	In Review	Center for Visual Analytics for Command, Control, and Interoperability Environments
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J. Kim, H. Li, J, Yue, E, Delp, "Tattoo Image Retrieval for Region of Interest,"Proceedings of the IEEE International Symposium on Technologies for Homeland Security, Waltham, MA, May 2016.	5/2016	(GARI) Gang Graffiti Recognition and Analysis	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Chicago LTE Video Pilot Lessons Learned Test Report	10/2015	Chicago LTE Project	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
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Chae, J., Zhang, J., Jeong, S., Jang, Y., Malik, A., Ebert, D., "Forecasting the Flow of Human Crowds", IEEE Visual Analytics Science and Technology (VAST) Conference, 2016	10/2016	SMART: Social Media Analytics and Reporting Toolkit	In Review	Center for Visual Analytics for Command, Control, and Interoperability Environments
Zhang, J., Ahlbrand, B., Malik, A., Chae, J., Min, Z., Ko, S. and Ebert, D., "A Visual Analytics Framework for Microblog Data Analysis at Multiple Scales of Aggregation", Computer Graphics Forum, 35: 441–450, 2016.	8/2016	SMART: Social Media Analytics and Reporting Toolkit	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Chae, J., Zhang, J., Ko, S., Malik, A., Connell, H., Ebert, D., "Visual Analytics for Investigative Analysis of Hoax Distress Calls using Social Media", IEEE International Conference on Technologies for Homeland Security, 2016	5/2016	SMART: Social Media Analytics and Reporting Toolkit	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Chae, J., Zhang, J., Jeong, S., Jang, Y., Malik, A., Ebert, D., "Forecasting the Flow of Human Crowds", IEEE Visual Analytics Science and Technology (VAST) Conference, 2016		SMART: Social Media Analytics and Reporting Toolkit	In Review	Center for Visual Analytics for Command, Control, and Interoperability Environments
Zhang, J., Ahlbrand, B., Malik, A., Chae, J., Min, Z., Ko, S. and Ebert, D., "A Visual Analytics Framework for Microblog Data Analysis at Multiple Scales of Aggregation", Computer Graphics Forum, 35: 441–450, 2016.		SMART: Social Media Analytics and Reporting Toolkit	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Chae, J., Zhang, J., Ko, S., Malik, A., Connell, H., Ebert, D., "Visual Analytics for Investigative Analysis of Hoax Distress Calls using Social Media", IEEE International Conference on Technologies for Homeland Security, 2016		SMART: Social Media Analytics and Reporting Toolkit	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
G. Wang, A. Malik, S. Chen, S. Afzal, D. S. Ebert. A Client-based Visual Analytics Framework for Large Spatiotemporal Data under Architectural Constraints. IEEE Symposium on Large Data Analysis and Visualization.	10/2015	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
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"Emergency Pocket Placard: Providing Emergency Response Information via Mobile Application" Chicora Chandler, Jotham Greer, Loretta A. Moore, Jacqueline M. Jackson, Nitin Khanna, Edward J. Delp Sept. 2016	9/2016	(MERGE) Mobile Emergency Response Guide	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
K. Thongkor, A. Parra, B. Zhao, T. Amornraksa, E. J. Delp, " Hazmat Sign Location Detection Based on Fourier Shape Descriptors," Proceedings of the IS&T International Symposium on Electronic Imaging, pp. 1-5, February 2016, San Francisco, CA. 02/2016	2/2016	(MERGE) Mobile Emergency Response Guide	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Albert Parra Pozo, August 2014, "Integrated Mobile Systems Using Image Analysis With Applications In Public Safety"	8/2014	(MERGE) Mobile Emergency Response Guide	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Bin Zhao, December 2014, "Image Analysis Using Visual Saliency with Applications in Hazmat Sign Detection and Recognition."	12/2014	(MERGE) Mobile Emergency Response Guide	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Albert Parra Pozo, August 2014, "Integrated Mobile Systems Using Image Analysis With Applications In Public Safety"	8/2014	(GARI) Gang Graffiti Recognition and Analysis	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments
Bin Zhao, December 2014, "Image Analysis Using Visual Saliency with Applications in Hazmat Sign Detection and Recognition."	12/2014	(GARI) Gang Graffiti Recognition and Analysis	Published	Center for Visual Analytics for Command, Control, and Interoperability Environments

Citation	Other project date	Project	Center of Excellence
Robinson, A. (2009). Visual Highlighting Methods for Geovisualization. 24th International Cartographic Conference. Santiago, Chile (conference CD, no page #s) {paper introduces a visual display method relevant to Penn State tool development in MDRP 1, 3, 12, and 13}	11/2009	MDRP 12: Foreign Animal and Zoonotic Disease Visual Analytics	Center for Visual Analytics for Command, Control, and Interoperability Environments
Robinson, A. (2009). Needs Assessment for the Design of Information Synthesis Visual Analytics Tools. IEEE International Conference on Information Visualization. Barcelona, Spain, 353-360. {joint work with MDRP 1}	7/2009	MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Center for Visual Analytics for Command, Control, and Interoperability Environments
Xue, X., H. Luo, J. Fan, ``Structured Max-margin Learning for Multi-Label Image Annotation", ACM Conf. on Image and Video Retrieval (CIVR'10), 2010.	3/2011	MDRP 14: Multimedia Visual Analytics for Investigative Analysis	Center for Visual Analytics for Command, Control, and Interoperability Environments
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MacEachren, A.M. and Pezanowski, S. (2009). "Geovisualization: Leveraging the Opportunities of Geographic Information." Adobe Developer Connection Education Developer Center: Articles from educators: Adobe: http://www.adobe.com/devnet/edu/articles/macEachren_pezanowski.html {this online overview highlighted Penn State work from MDRP 3, 12, and 13}	8/2010	MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Center for Visual Analytics for Command, Control, and Interoperability Environments
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Malik, A., Maciejewski, R., Collins, T., Ebert, D., Visual Analytics Law Enforcement Toolkit, IEEE Conference on Technologies for Homeland Security, 2010 (submitted)	11/2010	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Center for Visual Analytics for Command, Control, and Interoperability Environments

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Robinson, A. (2009). Visual Highlighting Methods for Geovisualization. 24th International Cartographic Conference. Santiago, Chile (CD only) {cross MDRP – 1, 3, 12 & 13}	11/2009	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Center for Visual Analytics for Command, Control, and Interoperability Environments
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Robinson, A. (2009). Visual Highlighting Methods for Geovisualization. 24th International Cartographic Conference. Santiago, Chile (CD only) {paper introduces a visual display method relevant to Penn State tool development in MDRP 1, 3, 12, and 13}	11/2009	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Center for Visual Analytics for Command, Control, and Interoperability Environments
X. Xue, H. Luo, J. Fan, ``Structured Max-Nargin Learning for Multi-Label Image Annotation", ACM Conf. on Image and Video Retrieval (CIVR'10), 2010.	7/2010	MDRP 6: Video Surveillance Visual Analytics	Center for Visual Analytics for Command, Control, and Interoperability Environments
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Hardisty, F. and A. C. Robinson (In Press). "The GeoViz Toolkit: Using component-oriented coordination methods to aid geovisualization application construction." International Journal of Geographic Information Science. {joint work with MDRP 3}		MDRP 12: Foreign Animal and Zoonotic Disease Visual Analytics	Center for Visual Analytics for Command, Control, and Interoperability Environments

Auer, T., MacEachren, A.M., McCabe, C. and Pezanowski, S. submitted: HerbariaViz: A web-based client-server interface for mapping and exploring flora observation data. Ecological Informatics. {joint work with MDRP 3}	9/2010	MDRP 12: Foreign Animal and Zoonotic Disease Visual Analytics	Center for Visual Analytics for Command, Control, and Interoperability Environments
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Citation	Thesis date	Project	Center of Excellence
Albert Parra Pozo, August 2014, “Integrated Mobile Systems Using Image Analysis With Applications In Public Safety	8/2014	(GARI) Gang Graffiti Recognition and Analysis	Center for Visual Analytics for Command, Control, and Interoperability Environments
Bin Zhao, December 2014, "Image Analysis Using Visual Saliency with Applications in Hazmat Sign Detection and Recognition."	12/2014	(GARI) Gang Graffiti Recognition and Analysis	Center for Visual Analytics for Command, Control, and Interoperability Environments
Raechel Anne Bianchetti, LOOKING BACK TO INFORM THE FUTURE: THE ROLE OF COGNITION IN FOREST DISTURBANCE CHARACTERIZATION FROM REMOTE SENSING IMAGERY, The Pennsylvania State University, Department of Geography, PhD, December, 2014.	12/2014	(GeoTxt) E2E: GeoTxt API	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ryan S. Mullins, INTERPRETIVE UNCERTAINTY AND THE EVALUATION OF SYMBOLS AND A TAXONOMY OF SYMBOL EVALUATION METHODS AND MOBILE EVALUATION TOOL, The Pennsylvania State University, Department of Geography, MS, December, 2014.	12/2014	(GeoTxt) E2E: GeoTxt API	Center for Visual Analytics for Command, Control, and Interoperability Environments
Terrorism Information Analyzer, Antoine Williams-Baisy,	5/2011	VACCINE Affinity Research Groups	Center for Visual Analytics for Command, Control, and Interoperability Environments
Using search engine auto suggested data to build a knowledge base for an unsupervised Word Sense Disambiguation system, Adetomiwa Oguntuga,	5/2011	VACCINE Affinity Research Groups	Center for Visual Analytics for Command, Control, and Interoperability Environments
Wenwen Dou Understanding the Bi-Directional Relationship Between Analytical Processes and Visualization Systems Computer Science Ph.D. May, 2012	5/2012	Multimedia, Social Media, Text, and Emergency Response Analytics	Center for Visual Analytics for Command, Control, and Interoperability Environments
Todd Eaglin Mobile Situational Awareness for Emergency Response M.S. June, 2013	6/2013	Multimedia, Social Media, Text, and Emergency Response Analytics	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ross Maciejewski, PhD, Purdue, Electrical and Computer Engineering, ECE		(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Center for Visual Analytics for Command, Control, and Interoperability Environments
Tom Auer, Explicitly representing geographic change in map animations with bivariate symbolization, the Pennsylvania State University, Department of Geography, M.S., August 2009	8/2009	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Center for Visual Analytics for Command, Control, and Interoperability Environments
Tom Auer, Explicitly representing geographic change in map animations with bivariate symbolization, the Pennsylvania State University, Department of Geography, M.S., August 2009 http://etda.libraries.psu.edu/theses/approved/WorldWideIndex/ETD-4217/index.html {Auer’s thesis research was not supported by DHS funds directly, but he was supported as a Graduate Assistant working on VACCINE research during his degree program working on MDRP 3 & 12}	8/2009	MDRP 12: Foreign Animal and Zoonotic Disease Visual Analytics	Center for Visual Analytics for Command, Control, and Interoperability Environments
Chen, J. 2010: Exploratory Learning From Space-Attribute Aggregated Data – A Geovisual Analytics Approach. Penn State University Department of Geography, Ph.D., Jan. 2010.	1/2010	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Center for Visual Analytics for Command, Control, and Interoperability Environments
Kevin Ross, SQSynC: Spatial Queries In Synchronous Collaboration, Penn State, Geography, MS, August, 2010	8/2010	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Center for Visual Analytics for Command, Control, and Interoperability Environments
Dong Jeong, Ph.D., Computer Science, “Knowledge Visualization: From Theory to Practice”		MDRP 11: Financial Fraud Visual Analytics	Center for Visual Analytics for Command, Control, and Interoperability Environments
Remco Chang, Ph.D., Computer Science, “Thinking Interactively with Visualization		MDRP 11: Financial Fraud Visual Analytics	Center for Visual Analytics for Command, Control, and Interoperability Environments
Brian LeBlanc, Information School, Masters Senior Project: Information Sharing in the Seattle Emergency Operations Center		MDRP 7: Introducing Sustainable Visual Analytics into Command Center Environments	Center for Visual Analytics for Command, Control, and Interoperability Environments
Albert Parra Pozo , “An Integrated Mobile System for Gang Graffiti Image Acquisition and Recognition”, Purdue, ECE, M.S., December 2011	12/2011	(MERGE) Mobile Emergency Response Guide	Center for Visual Analytics for Command, Control, and Interoperability Environments
Andrew Wade: Visual Analytics for Aviation Safety: A Collaborative Approach to Sensemaking. SFU School of Interactive Arts and Technology August 22, 2011	8/2011	MDRP 6: Video Surveillance Visual Analytics	Center for Visual Analytics for Command, Control, and Interoperability Environments
Sungahn Ko, AIDED DECISION-MAKING THROUGH VISUAL ANALYTICS SYSTEMS FOR LARGE MULTIVARIATE, SPATIOTEMPORAL, HIERARCHICAL AND NETWORK DATA, Purdue University, Electrical and Computer Engineering, PhD, 6 Aug 2013	8/2013	(MERGE) Mobile Emergency Response Guide	Center for Visual Analytics for Command, Control, and Interoperability Environments
Zhicheng Liu, Network-based visual analysis of tabular data, Ph.D. Dissertation, Georgia Institute of Technology, School of Interactive Computing, April 2012.	4/2012	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Center for Visual Analytics for Command, Control, and Interoperability Environments
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.	7/2012	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Center for Visual Analytics for Command, Control, and Interoperability Environments
Anuj Rattan Jaiswal, On statistical schema matching with embedded value mappings, The Pennsylvania S tate University, College of Information Sciences and Engineering, Ph.D. in IST, June 7, 2012.	6/2012	(GeoTxt) E2E: GeoTxt API	Center for Visual Analytics for Command, Control, and Interoperability Environments

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.	8/2013	(GeoTxt) E2E: GeoTxt API	Center for Visual Analytics for Command, Control, and Interoperability Environments
Anuj Rattan Jaiswal, On statistical schema matching with embedded value mappings, The Pennsylvania S tate University, College of Information Sciences and Engineering, Ph.D. in IST, June 7, 2012.	6/2012	MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Center for Visual Analytics for Command, Control, and Interoperability Environments
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.	8/2013	MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Center for Visual Analytics for Command, Control, and Interoperability Environments
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.	6/2013	MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	Center for Visual Analytics for Command, Control, and Interoperability Environments
Chen, J. 2010: Exploratory Learning From Space-Attribute Aggregated Data – A Geovisual Analytics Approach. Penn State University Department of Geography, Ph.D., Jan. 2010.	1/2010	Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Center for Visual Analytics for Command, Control, and Interoperability Environments
Kevin Ross, SQSynC: Spatial Queries In Synchronous Collaboration, Penn State, Geography, MS, August, 2010	8/2010	Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Center for Visual Analytics for Command, Control, and Interoperability Environments

Title	Program Sponsor	Presentation Date	Project	Presented Paper Type	Center of Excellence
"Interactive Computational Steering of Large Asynchronous Simulation Pipelines for Societal Infrastructure" Dr. Niklas Elmqvist and Dr. David Ebert. IEEE VIS 2014 conference paper presentation session	IEEE	11/2014	(VASA) – Visual Analytics for Security Applications	Presented Paper	Center for Visual Analytics for Command, Control, and Interoperability Environments
"Interactive Computational Steering of Large Asynchronous Simulation Pipelines for Societal Infrastructure" Dr. Niklas Elmqvist and Dr. David Ebert. IEEE VIS 2014 conference paper presentation session	IEEE	11/2014	(VASA) – Visual Analytics for Security Applications	Presented Paper	Center for Visual Analytics for Command, Control, and Interoperability Environments
Invited speaker, "Solved Problems in Visualization," Panel.	IEEE VIS 2015	10/2015	Multimedia, Social Media, Text, and Emergency Response Analytics	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
Presentation at the Indiana State Police InGang training	Indiana State Police	8/2014	(GARI) Gang Graffiti Recognition and Analysis	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
GARI Tutorial Training at the Cook County Sheriff Department, Chicago, Il.	Cook Co. Sheriff Dept.	2/2014	(GARI) Gang Graffiti Recognition and Analysis	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Participation in the NIST/FBI Tattoo contest – Tatt-C –report and presentation at NIST June 2015 workshop	NIST/FBI Tattoo Contest	6/2015	(GARI) Gang Graffiti Recognition and Analysis	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Maciejewski, R., "Integrating a Visual Analytics Curriculum Into Your Own Classroom," Bethune Cookman University, Florida, June 2015.	Bethune-Cookman University	6/2015	WDYTYA: The Uncertainty of Identity	Presented Paper	Center for Visual Analytics for Command, Control, and Interoperability Environments
"Visual Analytics for Investigative Analysis and Exploration of Documents and Data", John Stasko, July 2014, Keynote lecture at Canadian Visual Analytics School (CANVAS) at VIVA Center, Vancouver, B.C.	Canadian Visual Analytics School (CANVAS)	7/2014	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
"The Value of Visualization for Exploring and Understanding Data", John Stasko, August 2014, Boeing Data Analytics Community of Excellence, Web forum.	Boeing Data Analytics Community of Excellence	8/2014	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
"The Value of Visualization for Understanding Data and Making Decisions", John Stasko, September 2014, Keynote lecture at the IEEE Joint Intelligence & Security Informatics Conference (JISIC 14), The Hague, Netherlands.	IEEE joint Intelligence & Seucrity Informatics Conference (JISIC)	9/2014	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
"Value-Driven Evaluations of Visualizations", John Stasko, October 2014, Paper presented at the ACM BELIV '14 Workshop, Paris, France.	ACM BeLIV '14 Workshop	10/2014	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
"Data Visualization Principles (Some Things I've Le " , John Stasko, March 2015, Keynote lecture at the Visualizing Biological Data Conference (VIZBI '15), Boston, MA.	Visualizing Biological Data Conference (VIZBI '15)	3/2015	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Title: Native Code Development for the iLaw Enforcement App for Students Present: Leonardo Ferreira Date: 6/30 Meeting: Summer Research Symposium Location: Morgan State University	Morgan State University	6/2015	(iLEAPS) iLaw Enforcement Apps Assistance Program for Students	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
(presented by Karimzadeh) Wallgrün, J.O., Karimzadeh, M., MacEachren, A.M., Hardisty, F., Pezanowski, S. and Ju, Y. 2014: Construction and First Analysis of a Corpus for the Evaluation and Training of Microblog/Twitter Geoparsers. In Purves, R. and Jones, C., editors, GIR'14: 8th ACM SIGSPATIAL Workshop on Geographic Information Retrieval, Dallas, TX: ACM.	GIR '14: 8th ACM SIGSPATIAL Workshop on Geographic Information Retrieval	11/2014	(GeoTxt) E2E: GeoTxt API	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Maciejewski, R., "What's in a Name? Data Linkage, Demography and Visual Analytics," EuroVA, June, 2014.	EuroVA	6/2014	WDYTYA: The Uncertainty of Identity	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Maciejewski, R., "Enabling Predictive Analytics Through Visualization," University of Arizona, January, 2014	University of Arizona	1/2014	WDYTYA: The Uncertainty of Identity	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Maciejewski, R., "Abstracting Attribute Space for Transfer Function Exploration and Design," IEEE VIS, October, 2013.	IEEE VIS	10/2013	WDYTYA: The Uncertainty of Identity	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Maciejewski, R., "Bristle Maps: A Multivariate Abstraction Technique for Geovisualization," IEEE VIS, October, 2013.	IEEE VIS	10/2013	WDYTYA: The Uncertainty of Identity	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Lu, Y., "Box Office VAST – VADER," IEEE VIS, October, 2013.	IEEE VIS	10/2013	WDYTYA: The Uncertainty of Identity	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Maciejewski, R., "Analytical Brushing for Spatiotemporal Analysis," University College of London, United Kingdom, July, 2013.	University College of London	7/2013	WDYTYA: The Uncertainty of Identity	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Maciejewski, R., "Analytical Brushing for Spatiotemporal Analysis," City College of London, United Kingdom, July, 2013.	City College of London	7/2013	WDYTYA: The Uncertainty of Identity	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Maciejewski, R., "An Introduction to Concepts in Visual Analytics," Visual Analytics Summer School at Middlesex University, United Kingdom, July 2013.	Middlesex University	7/2013	WDYTYA: The Uncertainty of Identity	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments

Combining Computational Analyses and Interactive Visualization for Document Exploration and Sensemaking in Jigsaw, Carsten Görg, Oct. 2014, IEEE VIS Conference, Atlanta, GA.	IEEE VIS Conference	10/2014	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
The Value of Visualization for Exploring and Understanding Data, John Stasko, April 2014, Invited talk, Exploratory Data Analysis Workshop at SIAM Intl. Conference on Data Mining, Philadelphia, PA.	SIAM Intl.	4/2014	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
The Value of Visualization…and Why Interaction Matters, John Stasko, June 2014, Capstone Lecture at the 2014 EuroVis Conference, Swansea, Wales.	EuroVis Conference	6/2014	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Keynote Address, "Visual Analytics for Competitive Advantage," EG EuroVA 2013 (June, 2013).	EG EuroVA	6/2013	Multimedia, Social Media, Text, and Emergency Response Analytics	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
Invited Workshop organizer, "Thinking with Visual Information Systems," Association for Psychological Science Annual Conference (May, 2014)	Association for Psychological Science Annual Conference	5/2014	Multimedia, Social Media, Text, and Emergency Response Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
Invited Speaker, "Harnessing Knowledge Tools for Competitive Advantage," Harnessing the Power of Data Conference (Charlotte, May, 2014).	UNCC	5/2014	Multimedia, Social Media, Text, and Emergency Response Analytics	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
Emergency Pocket Placard: Image Processing of HazMat Placards Using MatLab		3/2009	Hazmat Placards	Poster	Center for Visual Analytics for Command, Control, and Interoperability Environments
2/22/2010, Jason Allen, "Enhancing Situation Documents with Disaster Related Images," Overview of Prototype System at Miami-Dade County Department of Emergency Management	Miami-Dade County Dept. of Emergency Management	2/2010	A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data; Public Safety Coalition Projects	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
3/9/2011, Jason Allen, "Enhancing Situation Documents with Disaster Related Images," Public Safety Consortium Meeting at Purdue University. 4/11/2011, Jason Allen, "Enhancing Situation Documents with Disaster Related Images," Evaluation Activity at Miami-Dade County Department of Emergency Management.	Miami-Dade County Dept. of Emergency Management	4/2011	A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data; Public Safety Coalition Projects	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Bristle Maps: a Mutlivariate Abstraction Technique for Geovisualization	InfoVis	10/2013	Bristle Maps - A Multivariate Abstraction Technique for Geovisualization	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
iOPAR - Operational Performance Assessment Reports		9/2012	iOPAR - Operational Performance Assessment Reports	Poster	Center for Visual Analytics for Command, Control, and Interoperability Environments
"Visual Analytics", John Stasko, National Academies Board on Science, Technology, and Economic Policy, Workshop on Measuring the Impacts of Federal Investments in Research, Session on Emerging Metrics and Models for Assessing Research Impacts, Washington D.C., April 2011	National Academies Board on Science, Technology, and Economic Policy	4/2011	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Presented Paper	Center for Visual Analytics for Command, Control, and Interoperability Environments
William Ribarsky, Invited panel organizer, —Analytics & Awareness‖, NC Defense Opportunities Workshop (April, 2012).	NC Defense Opportunities Workshop	4/2012	Multimedia, Social Media, Text, and Emergency Response Analytics	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
William Ribarsky, Invited panel organizer, —The Future of Big Data Analytics,‖ Charlotte Informatics 2012 (May, 2012).	Charlotte Informatics	5/2012	Multimedia, Social Media, Text, and Emergency Response Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
SensePlace was demonstrated at the 2010 Technologies for Critical Incident Preparedness Conference and Exposition in Philadelphia, PA.	2010 Technologies for Critical Incident Preparedness Conference and Exposition	2/2010	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
SensePlace was demonstrated at the NATO IST-085 Workshop on Visualizing Networks, University Park, PA, Oct. 7, 2009	NATO IST-085 Workshop on Visualizing Networks	10/2009	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
MacEachren, A. M. 2009. Grounding Geovisualization & ESDA Tool Design in Cartographic Theory, Practice, and Empirical Research, invited presentation at Joint Statistical Meeting, Washington, DC, Aug. 4-9, 2009	Joint Statistical Meeting	8/2009	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
MacEachren, A.M., Hardisty, F., and Stryker, M. 2009. GeoVISTA Center Exploratory Geovisualization & Visual Analytics Research & Development, invited presentation at NATO IST-085 Workshop on Visualizing Networks, University Park, PA, Oct. 7, 2009.	NATO IST-085 Workshop on Visualizing Networks	10/2009	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
MacEachren, A. M. Geovisual Analytics: Supporting visual reasoning with complex information, Annual Meeting of the AAG, April 14-18, 2010 – Washington, DC.	Annual Meeting of the AAG	4/2010	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments

P. Chen, I. Chen, R. Verma, A. Tran*, "An Undergraduate Data Mining Course Integrated with Research and Industry Projects", SIGCSE 2010, Poster session, March, 2010.	SIGCSE 2010	3/2010	EP 1: Leadership and Coordination	Poster	Center for Visual Analytics for Command, Control, and Interoperability Environments
Chicora Chandler, "Mobile Visual Analytics: Droid vs Iphone", ADMI/A4RC 2010, Jackson, MS, April 8-11, 2010.	ADMI/A4RC	4/2011	EP 2: MSI Collaboration	Poster	Center for Visual Analytics for Command, Control, and Interoperability Environments
Jotham Greer, "Mobile Visual Analytics: Translation of Text and Symbols", ADMI/A4RC 2010, Jackson, MS, April 8-11, 2010.	ADMI/A4RC	4/2011	EP 2: MSI Collaboration	Poster	Center for Visual Analytics for Command, Control, and Interoperability Environments
One Day Visualization and Data Analysis Workshop Exploring the science of data analysis through interactive maps, charts and graphs	Discovery Learning Research Center - Purdue University	6/2010	EP 3: K-12 Programs	Poster	Center for Visual Analytics for Command, Control, and Interoperability Environments
Capital Forum Indiana – January 31, 2010 Indianapolis. Capital Forum Indiana is a civic engagement and international education program that focuses on current global issues and U.S Foreign Policy. This program is intended for high school teachers and students across Indiana, and is part of a larger, multi-state initiative of The Choices Program at Brown University.	Capital Forum Indiana	1/2010	EP 3: K-12 Programs	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
Hoosier Science Teachers Association Conference – February 3&4, 2010, Indianapolis. VACCINE participated in the Discovery Park booth at the conference.	Hoosier Science Teachers Association	2/2010	EP 3: K-12 Programs	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
Indiana Department of Homeland Security Higher Education Consortium Annual Conference – October 14, 2010, Indianapolis. Tim Collins, Marti Burns. General VACCINE and Education presentation.	Indiana Department of Homeland Security	10/2010	EP 3: K-12 Programs	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
Regenstrief Center for Healthcare Engineering – Marti Burns, Purdue University. General VACCINE and Education presentation, March 1, 2010	Regenstrief Center for Healthcare Engineering	3/2010	EP 3: K-12 Programs	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Discovery Park Engagement Group – Marti Burns, Purdue University. General VACCINE and Education presentation, February 2, 2010.	Discovery Park Engagement Group	2/2010	EP 3: K-12 Programs	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Triton Central High School: Marti Burns, Shawn McKay, Karla Combs October 19, 2010. General VACCINE presentation and HS STEM research.	Triton Central High School	10/2010	EP 3: K-12 Programs	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
West Lafayette Junior High School: Marti Burns, Bryan Sims November 24, 2010. General VACCINE presentation and HS STEM research.	West Lafayette Junior High School	11/2010	EP 3: K-12 Programs	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
FODAVA Annual Meeting, December 2009, "Developing Visual Analytics Applications: Lessons Learned from the Trenches"	FODAVA	12/2009	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Emory University, November 2009, "Information Exploration and Analysis through Interactive Visualization"	Emory University	11/2009	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
VAST '09, October 2009, "Evaluating Visual Analytics Systems for Investigative Analysis: Deriving Design Principles from a Case Study"	VAST	10/2009	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
M.I.T., September 2009, "Visual Analytics for Investigative Analysis and Exploration of Document Collections"	M.I.T.	9/2009	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., Maciejewski, R., "Data Modeling and Exploration Using Visual Analytics," National Defense University, October, 2009.		10/2009	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., Maciejewski, R., "Public Health Data Exploration, Analysis, Modeling, and Prediction Using Visual Analytics," U. S. Department of Health and Human Services, January 2010.	U. S. Department of Health and Human Services	1/2010	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
CrimeViz was demonstrated at the 2010 Technologies for Critical Incident Preparedness Conference and Exposition in Philadelphia, PA (by Robert Roth)	2010 Technologies for Critical Incident Preparedness Conference and Expositio		MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
Kevin Ross was on invited participant in a panel at the DHS University Summit focused on further development of research that had been presented in winning posters from 2009	DHS University Summit		MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
Hardisty, F. (2009). The GeoViz Toolkit: An easy-to-use approach to ESDA. URISA Public Health, Providence, RI (Invited Plenary Presentation).	URISA Public Health		MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments

Hardisty, F. (2009). GeoViz Toolkit Tutorial. Workshop at URISA Public Health. Providence, RI.	URISA Public Health		MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
MacEachren, A. M. 2009. Grounding Geovisualization & ESDA Tool Design in Cartographic Theory, Practice, and Empirical Research, invited presentation at Joint Statistical Meeting, Washington, DC, Aug. 4-9, 2009	Joint Statistical Meeting	8/2009	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
11 Aug 2009,Gerth,Visualization for Network Cybersecurity, Stanford MediaX Visualizaton Course	Gerth	8/2009	MDRP 5: Cybersecurity Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
25 Aug 2009,Gerth, Stanford Network Cybersecurity, Palantir, Inc., Palo Alto, CA	Gerth	8/2009	MDRP 5: Cybersecurity Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
8 Oct 2009,Cleveland, RBSA for Keystroke Detection, NSA invited lecture, Ft. Meade. MD	NSA	10/2009	MDRP 5: Cybersecurity Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
8 Mar 2010,Gerth, Stanford/PNNL tools, US-CERT/DHS S+T EADB meeting, Arlington, VA	DHS	3/2010	MDRP 5: Cybersecurity Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
8 Mar 2010,Gerth, Isis, US-CERT analyst training, Arlington VA	Gerth	3/2010	MDRP 5: Cybersecurity Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
9 Mar 2010,Gerth, Visualization for Network Cybersecurity, DHS S+T PI meeting, Rosslyn, VA	Gerth	3/2010	MDRP 5: Cybersecurity Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
10 Mar 2010,Gerth,Cybersecurity Analytics, DHS UP Summit, Washington, DC	Gerth	3/2010	MDRP 5: Cybersecurity Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
24 Mar 2010 ,Barthur,CERIAS Information Security Symposium, Purdue Univ., W. Lafayette, IN	Barthur - CERIAS	3/2010	MDRP 5: Cybersecurity Visual Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
"Adaptive Development of a Common Operating Environment for Crisis Response and Management," ISCRAM 2010, Seattle, May 4, 2010.	ISCRAM	5/2010	MDRP 7: Introducing Sustainable Visual Analytics into Command Center Environments	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
MacEachren, A. M. 2009. Grounding Geovisualization & ESDA Tool Design in Cartographic Theory, Practice, and Empirical Research, invited presentation at Joint Statistical Meeting, Washington, DC, Aug. 4-9, 2009	Joint Statstical Meeting	8/2009	MDRP 12: Foreign Animal and Zoonotic Disease Visual Analytics	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
Hardisty, F. and A. MacEachren (2009). Research to Reality: Supporting Public Health Research, Surveillance, and Practice with Geovisual Analytics The Third Annual DHS University Network Summit. Washington, D.C.	DHS	3/2009	MDRP 12: Foreign Animal and Zoonotic Disease Visual Analytics	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
Hardisty, F. and A. Klippel (2010). Analysing Spatio-Temporal Autocorrelation with LISTA-Viz. GeoVA(t) - Geospatial Visual Analytics: Focus on Time. Guimarães, Portugal, ICA Commission on GeoVisualization.	ICA Commission	10/2013	MDRP 12: Foreign Animal and Zoonotic Disease Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ribarsky, W. Invited speaker, "Exploratory Multimedia Analysis Applied to Video Analytics", Video Analytics Workshop, IEEE VisWeek 2009 (Atlantic City, NJ).	IEEE	1/2011	MDRP 14: Multimedia Visual Analytics for Investigative Analysis		Center for Visual Analytics for Command, Control, and Interoperability Environments
Ribarsky, W. Distinguished Lecturer, "Developing a Visual Analytics Approach to Analytic Problem-Solving," School of Computational Science and Engineering, Georgia Tech, February, 2010.		2/2010	MDRP 14: Multimedia Visual Analytics for Investigative Analysis		Center for Visual Analytics for Command, Control, and Interoperability Environments
March 2010, Jean-Daniel Fekete, "Stack Zooming for Multi-Focus Interaction in Time-Series Data Visualization", IEEE Pacific Visualization Symposium.	IEEE Pacific Visualization Symposium.	3/2010	MDRP 11: Financial Fraud Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Elmqvist, N. CoE Explorer: Visualizing the DHS Centers of Excellence. Presented at the C2I panel at the U.S. DHS University Network Summit 2010, Washington, D.C. (March 2010).	DHS	3/2010	MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	Presented Paper	Center for Visual Analytics for Command, Control, and Interoperability Environments
NSF III Program Annual Review Meeting, Arlington, VA, April 2010 "Visual Analytics", John Stasko	NSF	4/2010	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
AAAS Symposium on Novel Methods for the Evaluation of Federal Research Programs, Washington, D.C., April 2010	AAA	4/2010	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Visual Analytics for Exploring and Investigating Research Programs", John Stasko NSF, Arlington, VA, August 2010	NSF	8/2010	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Justice Institute of British Columbia, Vancouver, B.C., September 2010 "Investigative Analysis of Document Collections with Jigsaw", John Stasko	JIBC	9/2010	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
SUNY Stony Brook, Computer Science Distinguished Lecture Series, February 2011	SUNY Stony Brook	2/2011	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments

Investigative Reporters and Editors, Computer-Assisted Reporting Conference, Raleigh, NC, February 2011	Investigative Reporters and Editors	2/2011	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
"Jigsaw", John Stasko CNN, Atlanta, GA, March 2011 "Investigative Analysis of Document"	CNN	3/2011	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
UHD Student Research Conference 2011, Specialized Data Analysis, Aggregation & Visualization Tool Packages for R", (Hooman Hemmati, Duber Gomez-Fonseca & Sarah Jennisca)	UHD	12/2011	EP 2: MSI Collaboration	Poster	Center for Visual Analytics for Command, Control, and Interoperability Environments
Hooman Hemmati, Duber Gomez-Fonseca and Sarah Jennisca; "Visual Analysis of Large-scale Information by Aggregation and Numerical Techniques", presented at TeraGrid 2010, Pittsburg, PA 2010	TeraGrid	8/2010	EP 2: MSI Collaboration	Poster	Center for Visual Analytics for Command, Control, and Interoperability Environments
Hooman Hemmati, Duber Gomez-Fonseca, Sarah Jennisca, Lilian Antunes and Tia Pilaroscia;"Specialized Data Analysis, Aggregation & Visualization Tool Packages for R", CAHSI Annual Meeting, San Juan, PR 2011	CAHSI	10/2011	EP 2: MSI Collaboration	Poster	Center for Visual Analytics for Command, Control, and Interoperability Environments
Robinson, A.C., Pezanowski, S., Hardisty, F., Roth, R.E., Blanford, J., and A.M. MacEachren. "A Web-Based Symbol Store for Sharing Map Symbology" Presentation at the annual meeting of the North American Cartographic Information Society in St. Petersburg, FL. October 13-15, 2010	North American Cartographic Information Society	10/2010	Symbology Standardization Support	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Robinson, A.C. "Challenges to Standardizing Map Symbology" Presentation at the annual meeting of the Association of American Geographers in Washington, DC. April 14-18, 2010.	Association of American Geographers	4/2010	Symbology Standardization Support	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Bianchetti, R.A., J. Blanford , A. Klippel, A.C. Robinson, and A.M. MacEachren. 2011. Critical Evaluation of International Emergency Management Symbology. The 107th Annual Meeting of the Association of American Geographers. Seattle, WA: April 15, 2011	American Geographers	4/2011	Symbology Standardization Support	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Guidero E, F Hardisty, RE Roth, A Klippel, AC Robinson, and AM MacEachren. 2011. Representing change using point symbols. The 107th Annual Meeting of the Association of American Geographers. Seattle, WA: April 15, 2011	American Geographers	4/2011	Symbology Standardization Support	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Pezanowski S, AC Robinson, E Guidero, R Bianchetti, F Hardisty, J Blanford, RE Roth, and AM MacEachren. 2011. An interactive, web-based tool for discovering and sharing map symbols. The 107th Annual Meeting of the Association of American Geographers. Seattle, WA: April 15, 2011	American Geographers	4/2011	Symbology Standardization Support	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
4/11/2011, Jason Allen, "Enhancing Situation Documents with Disaster Related Images," Evaluation Activity at Miami-Dade County Department of Emergency Management.	Miami-Dade County Department of Emergency Management.	4/2011	A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data; Public Safety Coalition Projects	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Hardisty, F. 2010a. Interactive Syndromic Surveillance of Influenza Rates using the Geo Viz Toolkit. Analysis, Visualization and Reporting (AVR) Webinar CDC.			MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
Hardisty, F. 2010b. Open Source Geovisual Analytics. GIS-Pro. Orlando, FL, URISA.			MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
Hardisty, F. 2010c. Using text analytics with spatial statistics to characterize H1N1 flu outbreaks. The 106th Annual Meeting of the Association of American Geographers. Washington, DC.			MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
Hardisty, F. and Klippel, A. (2010). Analyzing Spatio-Temporal Autocorrelation with LISTA-Viz. GeoVA(t) – Geospatial Visual Analytics: Focus on Time. Guimarães, Portugal, ICA Commission on GeoVisualization.			MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
Hardisty, F. (2011). Exploring Geospatial Data with the GeoVizToolkit. North Carolina GIS User's Group Meeting.			MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
Hardisty, F. and Kroon, J. (2011). Cloud-Enabled Space-Time Clustering. AAG Annual Meeting. Seattle.			MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments

Hardisty, F., Peuquet, D., Xu, S. and Robinson, A.C. (2011). Methods for Ad-hoc Delineation and Analysis of Categories of Spatio-Temporal Events. COM.Geo. Washington, D.C., ACM Digital Library.			MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
MacEachren, A.M. Geovisual Analytics: Supporting visual reasoning with complex information, Annual Meeting of the AAG, April 14-18, 2010 – Washington, DC.			MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
MacEachren, A.M. 2010. Geovisual Analytics for Crisis Management: Moving Beyond GIS. Invited keynote at Information Systems for Crisis Response and Management (ISCRAM) 2010, May 2-5, 2010, Seattle, WA.			MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
MacEachren, A.M. 2010. Geovisual Analytics for Health, panel presentation at the Visual Analytics Community (VAC) Consortium Conference, Aug. 31 – Sept. 1, 2010, University of Maryland, College Park MD.			MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
Murdock, M.J., Maziekas N.V., and R.E. Roth. 2011. Geovisual analytics of improvised explosive device incidents. The 107th Annual Meeting of the Association of the Association of American Geographers. Seattle, WA: April 12-16.			MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
Mitra, P., "Information Extraction for Geospatial Visual Analytics." University of Houston Downtown, Computer Science Seminar, Houston, 2010.			MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
Murdock M, B.G. Finch, N. Maziekas, and R.E. Roth 2010. The basic ordinance observational management system: Geovisual analytics of improvised explosive device incidents. The Association of American Geographers, Middle States Division 2010 Meeting. West Point, NY: October 22-23.		10/2010	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
Roth R.E., KS Ross, W Luo, BJ Finch, and AM MacEachren. 2010. A user-centered approach to extending spatiotemporal crime analysis tools. The 106th Annual Meeting of the Association of American Geographers. Washington, DC: April 15.		4/2010	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
Roth R.E. 2010. Geovisual analytics for crime analysis and homeland security VACCINE Consortium Technology Demo Day. West Lafayette, IN: July 14.		7/2010	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
Roth R.E. 2011. Useful and usable geovisualization for crime analysis. The Penn State Department of Geography Coffee Hour Colloquium Series. University Park, PA: March 18.		3/2011	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
Roth R.E. 2010. Harrisburg Crime Viz: Geovisual analytics for crime analysis. City of Harrisburg Bureau of Polce. Harrisburg, PA: April 27.		4/2011	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
KyungTae Kim. WordBridge: Using Composite Tag Clouds in Node-Link Diagrams for Visualizing Content and Relations in Text Corpora. Presented at the Hawaii International Conference on System Sciences (Visual Analytics Minitrack), Kauai, Hawaii, January 2011.	Hawaii International Conference	1/2011	MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Niklas Elmqvist. Dynamic Insets for Context-Aware Graph Navigation. Presented at IEEE EuroVis 2011, Bergen, Norway, June 2011.	IEEE EuroVis	6/2011	MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
KyungTae Kim. WordBridge: Using Composite Tag Clouds in Node-Link Diagrams for Visualizing Content and Relations in Text Corpora. Presented at the Hawaii International Conference on System Sciences (Visual Analytics Minitrack), Kauai, Hawaii, January 2011.	Hawaii International Conference	1/2011	MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	Presented Paper	Center for Visual Analytics for Command, Control, and Interoperability Environments
KyungTae Kim. WordBridge: Using Composite Tag Clouds in Node-Link Diagrams for Visualizing Content and Relations in Text Corpora. Presented at the Hawaii International Conference on System Sciences (Visual Analytics Minitrack), Kauai, Hawaii, January 2011	Visual Analytics Minitrack	1/2011	MDRP 18: Visual Analytics for the DHS Centers of Excellence	Presented Paper	Center for Visual Analytics for Command, Control, and Interoperability Environments
Niklas Elmqvist. Dynamic Insets for Context-Aware Graph Navigation. Presented at IEEE EuroVis 2011, Bergen, Norway, June 2011. http://www.slideshare.net/NickElm/dynamic-insets-for-contextaware-graph-navigation	IEEE EuroVis 2011	6/2011	MDRP 18: Visual Analytics for the DHS Centers of Excellence	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments

W. Ribarsky, Invited speaker, "Mobile Application for First Response and Emergency Evacuation in Urban Settings." ACM Com.Geo 2010 (Washington, DC, June 2010).	ACM	6/2010	Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
W. Ribarsky, Invited presentation, "Financial Visual Analytics," INFORMS 2010 (Austin, November, 2010).	INFORMS	11/2010	MDRP 11: Financial Fraud Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
W. Ribarsky, Invited Speaker, "A Mixed-Initiative Visual Analytics Approach to Topic Modeling in Research Collections," AAAS-NSF Workshop on Science Policy (October, 2010).	NSF	10/2010	MDRP 14: Multimedia Visual Analytics for Investigative Analysis		Center for Visual Analytics for Command, Control, and Interoperability Environments
J. Fan. WOCC'10: The 19th Annual Wireless and Optical Communications Conference (WOCC'10), Shanghai, China, 2010. Speech Title: A visual analytics framework for supporting human-centered multimedia computing	19th Annual Wireless and Optical Communications Conference	5/2010	MDRP 14: Multimedia Visual Analytics for Investigative Analysis		Center for Visual Analytics for Command, Control, and Interoperability Environments
J. Fan. ICMR'10: International Workshop on Multimedia Retrieval (ICMR'10), Amsterdam, 2010. Speech Title: Interactive exploration of large-scale image/video collections	ICMR	8/2010	MDRP 14: Multimedia Visual Analytics for Investigative Analysis		Center for Visual Analytics for Command, Control, and Interoperability Environments
J. Fan. SMLCMR'11: Intl. Conf. on Statistical Machine Learning and Cross-Media Retrieval (SMLCMR'11), Hangzhou, 2011. Speech Title: Cross-modal cleaning and exploration of large-scale social images.		5/2011	MDRP 14: Multimedia Visual Analytics for Investigative Analysis	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
W. Ribarsky, Invited Participant, U.S. - German Workshop on Visual Analytics for Security Applications (Berlin, February, 2010)	U.S.-German Workshop on Visual Analytics for Security Applications	2/2010	(VASA) – Visual Analytics for Security Applications		Center for Visual Analytics for Command, Control, and Interoperability Environments
W. Ribarsky, Invited speaker, "Mobile Application for First Response and Emergency Evacuation in Urban Settings." ACM Com.Geo 2010 (Washington, DC, June 2010	ACM Com. Geo	6/2010	SP 15-Task 3: Event Evacuation Planning; Public Safety Coalition Projects		Center for Visual Analytics for Command, Control, and Interoperability Environments
Military Outload Exercise After Action Review, Puget Sound Port Readiness Committee, October 14, 2010, presented by Prof. Mark Haselkorn.	Puget Sound Port Readiness Committee	10/2010	MDRP 7: Introducing Sustainable Visual Analytics into Command Center Environments		Center for Visual Analytics for Command, Control, and Interoperability Environments
Aligning Border Security Workflow and Decision Making with Supporting Information and Communication Systems, 2011 ISCRAM Conference – Lisbon, Portugal, May 9, 2011, presented by Prof. Mark Haselkorn.	ISCRAM	5/2011	MDRP 7: Introducing Sustainable Visual Analytics into Command Center Environments	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Defining "Fast": Factors Affecting the Experience of Speed in Humanitarian Logistics, 2011 ISCRAM Conference – Lisbon, Portugal, May 11, 2011, presented by Robin Mays	ISCRAM	5/2011	MDRP 7: Introducing Sustainable Visual Analytics into Command Center Environments	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
July 2010, Katherine Vogt, "Co-located Collaboration on a Large, High-Resolution Display," REU Symposium	REU	7/2010	Co-Located Collaborative Analysis on Large, High-Resolution Displays using Multiple Input Devices; Public Safety Coalition Projects	Poster	Center for Visual Analytics for Command, Control, and Interoperability Environments
September 2011, Lauren Bradel, "Co-located Collaborative Sensemaking on a Large High-Resolution Display with Multiple Input Devices," INTERACT '11 (Paper presentation)	INTERACT	9/2011	Co-Located Collaborative Analysis on Large, High-Resolution Displays using Multiple Input Devices; Public Safety Coalition Projects	Presented Paper	Center for Visual Analytics for Command, Control, and Interoperability Environments
November 2011, Lauren Bradel, "Benefits of Co-located Collaboration on Large, High-Resolution Displays," Grace Hopper Celebration of Women in Computing	Grace Hopper Celebration of Women in Computing	11/2011	Co-Located Collaborative Analysis on Large, High-Resolution Displays using Multiple Input Devices; Public Safety Coalition Projects	Poster	Center for Visual Analytics for Command, Control, and Interoperability Environments
2010 – Timothy Collins, Visual Analytics Law Enforcement Toolkit, IEEE International Conference on Technologies for Homeland Security		11/2010	Visual Analytics Law Enforcement Technology; Public Safety Coalition Projects	Presented Paper	Center for Visual Analytics for Command, Control, and Interoperability Environments
January 2011- Ross Maciejewski, Describing Temporal Correlation Spatially in a Visual Analytics Environmnet, Hawaii International Conference System Sciences	Hawaii International Conference System Sciences	1/2011	Visual Analytics Law Enforcement Technology; Public Safety Coalition Projects	Presented Paper	Center for Visual Analytics for Command, Control, and Interoperability Environments
March 2011 – Ahmad Razip, A Mobile Visual Analytics System For Crime Data, DHS University Programs Summit	DHS	3/2011	Visual Analytics Law Enforcement Technology; Public Safety Coalition Projects	Poster	Center for Visual Analytics for Command, Control, and Interoperability Environments
Abish Malik, Coast Guard Search and Rescue Visual Analytics, DHS University Programs Summit	DHS	3/2011	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
March 2011 – Shehzad Afzal, Visual Analytics Decision Support Environment for Epidemic Modeling and Response Evaluation, DHS University Programs Summit	DHS	3/2011		Power Point	
Visual Analytics for Investigative Analysis and Exploration of Documents and Data", John Stasko, Dalhousie University, Halifax, Nova Scotia, Canada, November 2011, Dorothy J. Killam Memorial Lecture Series	Dalhousie University	11/2011	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments

Bianchetti, R.A., A.M. MacEachren, A. Klippel, A.C. Robinson, F. Hardisty, J.Blanford, R. Li and J. Yang. (2011) Comparing Cartographic Point Symbol Design with Card Sorting Methods. North American Cartographic Information Society (NACIS) 2011. Madison, WI: October 12-14.	North America Cartographic Information	10/2011	Symbology Standardization Support	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Troedson, S. and A.C. Robinson. (2011) Using Web-Based Tools to Share Symbology: A Case Study with Mapmakers from the California Department of Water Resources. North American Cartographic Information Society (NACIS) 2011. Madison, WI: October 12-14.	North American Cartographic Information Society	10/2011	Symbology Standardization Support	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Luo, W., Yin, P., Hardisty, F., Blanford, J., MacEachren, A.M. (2011). Spatial social network visual analytic tool. The 107th Annual Meeting of the Association of American Geographers. Seattle, WA: April 12-16, 2011.	The 107th Annual Meeting of the Association of American Geographers	4/2011	MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Savelyev, A. Robinson, A.C., MacEachren, A.M. (2012) Analysis of Methods for Representing and Interacting with Qualitative Geographic Information. The 108th Annual Meeting of the Association of American Geographers. New York: Feb 24-28, 2012	The 108th Annual Meeting of the Association of American Geographers	2/2012	MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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.	The 108th Annual Meeting of the Association of American Geographers	2/2012	MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness		Center for Visual Analytics for Command, Control, and Interoperability Environments
MacEachren, A.M. (2011). Geovisual Analytics: Leveraging Geographic Information, invited presentation at Data Science & Epidemiology Workshop, Penn State University, Oct. 6-7.	Pennsylvania State University	10/2012	MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Abish Malik, Coast Guard Search and Rescue Visual Analytics, IEEE Visual Analytics Science and Technology Conference	IEEE Visual Analytics Science and Technology Conference	10/2011	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
iVALET, Ahmad Razip, 12/13/2012, VACCINE Public Safety Consortium Meeting, Purdue University	VACCINE	12/2012	iVALET - Mobile Visual Analytics Law Enforcement Toolkit	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
Fast Track presentations at the National Fusion Center Training Event in Phoenix, Arizona, April 2-5, 2012 presented by Indiana Intelligence Fusion Center	National Fusion Center - Phoenix, AZ	4/2012		Other	
S. Ghani. Perception of Animated Node-Link Diagrams for Dynamic Graphs. IEEE EuroVis 2012, June 7, Vienna, Austria.	IEEE	6/2012	MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	Presented Paper	Center for Visual Analytics for Command, Control, and Interoperability Environments
S. Ghani. MultiNode-Explorer: A Visual Analytics Framework for Generating Web-based Multimodal Graph Visualizations. IEEE EuroVA 2012, June 5, Vienna, Austria.	IEEE	6/2012	MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	Presented Paper	Center for Visual Analytics for Command, Control, and Interoperability Environments
Lauren Bradel, "Co-located Collaborative Sensemaking in Visual Analytics", Poster presented at Grace Hopper Women in Computing Conference, Nov 2011.	Grace Hopper Women in Computing Conference	11/2011	Co-Located Collaborative Analysis on Large, High-Resolution Displays using Multiple Input Devices; Public Safety Coalition Projects	Poster	Center for Visual Analytics for Command, Control, and Interoperability Environments
"The Role of Usability, Workflow, and Patient-Centered Cognitive Support in Improving Health Information Technology," AMIA 2011, Washington, D.C., October 24, 2011.	AMIA	10/2011	Enhancing Interactive Visual Analysis and Decision Making Environments	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
"Introducing the MATH Method and Toolsuite for Evidence-based HIT." AMA-IEEE Medical Technology Conference," Boston, October 18, 2011.	AMA-IEEE	10/2011	Enhancing Interactive Visual Analysis and Decision Making Environments	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
"Defining 'Fast': Factors Affecting the Experience of Speed in Humanitarian Logistics, " ISCRAM 2011, Lisbon, Portugal, May 2011.	ISCRAM	5/2011	Enhancing Interactive Visual Analysis and Decision Making Environments	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
"Aligning Border Security Workflow and Decision Making with Support Information and Communications Systems," ISCRAM 2011, Lisbon, Portugal, May 2011.	ISCRAM	5/2011	Enhancing Interactive Visual Analysis and Decision Making Environments	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Teaching Visual Analytics: Leveraging Multidisciplinarity," Eurographics 2012 Panel, Cagliari, Italy, May 2012.	Eurographics	5/2012	Cyber Education	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics: From Situational Awareness to Risk-Based Decision Making," Financial Risk Visual Analytics Workshop, Banff, CA, May 2012.	Financial Risk Visual Analytics Workshop	5/2012	COAST: Coastal Operations and Analysis Suite of Tools	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments

Ebert, D., "Visual Analytics: Powering Discovery, Innovation, and Decision Making (Much more than Big Data Analytics plus Visualization), Keynote talk, ISCRAM 2012, Information Systems for Crisis Response and Management, Vancouver, BC, April 2012.	ISCRAM	4/2012	COAST: Coastal Operations and Analysis Suite of Tools	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics: Powering Discovery, Innovation, and Decision Making (Much more than Big Data Analytics plus Visualization)," Keynote talk, BRAVA 2012, 1st Brazilian Visual Analytics Workshop, Sao Paulo, Brazil, March 2012.	BRAVA	3/2012	COAST: Coastal Operations and Analysis Suite of Tools	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Risk-Based Visual Analytics for Maritime Resource Allocation," 2nd USCG Maritime Risk Symposium, Piscataway, NJ, November 2011.	U.S. Coast Guard	11/2011	COAST: Coastal Operations and Analysis Suite of Tools	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Predictive and Proactive Visual Analytics," US Coast Guard Atlantic Area Command, Portsmouth, VA September 2011.	U.S. Coast Guard	9/2011	COAST: Coastal Operations and Analysis Suite of Tools	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics: From Situational Awareness to Risk-Based Decision Making," Financial Risk Visual Analytics Workshop, Banff, CA, May 2012.	Financial Risk Visual Analytics Workshop	5/2012	COAST: Coastal Operations and Analysis Suite of Tools	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics: Powering Discovery, Innovation, and Decision Making (Much more than Big Data Analytics plus Visualization), Keynote talk, ISCRAM 2012, Information Systems for Crisis Response and Management, Vancouver, BC, April 2012.	ISCRAM	4/2012	COAST: Coastal Operations and Analysis Suite of Tools	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics: Powering Discovery, Innovation, and Decision Making (Much more than Big Data Analytics plus Visualization)," Keynote talk, BRAVA 2012, 1st Brazilian Visual Analytics Workshop, Sao Paulo, Brazil, March 2012.	BRAVA	3/2012	COAST: Coastal Operations and Analysis Suite of Tools	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Risk-Based Visual Analytics for Maritime Resource Allocation," 2nd USCG Maritime Risk Symposium, Piscataway, NJ, November 2011.	U.S. Coast Guard	11/2011	COAST: Coastal Operations and Analysis Suite of Tools	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Predictive and Proactive Visual Analytics," US Coast Guard Atlantic Area Command, Portsmouth, VA September 2011.	U.S. Coast Guard	9/2011	COAST: Coastal Operations and Analysis Suite of Tools	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics: Powering Discovery, Innovation, and Decision Making (Much more than Big Data Analytics plus Visualization), Keynote talk, ISCRAM 2012, Information Systems for Crisis Response and Management, Vancouver, BC, April 2012.	ISCRAM	4/2012	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics: Powering Discovery, Innovation, and Decision Making (Much more than Big Data Analytics plus Visualization)," Keynote talk, BRAVA 2012, 1st Brazilian Visual Analytics Workshop, Sao Paulo, Brazil, March 2012.	BRAVA	3/2012	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visualization and Analytics For Geospatial and Temporal Data," Ohio State Highway Patrol, Columbus, OH, March 2012.	Ohio State Patrol	3/2012	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics for Command Control and Interoperability Environment, U.S. Department of Homeland Security Science and Technology All Hands Meeting, Washington, DC, March 2012.	DHS	3/2012	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Predictive Visual Analytics for Discovery and Decision Making," Keynote Talk, Eli Lilly Corporate Research Symposium, Indianapolis, IN, January 2012.	Eli Lilly	1/2012	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics for Decision Making," HICSS Tutorial on Visual Analytics, HICSS 2012, Maui, HI, January 2012.	HICSS	1/2012	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics Applications for Decision Making: From Research to End-User," Keynote Talk, NSF FODAVA Meeting, Atlanta, GA, December 2011.	FODAVA	12/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics for Transportation Security," U.S. Transportation Security Agency Headquarters, Washington, DC, December 2011.	TSA	12/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments

Ebert, D., "Visual Analytics for Public Health and Safety," NATO Workshop on Visualization and Health, Vancouver, CA, November 2011.	NATO	11/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics to Enable Effective Policy and Decision Making," IEEE Visweek Panel on Visual Analytics for Policy Making, IEEE Visweek 2011Conference, Portsmouth, VA, October 2011.	IEEE	10/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Predictive and Proactive Visual Analytics," ACM SIGKDD 2012 Conference Tutorial, San Diego, CA, August 2011.	ACM	8/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics to Enable Discovery and Decision Making: Potential, Challenges, and Directions," Consortium for Supercomputing Advisory Council: Challenges and Future of High-Performance Computing, Washington, DC., September 2011	Supercomputing Advisory Council	9/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Predictive and Proactive Visual Analytics," US Coast Guard Atlantic Area Command, Portsmouth, VA September 2011.	U.S. Coast Guard	9/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Predictive Interactive Visual Analytics for Homeland Security, U.S. Transportation Safety Agency, Indianapolis, IN, June 2011.	TSA	6/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Predictive Interactive Visual Analytics for Homeland Security, State of Ohio Intelligence Fusion Center, Columbus, OH, July 2011.	State of Ohio Fusion Center	7/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics at Scale," Scientific Visualization Workshop, Dagstuhl Germany, June 2011.	Scientific Visualization Workshop	6/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics at Scale," VAC Consortium Meeting, College Park, MD, May 2011.	VAC	5/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics for Transportation Security," U.S. Transportation Security Agency Headquarters, Washington, DC, December 2011.	TSA	12/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics for Public Health and Safety," NATO Workshop on Visualization and Health, Vancouver, CA, November 2011.	NATO	11/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics to Enable Effective Policy and Decision Making," IEEE Visweek Panel on Visual Analytics for Policy Making, IEEE Visweek 2011Conference, Portsmouth, VA, October 2011.	IEEE	10/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Predictive and Proactive Visual Analytics," ACM SIGKDD 2012 Conference Tutorial, San Diego, CA, August 2011.	ACM	8/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics to Enable Discovery and Decision Making: Potential, Challenges, and Directions," Consortium for Supercomputing Advisory Council: Challenges and Future of High-Performance Computing, Washington, DC., September 2011	Supercomputing Advisory Council	9/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Predictive and Proactive Visual Analytics," US Coast Guard Atlantic Area Command, Portsmouth, VA September 2011.	U.S. Coast Guard	9/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments

Ebert, D., "Predictive Interactive Visual Analytics for Homeland Security, U.S. Transportation Safety Agency, Indianapolis, IN, June 2011.	TSA	6/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Predictive Interactive Visual Analytics for Homeland Security, State of Ohio Intelligence Fusion Center, Columbus, OH, July 2011.	State of Ohio Fusion Center	7/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics at Scale," Scientific Visualization Workshop, Dagstuhl Germany, June 2011.	Scientific Visualization Workshop	6/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics at Scale," VAC Consortium Meeting, College Park, MD, May 2011.	VAC	5/2011	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Interactive Visual Analytics for Crisis Management," US/Sweden Visual Analytics for Floods and Pandemics Workshop, Norrkoping, Sweden, April 2011.	US/Sweden	4/2011	LAHVA: Linked Animal-Human Health Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics for Public Health and Safety," NATO Workshop on Visualization and Health, Vancouver, CA, November 2011.	NATO	11/2011	LAHVA: Linked Animal-Human Health Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics for Command Control and Interoperability Environment, U.S. Department of Homeland Security Science and Technology All Hands Meeting, Washington, DC, March 2012.	DHS	3/2012	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics for Decision Making," HICSS Tutorial on Visual Analytics, HICSS 2012, Maui, HI, January 2012.	HICSS	1/2012	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics Applications for Decision Making: From Research to End-User," Keynote Talk, NSF FODAVA Meeting, Atlanta, GA, December 2011.	FODAVA	12/2011	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics for Transportation Security," U.S. Transportation Security Agency Headquarters, Washington, DC, December 2011.	TSA	12/2011	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Risk-Based Visual Analytics for Maritime Resource Allocation," 2nd USCG Maritime Risk Symposium, Piscataway, NJ, November 2011.	U.S. Coast Guard	11/2011	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics to Enable Discovery and Decision Making: Potential, Challenges, and Directions," Consortium for Supercomputing Advisory Council: Challenges and Future of High-Performance Computing, Washington, DC., September 2011.	Consortium for Supercomputing	9/2011	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Predictive and Proactive Visual Analytics," US Coast Guard Atlantic Area Command, Portsmouth, VA September 2011.	U.S. Coast Guard	9/2011	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Predictive and Proactive Visual Analytics," ACM SIGKDD 2012 Conference Tutorial, San Diego, CA, August 2011.	ACM	8/2011	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Predictive Interactive Visual Analytics for Homeland Security, U.S. Transportation Safety Agency, Indianapolis, IN, June 2011.	TSA	6/2011	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics at Scale," Scientific Visualization Workshop, Dagstuhl Germany, June 2011.	Science Visualization Workshop	6/2011	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics at Scale," VAC Consortium Meeting, College Park, MD, May 2011.	VAC	5/2011	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	Presented Paper	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Predictive Interactive Visual Analytics for Homeland Security, State of Ohio Intelligence Fusion Center, Columbus, OH, July 2011.	State of Ohio Fusion Center	7/2011	iVALET - Mobile Visual Analytics Law Enforcement Toolkit	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics for Decision Making," HICSS Tutorial on Visual Analytics, HICSS 2012, Maui, HI, January 2012.	HICSS	1/2012	iVALET - Mobile Visual Analytics Law Enforcement Toolkit	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics Applications for Decision Making: From Research to End-User," Keynote Talk, NSF FODAVA Meeting, Atlanta, GA, December 2011.	FODAVA	12/2011	iVALET - Mobile Visual Analytics Law Enforcement Toolkit	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics for Command Control and Interoperability Environment, U.S. Department of Homeland Security Science and Technology All Hands Meeting, Washington, DC, March 2012.	DHS	3/2012	iVALET - Mobile Visual Analytics Law Enforcement Toolkit	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments

Ebert, D., "Visual Analytics for Command Control and Interoperability Environment, U.S. Department of Homeland Security Science and Technology All Hands Meeting, Washington, DC, March 2012.	DHS	3/2012	Coast Guard PROTECT Visualization	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Predictive and Proactive Visual Analytics," US Coast Guard Atlantic Area Command, Portsmouth, VA September 2011.	U.S. Coast Guard	9/2011	Coast Guard PROTECT Visualization	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics for Command Control and Interoperability Environment, U.S. Department of Homeland Security Science and Technology All Hands Meeting, Washington, DC, March 2012.	DHS	3/2012	Coast Guard Swimmer Deaths	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Visual Analytics Applications for Decision Making: From Research to End-User," Keynote Talk, NSF FODAVA Meeting, Atlanta, GA, December 2011.	FODAVA	12/2011	Coast Guard Swimmer Deaths	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Risk-Based Visual Analytics for Maritime Resource Allocation," 2nd USCG Maritime Risk Symposium, Piscataway, NJ, November 2011.	U.S. Coast Guard	11/2011	Coast Guard Swimmer Deaths	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D., "Predictive and Proactive Visual Analytics," US Coast Guard Atlantic Area Command, Portsmouth, VA September 2011.	U.S. Coast Guard	9/2011	Coast Guard Swimmer Deaths	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
The Value of Visualization for Exploring and Understanding Data, John Stasko, Nov. 2013, Distinguished Lecture Series , Univ. of Arizona Computer Science Dept., Tucson, AZ.	U of Arizona	11/2013	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Hardisty, Frank, and Alexander Savelyev. 2013. "Coordinating Views within Interactive Web Geovisualization." In 26th International Cartographic Conference, Dresden, Germany.	ICC	8/2013	(GeoTxt) E2E: GeoTxt API	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Karimzadeh, M. (2014). Geospatial Cyberinfrastructure to Support Sustained Polar and Environmental Sciences. The 110th Annual Meeting of the Association of American Geographers. Tampa: April 8-12, 2014. http://meridian.aag.org/callforpapers/program/AbstractDetail.cfm?AbstractID=60308	AAG	4/2014	(GeoTxt) E2E: GeoTxt API	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
MacEachren, AM (2013) Moving forward: Reasoning about movement and other things dynamic. Keynote address at the European Cooperation in Science and Technology MOVE conference, Vienna, Austria, October 1, 2013.	European Cooperation in Science and Technology MOVE	10/2013	(GeoTxt) E2E: GeoTxt API	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
MacEachren, Alan M. (2013) Geo-Visual Analytics & 'Big' Data: Leveraging Geo-Information in Unstructured Data, Dept. of Geography Coffee Hour, Penn State, Dec. 6, 2013	Penn State University	12/2013	(GeoTxt) E2E: GeoTxt API	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Mullins R., Hardisty F., Pezanowski S., Sujatha Das, Savelyev A., MacEachren AM, Mitra P., Jaiswal A. (2013) Designing a Web Service to Geo-Locate Subjects of Volunteered, Textual Geographic Information. August 29th 2013, International Cartographic Conference, Dresden, Germany.		8/2013	(GeoTxt) E2E: GeoTxt API	Presented Paper	Center for Visual Analytics for Command, Control, and Interoperability Environments
Hulsey, S. (2013) Symbol Sharing Tools for Cartographers at NASA. North American Cartographic Information Society (NACIS) annual meeting 2013, Greenville, SC, October 9-11, 2013.	NACIS	10/2013	Symbology Map Transition	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Mullins, R. (2013) Questions Facing Map Design in the Age of Mobility and Siri. North American Cartographic Information Society (NACIS) annual meeting 2013, Greenville, SC, October 9-11, 2013.	NACIS	10/2013	Symbology Map Transition	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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	Morgan Innovation Day	2/2013	(iLEAPS) iLaw Enforcement Apps Assistance Program for Students	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Title: iLEAPS Radio Interview Interviewees: Dr. Kofi Nyarko, Benjamin Hall Date: March 19, 2013 Station: WEAA 88.9 FM Location: Baltimore, MD	WEAA 88.9fm	3/2013	(iLEAPS) iLaw Enforcement Apps Assistance Program for Students	Other	Center for Visual Analytics for Command, Control, and Interoperability Environments
Presentation 1: Survey, problem statement and technical plan. 11 January 2013 (presenter: Min Chen)		1/2013	UKVAC II		Center for Visual Analytics for Command, Control, and Interoperability Environments
Presentation 2: Formulation of the QCAT technique. 31 May 2013 (presenter: Min Chen)		5/2013	UKVAC II		Center for Visual Analytics for Command, Control, and Interoperability Environments
Presentation 3: Implementation of the QCAT technique. 6 September 2013 (Presenter: Simon Walton)		9/2013	UKVAC II		Center for Visual Analytics for Command, Control, and Interoperability Environments
Presentation 4a: Overview. 13 December 2013 (Presenter: Min Chen)		12/2013	UKVAC II		Center for Visual Analytics for Command, Control, and Interoperability Environments
Presentation 4b: Technical Report. 13 December 2013 (Presenter: Simon Walton)		12/2013	UKVAC II		Center for Visual Analytics for Command, Control, and Interoperability Environments

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.	Arizona State University	1/2013	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Maciejewski, R., "Analytical Brushing for Spatiotemporal Analysis," Computer Graphics and Visualization Summit, King Abdullah University of Science and Technology (KAUST), Saudi Arabia, April, 2013	KAUST	4/2013	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
The Value of Visualization for Exploring and Understanding Data, John Stasko, Feb. 2013, Distinguished Seminar Series , Purdue University Industrial Engineering Dept. , West Lafayette, IN.	Purdue University	2/2013	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
The Value of Visualization for Exploring and Understanding Data, John Stasko, May 2013, Keynote Lecture, Graphics Interface Conference, Regina, Saskatchewan, Canada	GIC	5/2013	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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.	IEEE VAST	10/2012	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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		4/2013	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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.	Argonne National Laboratory	5/2013	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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		4/2013	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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.	Argonne National Laboratory	5/2013	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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		4/2013	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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.	Argonne National Laboratory	5/2013	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Frank Hardisty, Visualizing Spatial, Temporal, and Social Graph Phenomena with the GeoViz Toolkit, May 23rd 2013, FOSS4G-NA, Minneapolis, MN.	FOSS4G-NA	5/2013	(GeoTxt) E2E: GeoTxt API	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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.	U.S. Army Corps of Engineers	6/2013	(GeoTxt) E2E: GeoTxt API	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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	North American Cartographic Information Society	10/2012	Symbology Standardization Support	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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	AAG	4/2013	Symbology Standardization Support	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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.	GeoCart	8/2012	Symbology Standardization Support	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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	NACIS	10/2012	Symbology Standardization Support	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments

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.	NACIS	10/2012	Symbology Standardization Support	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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.	North American Cartographic Information Society	10/2012	Symbology Standardization Support	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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	AAG	4/2013	Symbology Standardization Support	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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.	GeoCart	8/2012	Symbology Standardization Support	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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	NACIS	10/2012	Symbology Standardization Support	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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.	NACIS	10/2012	Symbology Standardization Support	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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.	AAG	2/2012	MDRP 13: (SensePlace 2) Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Luo, W. (2012) Geo-Social Visual Analytics with Applications to Catastrophic Risk Management. Invited Speaker at the Global Catastrophic Risk Institute. October 25, 2012	Global Catastrophic Risk Institute	10/2012	MDRP 13: (SensePlace 2) Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
MacEachren, Alan M. (2012) Geovisualization to Geovisual Analytics: Visual Reasoning with Big & Messy Data GI Forum, Invited Keynote at Salzburg, Austria, July 5, 2012.		7/2012	MDRP 13: (SensePlace 2) Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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	University of Zurich	3/2013	MDRP 13: (SensePlace 2) Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Frank Hardisty, Visualizing Spatial, Temporal, and Social Graph Phenomena with the GeoViz Toolkit, May 23rd 2013, FOSS4G-NA, Minneapolis, MN	FOSS4G-NA	5/2013	MDRP 13: (SensePlace 2) Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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.	AAG	2/2012	MDRP 13: (SensePlace 2) Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Luo, W. (2012) Geo-Social Visual Analytics with Applications to Catastrophic Risk Management. Invited Speaker at the Global Catastrophic Risk Institute. October 25, 2012	Global Catastrophic Risk Institute	10/2012	MDRP 13: (SensePlace 2) Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments

MacEachren, Alan M. (2012) Geovisualization to Geovisual Analytics: Visual Reasoning with Big & Messy Data GI Forum, Invited Keynote at Salzburg, Austria, July 5, 2012.		7/2012	MDRP 13: (SensePlace 2) Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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	University of Zurich	3/2013	MDRP 13: (SensePlace 2) Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Frank Hardisty, Visualizing Spatial, Temporal, and Social Graph Phenomena with the GeoViz Toolkit, May 23rd 2013, FOSS4G-NA, Minneapolis, MN	FOSS4G-NA	5/2013	MDRP 13: (SensePlace 2) Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Fisher, B (2012) Visual Analytics as a Cognitive Science. Dagstuhl Seminar No. 12081 on Information Visualization, Visual Data Mining and Machine Learning.	Dagstuhl	2/2012	MDRP 6: Video Surveillance Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
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)	OBSSR	1/2012	MDRP 6: Video Surveillance Visual Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
William Ribarsky, Keynote Speaker, "Analytics and the Textual World," Workshop on Interactive Visual Text Analytics, IEEE VisWeek 2012 (October, 2012).	IEEE	10/2012	Multimedia, Social Media, Text, and Emergency Response Analytics	Presented Paper	Center for Visual Analytics for Command, Control, and Interoperability Environments
William Ribarsky, Invited Speaker, "Texts and Big Data Analytics," Clemson University (November, 2012)	Clemson University	11/2012	Multimedia, Social Media, Text, and Emergency Response Analytics	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
William Ribarsky, Invited Speaker, "Social Media Analysis as Social History," University of Indiana (April, 2013)		4/2013	Multimedia, Social Media, Text, and Emergency Response Analytics		Center for Visual Analytics for Command, Control, and Interoperability Environments
VADER/VIS VAST 2015 Grand Challenge Entry	VAST	10/2015	Geographic Network Analytics Correlations for VALET	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Visualizing the Impact of Geographical Variations on Multivariate Clustering	EuroVis	6/2016	Geographic Network Analytics Correlations for VALET	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
"The Value of Visualization for Exploring and Understanding Data", John Stasko, October 2015, Invited lecture at Emory University, Atlanta, GA.	Emory University	10/2015	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
"The Value of Visualization for Exploring and Understanding Data", John Stasko, November 2015, Invited lecture at Lehigh University, Bethlehem, PA.	Lehigh University	11/2015	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
"New Approaches for Information Visualization: Rethinking Existing Notions", John Stasko, Jaunary 2016, Invited lecture at Oak Ridge National Lab, Oak Ridge, TN.	Oak Ridge National Lab	1/2016	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
"Introduction to Visual Analytics", Alex Endert, March 2016, Presented at Visual Analytics Spring School at Middlesex University, London, UK.	Middlesex University	3/2016	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
"Putting User Interaction First: The Importance of User Interaction for Visual Analytics", Alex Endert, April 2016, Invited lecture at Oak Ridge National Laboratory, Oak Ridge, TN.	Oak Ridge National Laboratory	4/2016	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
"The Value of Visualization for Exploring and Understanding Data", John Stasko, April 2016, Invited lecture at Bentley University, Waltham, MA.	Bentley University	4/2016	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
The Value of Visualization for Exploring, Presenting, and Understanding Data", John Stasko, May 2016, Invited lecture at Nokia Corp., San Jose, CA.	Nokia Corp.	5/2016	MDRP 1: (Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
City of Chicago Long-Term Evolution (LTE) Broadband Pilot	IACP	10/2015	Chicago LTE Project	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Superpixels Shape Analysis for Carried Object Detection	WACVW	3/2016	Chicago LTE Project	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Tattoo Image Retrieval for Region of Interest		5/2016	(GARI) Gang Graffiti Recognition and Analysis	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Automatic and Manual Tattoo Localization	Mitre Corporation	5/2016	(GARI) Gang Graffiti Recognition and Analysis	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments

Superpixels Shape Analysis For Carried Object Detection	IEEE	3/2016	VBOLO	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Person re-identification using a patch-based appearance model	IEEE	9/2016	VBOLO	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Accuracy Prediction for Pedestrian Detection	IEEE	9/2017	VBOLO	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments
Quality-Adaptive Deep Learning for Pedestrian Detection	IEEE	9/2017	VBOLO	Power Point	Center for Visual Analytics for Command, Control, and Interoperability Environments

Title	Patent number	Patent status	Patent date	Project	Center of Excellence
Visual Analytics Law Enforcement Tools	U.S. 8,849,728	Patent Awarded	9/2014	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Center for Visual Analytics for Command, Control, and Interoperability Environments
Proactive Spatiotemporal Resource Allocation and Predictive Visual Analytics		Patent Applied	11/2014	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	Center for Visual Analytics for Command, Control, and Interoperability Environments
Maciejewski, R., Hafen, R., Rudolph, S., Cleveland, W., Ebert, D., "Forecasting hotspots using predictive visual analytics approach," U. S. Patent 8,924,332 B2 issued on Dec. 30, 2014	U. S. Patent 8,924,332 B2	Patent Awarded	12/2013	WDYTYA: The Uncertainty of Identity	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D. S., Maciejewski, R., Tyner, B., Jang, Y., Cleveland, W., Amass, S., "Animal Symptom Visual Analytics," U. S. Patent 8,882,664 B2 issued on November 11, 2014.	U. S. Patent 8,882,664 B2	Patent Awarded	11/2014	WDYTYA: The Uncertainty of Identity	Center for Visual Analytics for Command, Control, and Interoperability Environments
Ebert, D. S., Collins, T., Maciejewski, R., Malik, A., "Visual Analytics Law Enforcement Tools," U. S. Patent 8,849,728 B2 issued on September 30, 2014	U. S. Patent 8,849,728 B2	Patent Awarded	9/2014	WDYTYA: The Uncertainty of Identity	Center for Visual Analytics for Command, Control, and Interoperability Environments
M. Boutin, S. Biddanda, N. Elmqvist, D. Ebert. Method for Visualizing the Results of an Electronic Search. Provisional patent 61/348,542, May 2010.	Provisional patent 61/348,542	Patent Awarded	5/2010	MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	Center for Visual Analytics for Command, Control, and Interoperability Environments
M. Boutin, S. Biddanda, N. Elmqvist, D. Ebert. Method for Visualizing the Results of an Electronic Search. Provisional patent 61/348,542, May 2010.	Provisional patent 61/348,542	Patent Awarded	5/2010	MDRP 18: Visual Analytics for the DHS Centers of Excellence	Center for Visual Analytics for Command, Control, and Interoperability Environments
	U.S. 13/291,761	Patent Applied		Visual Analytics Law Enforcement Technology; Public Safety Coalition Projects	Center for Visual Analytics for Command, Control, and Interoperability Environments
U.S. Provisional Patent, "Modeling & Analysis Tool for Healthcare Processes (MATH)," filed on January 13, 2012, serial number 61/586,227.	serial number 61/586,227.		1/2013	Enhancing Interactive Visual Analysis and Decision Making Environments	Center for Visual Analytics for Command, Control, and Interoperability Environments
U.S. Provisional Patent, "Methods and Systems for Improving Clinical Workflow by Enabling Remote Clinician-Patient Interaction," filed on May 27, 2011, serial number 61/490,840.	serial number 61/490,840.		5/2011	Enhancing Interactive Visual Analysis and Decision Making Environments	Center for Visual Analytics for Command, Control, and Interoperability Environments

IX. Projects by Thematic Area

Code 2	Theme	Proj Title (PIR)	Start Date	End Date	Abstract (PIR)	Output Description	Next Step	Status (R)	Theme (P)	Proj Type (P/R)	Awd Amt (PIR)	Awd No. (P)	Compliance (R)	Data Collection Method	Is Deleted	Other Project Type	Primary End User	PI (P/R)	PI Organization (P/R)	MSIs (P)	States (P)	Collab COEs (P)	Users (P/R)	Primary End User	Exec Summ (P/R)	Prod/Final	Research .	Comoleted	Analytic M	Academic	Stages of Transition
	Resource Allocation	Pluglest	2016/09	2017/06	Pluglest is an Annual Event where different solution providers of sensors, analytics and decisions support tools and information sharing capabilities integrated their products in real time during on-water simulations of different scenarios.	Pluglest took place during the Maritime Security 2016 West Annual Conference, from Sept.20-22, 2016 in Everett, WA. Pluglest is a DHS exercise that allows different solution providers of sensors, analysis and decisions support tools, and information sharing capabilities integrated their products in real time during on-water simulations of different scenarios. Multiple radar and tracking devices were setup around Possession Sound by DHS and other vendors, and data were uploaded to a web service our system was able to collect and display. We shared a booth with DHS S&T, demonstrated cpSARVA , a modified version of VALET for displaying these collected data and calculated clusters and anomalies, and gave a short talk on what role our visual analytics systems could play in different hypothetical scenarios mentioned. Some other vendors with graphical user interfaces have shown interest to our systems, and we have received positive feedback from other attendees and the DHS S&T group.	DHS S&T plans to shft Plugfest participation to a broader DoD PlugFest. VACCINE will participate as requested.	In Progress			150000	2009-ST-061-CI001	No		FALSE			David Ebert	Purdue University			Center for Visual Analytics for Command, Control, and Interoperability Environments			2016				Modeling		Pilot/Field Testing and Evaluation in an Operational Environment
1	Law Enforcement	VBOLO	2016/08	2017/06	The goal of this project is to investigate methods for re-identifying subjects as they appear in surveillance video at the Greater Cleveland Regional Transit Authority (GCRTA). The GCRTA has expressed interest in tools that will allow them to identify subjects as they re-appear in their surveillance system. In many cases a subject who has previously committed a crime will re-enter the system hours or days later and appear in GCRTA surveillance video. The GCRTA would like to re-identify (re-id) that subject so they can be apprehended after their re-entry to the system. In some sense, what the GCRTA would like to create is an automatic or electronic be on the lookout (BOLO) system. We call this system EBOLO. We envision the EBOLO system would be one where the subject to be added to a BOLO would be manually highlighted by the GCRTA from surveillance video of an incident. The system would then use computer vision and image processing techniques to create features of the subject from the surveillance video. One could think of these features as the subjects EBOLO fingerprint.We then use these features to continuously monitor the video surveillance system to determine when that subject reappeared in the video. The systems would then flag or alarm that the subject has reappeared and where they are located.	We are continuing to refine the vbolo system and working closely with our project partners and law enforcement. The current vBOLO system can currently find the correct person in a lineup of 10 automatically-detected candidates 90% of the time for one camera. CVADA-Purdue and ALERT expect to improve performance of vBOLO to find the correct person in a lineup of five candidates 95% of the time. This would involve the addition of high resolution video, facial analysis, motion features, improved body features, and subject attributes. Additional funds are needed for system integration and deployment Collaboration with end-user;	Additional funds are needed for system integration and deployment. We want to integrate person detection, body matching techniques, dynamics (gait analysis) and facial recognition methods in one framework and investigate the degradation of performance that might result from the operational settings, such as video compression and packet losses.	In Progress	Visual Analytics of Unstructured and Streaming Data	Research		120000	2009-st-061-ci001	No		Field Monitors	FALSE			Edward Delp; Edward Delp	Purdue University; Purdue University		IN; OH	Center for Visual Analytics for Command, Control, and Interoperability Environments; Northeastern University	State and Local Transportation		2016	Emergency Preparedness and Response; Transportation Security	Data Collection/ Generation	Qualitative Analysis	Engineering - Electrical; Mathematics	Pilot/Field Testing and Evaluation in an Operational Environment
E	Education	success visualization project	2016/07	2017/06	VACCINE recognizes the importance of showing the impact and successes of the Center for the work it will have performed in its 8-year history. Action will occur in Year 8 to produce materials for DHS that demonstrate the positive impact that their financial investments have made. VACCINE plans to accomplish this through allocating the time of an existing VACCINE student (pulling from the Center's own expertise in visual analytics) in order to develop visualization of the Center's historical success and impact over the eight year period. The Center will create an interactive "event river" visualization tool of our COE success and impact that will be placed on our website in the form of a "timeline." Key pieces of information about each project that will be able to be accessed from this visualization through time including the project reports and videos, links to news stories, one-page fact sheets about each technology, etc. Such a visualization tool will aid in easy and lasting sharing of information in presentations, iPad demos, etc. by VACCINE as well as any DHS staff when communicating about the work of the Center.	We have started the development of a visualization of the Center's historical success and impact over the eight year period. The Center will create an interactive "event river" visualization tool of our COE success and impact that will be placed on our website in the form of a "timeline." Key pieces of information about each project that will be able to be accessed from this visualization through time include the project reports and videos, links to news stories, one-page fact sheets about each technology, etc. Such a visualization tool will aid in easy and lasting sharing of information in presentations, iPad demos, etc. by VACCINE as well as any DHS staff when communicating about the work of the Center.	We plan to complete this visualization tool in 2017.	In Progress	Information-driven Visualization, Modeling and Simulation of Data			0	N/A	No			FALSE			David Ebert	Purdue University		IN	Center for Visual Analytics for Command, Control, and Interoperability Environments	Other DHS		2016					Basic Research, Operational Use, Prototype Demonstration
E	Education	Crisis Informatics Course Development	2015/12	2016/06	The goal of this proposal is to enhance and grow a newly developed course entitled Crisis Informatics. Crisis Informatics explores the use of information and communication technologies in crisis management. In particular, it examines how information generated through social media is collected, organized, processed, and used for crisis management.	The Crisis Informatics Course has been developed and has been offered once a year at the graduate level since Fall 2015. The course includes a visual analytics component which is mainly constituted of hands-on class activities involving the use of visual analytic toolkits (NODEXL, SMART) to explore crisis related information generated through social media.	1. Enhance the Visual Analytics component of the course by adding more elaborated hands-on exercises ; 2. Develop the undergraduate level of the course ; 3. Make both the graduate and the undergraduate levels of the course a model that could be adopted and taught in other Institutions.	Complete	Big Data Visual Analytics	Workforce Development/Education		38750	2009-ST-061-CI001	No		Compiling and Sorting Database	FALSE			Louis Ngamassi	Prairie View A & M University	Prairie View A&M University	TX		Academic Community		06/2016	Advanced Data Analysis and Visualization; Emergency Preparedness and Response; Human Factors Aspects of Technology	Low Risk	Qualitative Analysis	Classroom Education; Exercise; Online Education; Information Science; Information systems; Risk management/assessment; Security Informatics	Pilot/Field Testing and Evaluation in an Operational Environment
1	Law Enforcement	Geographic Network Analytics Correlations for VALET	2015/11	2017/07	In the field of security, the exploration of criminal incident reports for detecting trends, discovering anomalies and evaluating resource usage is an ever expanding issue for law enforcement agencies. An especially useful tool would be an analyzer program to reveal the relationship between infrastructure and crimes so as to make inferences about how to best deploy officials to enable smarter cities. Previous work on VALET in collaboration with ASU and PU has seen the deployment of geographical network analytics to create novel hotspot maps. In this work, we propose the use of the network data to form the basis of a predictive analytics method to capture correlations between infrastructure (locations in the town such as grocery stores, bus stops, etc.) and crimes. The first part of this task involves developing the methodology of automatically extracting city infrastructure using publically available data sources. Once this information is extracted, we will fuse this as a layer in VALET and enable the exploration of correlations of spatiotemporal hotspots to regional locations (businesses, parks, etc.). In this way, analysts can explore relationships on the geographic network. Using the spatial and temporal autocorrelations, we will then develop a novel method of criminal incident prediction along the geographic network. The second component of this project is to integrate these features into a visual analytics environment for law enforcement agencies and learn various design principles for Human-Computer Interaction and data visualization. This would involve working directly with VACCINE and PU and for this task we propose a graduate student exchange with PU (as done in the summer of 2015) to engage in the addition of these techniques to the current Val ET system. This will enable the final	Currently, ASU has developed a network based density estimate model to explore geographical boundaries of gang territories as well as improve hotspot analysis and detection. This work has resulted in an online service for creating network density estimate models and we are in the process of porting these features to other systems for further deployment. The expected impact is improved data analytics for law enforcement as well as serving as a basis for improved network based modeling of crime and crime hotspots.	The next step is a mathematical evaluation of the network model to determine the predictive capability and define the guidelines for use. We will compare this to the standard kernel density estimate as a projection on to a map for error comparison to determine under what conditions the simplified version will be effective.	In Progress	Data-driven Decision Support	Research		50000	2009-ST-061-CI001	No		Data Mining	FALSE			Ross Maciejewski; Ross Maciejewski	Arizona State University; Arizona State University		AZ; IN	Center for Visual Analytics for Command, Control, and Interoperability Environments	Academic Community		2016	Advanced Data Analysis and Visualization; Emergency Preparedness and Response; Social, Behavioral, and Economic Sciences		Case Studies; Statistical Analysis	Geographic Information sciences; Geography ; Information Science; Information systems; Computer Science; Criminology	Basic Research
1	Law Enforcement	Safety in View: A Public Safety Visual Analytics Tool Based on CCTV Camera Angles of View	2015/06	2015/07	Campus security and police departments have implemented a multitude of safety precautions, including CCTV cameras. This is a Public Safety Visual Analytics Tool Based on CCTV Camera Angles of View. The efficiency and effectiveness of using CCTV camera resources for preventing crimes result in higher demand. We implemented a visual analytics tool to analyze the existing CCTV camera resources and suggest improved allocation schemes based on blind spots and crime data. Our tool provides the user with an interactive safe path calculation method for walking purpose on the basis of the maximum monitoring area. Additionally, avoiding buildings in the calculated path is an optional control factor. Our tool also provides functions for crime data analysis. The camera-alarming function highlights the cameras that a specific crime occurred in their visible range. The camera-ranking function highlights the camera that records the largest number of crime incidents. Based on the historical crime data, we suggest locations for future camera installation.	Journal article was created.	The next step is to further refine the user study and system in order to evaluate the underlying designs and begin developing guidelines for how to promote user exploration for predictive analytics.	Complete		Research		0	2009-ST-061-CI001	No		Expert Consultation	FALSE			David Ebert	Purdue University		IN		State and Local First Responders				Case Studies	Computer Science	
1	Law Enforcement	Officer Performance Visualization System	2015/05	2017/07	Collaborating with Chief Patrick Flannelly, we propose the Officer Performance project to gamify the performance of police officers in Lafayette Police Department for better performance comparison and for motivating maximized performance. Prototype delivered in Aug 2016.	Prototype delivered to the Lafayette Police Department in Aug 2016.	The next step is to formalize the name profiler toolkit and evaluate its effectiveness in providing probability estimates for online identities.	In Progress		Research		0	2009-ST-061-CI001	No		Compiling and Sorting Database	FALSE			David Ebert	Purdue University		IN		State and Local First Responders		2016	Communications and Interoperability; Social, Behavioral, and Economic Sciences		Modeling; Statistical Analysis	Computer Science	Pilot/Field Testing and Evaluation in an Operational Environment
1	Law Enforcement	Chicago LTE Project	2015/05	2016/02	The Chicago LTE Project was a wireless LTE mobile video transmission test and analysis for police and urban environments. The goals of this project were to test the viability and performance of the LTE National Public Safety Broadband Network (NPSBN) with respect to transport of video imagery. One cell using the NPSBN was installed in Chicago at the Chicago Police Department District 7. We conducted a test plan to characterize the performance of the network and analyzed the data collected. The test plan consisted of three parts: First, objective perceptual video quality tests designed to measure the video quality when video is streamed in real-time over the LTE network were conducted. Second, subjective measurements were conducted to characterize the performance of applications of interest under various test conditions. Third, network performance metrics were obtained to test the key performance indicators associated with the network. Based on the analysis of the data collected during our testing it was concluded that a PSBN LTE network provides an unprecedented opportunity to increase the capacity and to meet the needs and requirements of public safety with respect to video delivery. Careful analysis should be used for Quality of Service (QoS), prioritization and Radio Frequency (RF) planning when designing a NPSBN LTE system. It was also noted that adaptive video coding methods, used in many video systems, might not suit public service operational scenarios. System designer should also take into consideration video usage in a task-based approach.	Our initial test plan intended to conduct subjective assessments of non-video applications used by the CPD such as RTVI, CAD, VidSys and Shotspotter. However, due to operational issues and requirements by the CPD, only subjective assessment of RTVI was conducted. This project invoked investigating the delivery of real time video delivery to police vehicles. The project was sponsored DHS with the project partners being Purdue, Motorola, and the Chicago Police. The major effort here was the work of Motorola in setting up a Public Service LTE cell site for the Chicago Police. We used this cell site for doing our video testing.	In the future, we want to design an objective video quality metric based on advanced image and video processing techniques combined with machine learning strategies to estimate video quality in dynamic scenes. This metric would indicate to the law enforcement officer which video analytic might be useful to him/here given the video quality. The Chicago LTE pilot project also demonstrates that the 700MHz National Public Safety Broadband Network (NPSBN) will provide unprecedented resources in terms of network capacity and communication speeds. However, Quality of Service (QoS) and prioritization should still be taken into consideration while scheduling network resources. Mission critical users or emergency responders should be allocated resources according to a well-defined QoS and prioritization model. In the future, we want to characterize the performance of the NPSBN when a Priority and QoS framework is implemented within the network.	Complete		Research		220293	2009-ST-061-CI001	No		Field Monitors	FALSE			Edward Delp; Edward Delp	Purdue University; Purdue University		IN; IL		Private Sector Other, State and Local First Responders		2015	08/2015					
3	Social Media Tools	Context-Driven Visual Analytics for Cyber Defensive Operations - Oak Ridge N Lab	2015/01	2016/07	We've developed a novel graph-analytic approach for detecting anomalies in network flow data called GraphPrints. Building on foundational network-mining techniques, our method represents time slices of traffic as a graph, then counts graphlets--small induced subgraphs that describe local topology. By performing outlier detection on the sequence of graphlet counts, anomalous intervals of traffic are identified, and furthermore, individual IPs experiencing abnormal behavior are singled-out. Initial testing of GraphPrints is performed on real network data with an implanted anomaly. Evaluation shows false positive rates bounded by 2.84% at the time-interval level, and 0.05% at the IP-level with 100% true positive rates at both	GraphPrints was created, a graph analytic approach for detecting anomalies in network flow data. Initial testing has been completed.	Research will continue as funded along with attendance to workshops.	Complete	Information-driven Visualization, Modeling and Simulation of Data			820000	2009-ST-061-CI001	No		Data Mining	FALSE			Bobby Bridges			IN; TN		Academic Community; DHS Science and Technology Directorate; Other Industry				Advanced Data Analysis and Visualization		Modeling; Statistical Analysis	Mathematical and Computational Modeling	Basic Research

3	Social Media Tools	SMART: Social Media Analytics and Reporting Toolkit	2014/07	2017/07	Recent advances in technology have enabled social media services to support space-time indexed data. Such spatiotemporal data has immense value for increasing situational awareness of local events, providing insights for investigations and understanding the extent of incidents. However, the large volume of unstructured social media data hinders effective exploration and examination. Analysts require new methods for monitoring their topics of interest, identifying trends and anomalies, and dealing with the data volume and its dynamic nature. Our system provides users with scalable and interactive social media data (e.g., Twitter, Facebook) analysis and visualization including the exploration and the examination of abnormal topics and events. We have developed a new approach to let analysts build task-tailored message filters (classifiers) in an interactive and visual manner. The created filter methods can be orchestrated and adapted afterwards for interactive, visual real-time monitoring and analysis. In addition, web and news media sources (i.e., Google and CNN trends) are incorporated in the system. Our system also provide an email alert service to automatically send emails if the number of incoming tweets containing specific keywords exceeds a threshold. We provide such functionalities through not only desktop application, but also highly interactive and accessible Web interfaces.	The Initial Prototype was deployed in July 2013 to the Boy Scouts of America for testing at their Annual Jamboree. The USCG tested SMART at the Thunder Over Louisville event. This is a day-long air show and fireworks display held on and along the Ohio River in Louisville, Kentucky. Thunder Over Louisville serves as the kickoff event for the annual Kentucky Derby Festival, culminating with the Kentucky Derby on the first Saturday in May. The 2014 event drew an estimated 650,000 spectators to the Kentucky and Indiana sides of the Ohio River, as well as approximately 120 recreational boats that anchored in the river. SMART is still in testing and evaluating with a number of police and federal agencies.	The Red Cross is interested in testing SMART for its application and use in disaster preparedness and response initiatives.	In Progress		Research	10000	2009-ST-061-CI001	No	Data Mining	FALSE		David Ebert	Purdue University	IN; TN	DHS Federal Emergency Management Agency; DHS U.S. Coast Guard; State and Local First Responders		2016			Case Studies; Modeling; Sampling; Statistical Analysis		
2	Resource Allocation	Analyzing High-dimensional Multivariate Network Links with Integrated Anomaly Detection, Highlighting and Exploration	2014/07	2015/06	This research focuses on the integration of a family of visual analytics techniques for analyzing high- dimensional, multivariate network data that features spatial and temporal information, network connections, and a variety of other categorical and numerical data types. Such data types are commonly encountered in transportation, shipping, and logistics industries. Due to the scale and complexity of the data, it is essential to integrate techniques for data analysis, visualization, and exploration. We present new visual representations, Petal and Thread, to effectively present many-to-many network data including multi-attribute vectors. In addition, we deploy an information-theoretic model for anomaly detection across varying dimensions, displaying highlighted anomalies in a visually consistent manner, as well as supporting a managed process of exploration. Lastly, we evaluate the proposed methodology through data exploration and an empirical study.	Initial work focused on airport data for TSA.	N/A		Complete	Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		David Ebert	Purdue University	IN				Case Studies; Statistical Analysis		
4	Disease Surveillance	Social Media and Healthcare Analytics for Identification of Emerging Health Threats	2014/07	2015/06	Assessing current and emerging health threats is important for public health officials in order to make timely decisions about mitigative measures and allocation of resources required under different scenarios. Syndromic surveillance systems often rely on analyzing data received from a specific domain such as chief complaints data collected through hospitals, social media streams, aggregated web searches, news stories, etc. Information collected through multiple data sources could provide better understanding of extent and severity of emerging health threats and also reduces dependence on a single data source. It also helps scientists understand the characteristics of syndromic diseases, discover correlations among different factors and understand contributing factors in disease outbreak scenarios. This project focusses on providing a visual analytics environment that enables analysts combine chief complaints data collected through hospitals, social media data from Twitters API and weather data to make comprehensive assessments about disease outbreaks.	Presentations have been done.	N/A		Complete	Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		David Ebert	Purdue University	AZ; IN				Modeling; Statistical Analysis	Biostatistics and bioinformatics; Computer Science	
3	Social Media Tools	Mobile Application Communication	2014/07	2015/06	Note: George Mason U. Task 1: Extend the monitoring to hundreds of thousands of applications and include all official and 3rd party markets. Going beyond the pilot, we plan to extend our coverage to hundreds of thousands of applications. Currently each market has more than 1,000,000 applications that can hide a lot of badly designed and malicious apps. In this task we plan to build: Appliance-based repository of over 1M apps from across major platforms (iOS, Android, Microsoft). Extract and perform open source analysis of meta-data. Instantiate and monitor network traffic of all apps. Maintain data set of over 1M apps and 10,000+ updates per month, running 24x7 in cloud based infrastructure. Task 2: Transition the technology to DHS This task will prepare an appliance that will be engineered to be deployed within DHS and other DoD entities. Kryptowire will provide the necessary engineering support and documentation required to setup and operate the portal and will train any government personnel to be able to use the portal to perform analytics and to share information between DHS and other agencies.	The constant internet connectivity of smart devices coupled with their pervasive use and the desire of users to try new mobile applications make it a remarkable exploitation target. Malware can easily pose as innocuous, must have applications, all the while causing damage ranging from losing contact information to locking of the device. Current research indicates an increasing threat of malware for mobile platforms even in the presence of anti-malware checks: Android Bouncer has been employed in Google Play market to identify malicious applications. However, it seems that the attackers have found ways to evade detections, adapting to many of the current standards. To make matters worse, there are other, third-party markets that are available for downloading Android applications that can easily purvey malicious applications. Another challenge is that not all applications reveal their malicious behavior when they are installed or even run on the device. Instead, the malicious behavior can be triggered based on different conditions. However, most software testing is performed towards checking the quality of software or apps but recently security testing has gained popularity and has proved its importance. Testing mobile application is not an easy task due to variety of inputs and heterogeneity of the technologies.	N/A		Complete	Research	504901	2009-ST-061-CI001	No		FALSE				VA						
3	Social Media Tools	Explore Impact of Visualization on Predictive Analysis	2014/07	2017/06	Data science is an interdisciplinary field that focuses on the process and systems used to extract knowledge from large data sets. The primary goal is to determine trends and patterns that can be used to generate models and predict behaviors of interest. This type of analysis occurs across all areas of science as data is collected and mined to assess the likelihood that a similar trend, pattern or behavior may occur across similar samples. While visual analytics can serve to enable the human-in-the-loop as part of data science, a variety of challenges still remain, and perhaps the most challenging is how much human should be in the data science process? This project will explore visual analytics methods for predictive analytics, focusing on social media for forecasting. The platform developed will then be used for experiments in exploring at what level of predictive accuracy does a human-in-the-loop help or hinder analysis. 5 of our 7 subjects were able to best a movie prediction website (BoxOffice.com) and only two subjects erred on the far low end of the spectrum for this movie (subjects 3 and 5). These results demonstrate that such tools can quickly bring novice users up to speed in predictive modeling when compared with experts.	Given the conflicting demands of model accuracy, comprehensibility and trustworthiness, the question of how much human knowledge and interaction is needed or warranted in relation to the model becomes a critical question for predictive visual analytics. How much of the human do we want in the loop of model prediction? Are humans able to accurately make predictions or outperform models with the aid of visual analytics? The goal of this study is to explore these questions. This work presents the results from the user study, an analysis of user interactions within the system, and serves as a starting point to discuss how much human-in-the-loop is useful for predictive visual analytics.	The next step is to further refine the user study and system in order to evaluate the underlying designs and begin developing guidelines for how to promote user exploration for predictive analytics.	In Progress	Data-driven Decision Support	Research	193686	2009-ST-061-CI001	No	Bench Tests	FALSE		Ross Maciejewski; Ross Maciejewski	Arizona State University; Arizona State University	AZ	Academic Community		2016	Advanced Data Analysis and Visualization; Human Factors Aspects of Technology; Social, Behavioral, and Economic Sciences	Data Collection/Generation	Case Studies	Laboratory Testing and Evaluation	
2	Resource Allocation	Exascale Data Visualization: Information-assisted data analysis and visualization	2014/07	2015/06	Exascale Data Visualization: Information-assisted data analysis and visualization		N/A		Complete	Research	0	2009-ST-061-CI001	No		FALSE		Kelly Gaither	University of Texas	TX								
2	Resource Allocation	Critical Infrastructure in Large Scale Emergencies	2014/07	2015/06	The goal of this project, part of the Visual Analytics for Security Applications (VASA) project, is to apply visual analytics to disaster prevention and crisis response, with a focus on critical infrastructures in logistics, transportation, food safety, digital networks and power grids at the national levels. The connectedness and dependency of these critical infrastructures make the problem of monitoring and understanding their functioning and dependencies one of the most complex analytical tasks faced by our societies. Their proper functioning is crucial for the well-being of the population, economic viability, and most of all to prevent loss of life	Tool created works on iPad.	More funding needed.		Complete		0	2009-ST-061-CI001	No		FALSE		William Ribarsky	University of North Carolina at Charlotte	NC	Department of Energy National Labs; Private Sector Other						
3	Social Media Tools	Multimedia Analytics for Open Source Media	2014/07	2016/06	In this project, we are developing a novel visual analytics framework to support automatic understanding, exploration, and more effective analysis of large-scale online multimedia documents for homeland security applications. Investigators in many areas often use multiple public information sources. More and more, these sources have multimedia content. The analysts are greatly hampered and sometimes stymied by the fact that there are no automated tools for intelligent categorization and analysis of the copious amounts of information that flow from these sources. For example, there are few tools to understand the content of unannotated images and video. There is hardly anything to extract and relate themes or stories from multimedia content (for example, from broadcast video or multimedia Web pages) and organize them for exploratory analysis. Thus analyzing online news over days or weeks from multiple sources in several languages is untenable because trained analysts would have to actually watch the many thousands of hours of video. These general techniques are also being applied to document collections and to online sources such as blogs and Twitter feeds.		N/A		Complete		0	2009-ST-061-CI001	No		FALSE		William Ribarsky; William Ribarsky	University of North Carolina-Charlotte; University of North Carolina at Charlotte	NC	DHS Labs						
1	Law Enforcement	Parallelizing Video Algorithms for Public Safety Applications	2014/07	2015/06			N/A		Complete	Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		Kelly Gaither	University of Texas, Austin	IN; TX				Case Studies; Modeling; Sampling; Statistical Analysis		
5	Financial Flows Tools	RISK VA	2014/07	2016/12	This work focuses on using visual analytics methods to discover and investigate emerging risks in financials and banking. Consumer credit risk analysis plays a significant role in stabilizing a bank's investments and in maximizing its profits. Finding and assessing unforeseen risk is now a big topic for the government and the financial industry. Due to the size and complexity of the data involved in risk analysis, risk analysts are facing challenges in monitoring these data, comparing their geospatial and temporal patterns, and developing appropriate management strategies based on the correlation from multiple analysis perspectives. In response to this challenge, we are developing exploratory methods to support analyst reasoning about and discovery of emerging risk. RiskVA supports looking at stability factors over time for business and customer transaction in particular geographic areas and comparing results. RiskVA further looks at trends in both secured and unsecured (e.g., credit card) debt. It helps identify emerging risks as economic conditions change.	This work was done with managers at Bank of America and was made available to BoA financial analysts. A version can be made available to government agencies to assist in the investigation of financial debt. RiskVA has also been extended to perform consumer analytics. Both geospatial and temporal visualizations were employed to effectively examine the market impacts from diverse consumer groups.	Potential licensing to a government contractor.		Complete	Research	0	2009-ST-061-CI001	No		FALSE		William Ribarsky; William Ribarsky	University of North Carolina-Charlotte; University of North Carolina at Charlotte	NC	Academic Community; Banking Industry; Insurance Industry; Policymakers		2016		Case Studies; Statistical Analysis		
3	Social Media Tools	Multimedia Visual Analytics for News, Blogs, RSS Feeds and other Streaming Data	2014/07	2016/06		Research paper was created.	N/A		Complete	Research	0	2009-ST-061-CI001	No		FALSE		William Ribarsky	University of North Carolina at Charlotte	NC								
2	Resource Allocation	SmartGridVis Project	2014/07	2015/06	Foundation for VASA				Complete	Research	0	2009-ST-061-CI001	No		FALSE		William Ribarsky	University of North Carolina at Charlotte	IN; NC								

	2	Resource Allocation	SP 14 Task 5: Visual Analytics for Security Applications - VASA	2014/07	2015/06	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. In order to provide awareness of current and forecasted impact caused by the natural events, our system presents historical and simulated events (e.g., hurricanes, tornadoes, blizzards) where users can instantly consider various scenarios, alternative and operational and simulation attributes. Based on these decisions and parameters, new simulations may be run to explore the effects on multiple critical infrastructures (e.g., power, computer networks, water, transportation, sewer) and the effectiveness of contingency plans and mitigation strategies. One example is a franchise food network where food delivery routes need to be changed based on store and infrastructure damage. In our visual analytics environment, analysts and decision-makers can effectively monitor the situation, understand the impact of these storms on critical infrastructure, and evaluate potential re-routed road paths for the food network with adjusted parameters.	Hypothetical stores in North Carolina damaged by Hurricane Irene were looked at. In our visual analytics environment, analysts and decision-makers can effectively monitor the situation, understand the impact of these storms on critical infrastructure, and evaluate potential re-routed road paths for the food network with adjusted parameters.		Complete	Research	25000	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE	William Ribarsky; William Ribarsky	University of North Carolina-Charlotte; University of North Carolina at Charlotte	NC						Case Studies; Modeling; Sampling; Statistical Analysis		
	1	Law Enforcement	WDYTYA: The Uncertainty of Identity	2013/07	2016/12	Our goal is to link information pertaining to real and virtual worlds in order to better manage the uncertainties inherent in establishing human identity. Our basic premise is that uncertainty in identifying and characterising individuals may be managed and understood by: (a) exploring and analysing spatio-temporal profiles of lifestyles and activity patterns; (b) concatenating and conflating detailed but under-exploited datasets in the virtual and real domains; and, more speculatively (c) seeking and analysing crowd sourced volunteered data that link physical and virtual identities. Through these actions it will be possible to improve our ability to characterize and validate an individual's identity, to devise improved profiles of individuals and groups that bridge the real and virtual domains, and to document and manage the uncertainties inherent in these tasks.	Within social network data, there exist communities of users that grow and shrink over time. These communities share information and their network links and shared information can provide additional information about the spread of topics and information exchange in both the real and virtual world. These connections can provide direct clues as to the nature of an individual's identity and their role within both online and offline communities, allowing for the creation of cyber-geodemographic profiles. In order to extract such information, the "Who Do You Think You Are?" (WDYTYA) Spatiotemporal Network Dynamics for Community Detection (WDYTYA: SNDCD) project has explored the overall characterization of social network structure with respect to its relationship with geographic places. Key questions include the definition of new metrics for quantifying the influence and correlation of geographic locations on the formation of relationships and the degree of similarity of individuals and the quantitative analysis of these relationships over time. Such information can be directly used for outlier detection, as well as for profiling groups of people and/or entire urban areas or regions. With respect to Twitter, tweets can be generated using computers or mobile phones to which a geographic location might be associated. In particular, mobile devices are embedded in the physical world and are carried by people in their everyday lives. Therefore, these can be considered as links between physical and virtual worlds: in other words, it is possible to link information about physical and virtual users' behavior by analyzing their movement and their activity on online social networks and other websites. The characterization of the correlation and interdependency between virtual and physical networks will be an essential contribution of the proposed research work. Furthermore, location over time can be studied in terms of trajectories in a physical space. WDYTYA: SNDCD plans to quantify the similarity of users not only with respect to their locations at certain times but also with respect to their relationships in geographic space (locally and globally). The project team has developed visual analytics tools for describing average characteristics of individuals and communities in	The next step is to formalize the name profiler toolkit and evaluate its effectiveness in providing probability estimates for online identities.	Complete	Research	199006	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE	Ross Maciejwski; Ross Maciejewski	Arizona State University; Arizona State University	AZ	Center for Visual Analytics for Command, Control, and Interoperability Environments	Academic Community	2016	Advanced Data Analysis and Visualization; Human Factors Aspects of Technology; Social, Behavioral, and Economic Sciences	Applied Known	Sampling; Statistical Analysis	Computer Science	Basic Research
	4	Disease Surveillance	GIS Implementations	2013/07	2014/06	Abstract Disparities in the geographic accessibility to health care may be due to the location/distribution of the population and the characteristics of the transportation infrastructure relative to spatial arrangement of the health care delivery system within a region. Access to health care is a complicated concept and is largely dependent on the characteristics of the population in need of services. The most significant features affecting the health status and health outcomes involve distance between the populations geographic regions and health care facilities and the travel time taken to reach the health care delivery system. Because of Mississippi's rural nature and uneven distribution of physicians, geographic disparities exist in access to primary care services leaving women, children, elderly and general populations in underserved health care regions. The purpose of the research is to identify hot spots of vulnerable population burdened due to geographical accessibility to right kind of health services. This research investigates these features by using network-based GIS methods in ten counties with urban-rural settings. The methodology assesses the geographic accessibility of three types of critical health care facilities: obstetrician/gynaecology (Women in child bearing age); paediatrics (children) and Trauma/Burn Centers (general population). To examine, using network analyst GIS functionalities, these facilities are geocoded, and optimal travel-time based service areas were generated and pertinent vulnerable population data layers were developed. The results identified hot spots of vulnerable populations residing outside the optimal service areas, with rural regions and pregnant women bearing most of the health burden due to geographic inaccessibility. This GIS	Journal articles were created.	N/A	Complete	Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE	Richard Alo; Richard Alo	University of Houston-Downtown; Jackson State University	IN; MS						Modeling; Sampling; Statistical Analysis		
	2	Resource Allocation	Flight Delay Data Exploration System for Analyzing Spatiotemporal Multivariate Data	2013/07	2014/06	Complex data with combinations of these characteristics: temporal, spatial, network-based, and multi-variate makes analysis more difficult. Example data sets showing such complexity include data from transportation, shipping, and logistics industries that have many connected operational places (e.g., origin and destination pairs) with multiple variables describing the operations in the places based on time, transactions, or incidents. In this work, we focus a visual analytics system that enables effective analysis through a suite of linked views that include networked geographical map, pixel-oriented network matrices, calendar, and clock views. In addition, we have designed new visual representations, Petal and Threads, to provide features of multiple variables among operational locations with minimized visual clutter.	Initial work focused on airport data for TSA.	N/A	Complete	Research	0	2009-ST-061-CI001	No		FALSE	Min Chen, David Ebert										
E		Education	SEED 1: Investigation of the Impacts of Visualization Literacy on the Performance of Visual Analysis; International Collaborations	2013/07	2014/06	The rapid evolution of visual analytics (VA) has created many innovative visualization techniques. These novel visualizations provide some visual analysts with additional capabilities and insights, but others perceive them unfamiliar and difficult to use due to their novelty. One factor that could explain individual differences would be the level of prior knowledge about visualizations, which we called visualization literacy. For example, one who knows parallel coordinates may easily find an interesting multidimensional pattern from a parallel coordinate view, but others without the knowledge will fail to gain the same insight. In spite of this obviousness, visualization literacy remains as one of uncharted areas in visual analytics research. We have not clearly understood how low or high visualization literacy impact on visualization performance, in what situations low visualization literacy becomes a more limiting factor than other innate individual differences (e.g., cognitive style and personal traits), and how to measure visualization literacy. This lack of understanding of visualization literacy increases the unidentifiable variances in evaluation studies and slows down development of systematic methods to educate visual analytics users. Thus, the aim of this proposed study is to better understand the influences of visualization literacy on the performance of visual analysts (visualization performance, henceforth) and develop initial cognitive model to predict the performance of visual analysts. Eventually, the results of the current project could be incorporated into a comprehensive mathematical/computational cognitive model and a measurement tool of visualization literacy. This is a collaborative project between two institutes: Purdue University and Simon Fraser University. The former will	This project began a collaboration which resulted in one journal article during the project and several others after the project concluded. This line of inquiry also contributed to a successful 3 year NSERC Strategic Partnership Project grant proposal "Visual analytics for emergany management"	N/A	Complete	Research	0	2009-ST-061-CI001	No	Survey	FALSE	David Ebert	Purdue University	IN		State and Local First Responders	2010					
	2	Resource Allocation	ORAM	2013/07	2016/06	The Coast Guard Atlantic Area Command developed the Operational Risk Assessment Model (ORAM) to support mission planning and analysis of the 11 Coast Guard missions at the operational level. The model calculates and compares risk among Coast Guard missions and geographical areas and produces a calculated risk index number (RIN) that allows for a common measurement across different areas. VACCINE improved the cgSARVA framework to create geographical visualizations to support the trade off decisions that the model is aimed to address. An interactive visual analytics system can help derive insights from large amounts of data and facilitate the risk management process thereby providing a suitable solution. An interactive visual analytics system can also assist analysts and decision makers in long term planning and assessment of mitigation strategies. Our system provides multiple linked views to perform spatiotemporal analysis of risk, integrated techniques and components to visualize and identify risk priority areas, spatial distribution of RIN values, and perform coverage efficiency analysis. All of these components are integrated to provide a complete risk picture to the analyst.	System was developed and provided to LANT7 (USCG) for evaluation.	N/A	Complete	Research	0	2009-ST-061-CI001	No		FALSE	David Ebert	Purdue University									
			UKVAC Joint Research Project	2013/07	2014/06	In this WP, we researched into the big data problem exemplified by the ASA Flight Dataset. We developed an information-theoretic anomaly detection method called QCAT (Query with Conditional Attributes), and reported its implementation, performance characteristics, and an example application for aiding query design.	In collaboration with the Purdue team, we integrated anomaly analysis capacity (Oxford) with a flight data visualization system (Purdue). Thus resulted in a research paper: S. Ko, S. Afzal, S. Walton, Y. Yang, J. Chae, A. Malik, Y. Jang, M. Chen, and D. Ebert. Analyzing high-dimensional multivariate network links with integrated anomaly detection, highlighting and exploration. Proc. IEEE VAST 2014, pp.83-92, 2014.	The information-theoretic framework for anomaly analysis was further applied to cybersecurity in a CPNI-funded project Corporate Insider Threat Detection. CPNI stands for Centre for Protection of National Infrastructure (UK).	Complete		0	2009-ST-061-CI001	No		FALSE	Min Chen										
	2	Resource																								

3	Social Media Tools	Visual Analytics of Microblog Data for Public Response Behavioral Analysis in Disaster Events	2013/07	2016/06	Public Behavior Response Analysis in Disaster Events Utilizing Visual Analytics of Microblog Data Junghoon Chae, Dennis Thom, Yun Jang , SungYe Kim, Thomas Ertl, David S. Ebert 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. A growing number of Location-based Social Network services provides time-stamped, geo-located data that opens new opportunities and solutions to a wide range of challenges. Such spatiotemporal data has substantial potential to increase situational awareness of local events and improve both planning and investigation. However, the large volume of unstructured social media data hinders exploration and examination. To analyze such social media data, our system provides the analysts with an interactive visual spatiotemporal analysis and spatial decision support environment that assists in evacuation planning and disaster management. We demonstrate how to improve investigation by analyzing the extracted public behavior responses from social media before, during and after natural disasters, such as hurricanes and tornadoes.	Became SMART			Complete	Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		David Ebert; Tom Ertl	Purdue University;	IN					Modeling; Sampling; Statistical Analysis			
4	Disease Surveillance	Visual Analytics Environment for Public Health Surveillance	2013/07	2014/06	Assessing current and emerging public health threats is important for public health officials in order to make decisions regarding mitigative actions and allocation of resources. It also helps scientists understand the characteristics of syndromic diseases and improve their models. Patient hospital admittance records are first classified into 7 syndromes (Botulinic, Constitutional, Gastrointestinal, Hemorrhagic, Neurological, Rash, Respiratory), then the categorized data is passed to different linked components of the system. In the time series plots, EWMA control charts with a 99% confidence interval upper bound are used to identify anomalies in the data represented by red dots in the temporal plots. Hospital admittance data is also geocoded and can be used to identify any spatiotemporal patterns. Our system also allows the analyst to explore different epidemic models and visualize the spread of an epidemic in any geographical region using spatiotemporal view under certain conditions.	Software product that enables analysis to understand the characteristics of syndromic diseases and understand their models. It consists of linked spatial and temporal components that provides overview of current spread status, and helps study different aspects of syndromic surveillance.	Integrate social media data and other pre-diagnosis information for improved surveillance and response. After that, begin exploring models and comparing to ground truth in order to demonstrate the efficacy of the tool for potential clients.	Complete	Research	0	2009-ST-061-CI001	No		FALSE		David Ebert	Purdue University	AZ; IN								
E	Education	SP 14 Task 2: Public Safety Consortium	2013/07	2015/06	The role of developing detailed operational requirements is critical for the successful transition of technologies into the various homeland security fields. The VACCINE Center of Excellence recognizes the need for significant end-user-in-the-loop involvement in the entire life cycle development process. The VACCINE team has refined our business model (Figure 4) with the goal of connecting homeland security researchers with the first responder community. Understanding the requirements of our end-users is key to the research and development of technologies that can be transitioned to the broader public safety community. Our Public Safety Consortium consists of a number of law enforcement, fire, and emergency management agencies that allow data to be shared and research conducted, furthering the development of next generation homeland security technologies. The Consortium provides a framework where VACCINE can deploy its tools to the various agency members, and our end-users provide in-field or real world evaluation feedback on their requirements. The group meets regularly to discuss ongoing requirements to technology being developed, improvements to technologies that have been deployed and are being evaluated, as well as to brainstorm tools that are needed. VACCINE sees this Consortium as a resource that can be utilized by not only VACCINE but also DHS S&T. The Public Safety Consortium continues to grow, and VACCINE has recently reached out to other states outside the State of Indiana to engage their public safety professionals in our discussion of new technologies. Our ultimate goal is to develop technologies that have been vetted and verified by having end-users in the development process. Technologies that have been developed in this fashion will	Process to engage First Responders used by VACCINE	None	Complete	Seminar/Symposium/Workshop	30804	2009-ST-061-CI001	No		FALSE				FL; IN; NC; OH	State and Local First Responders							
2	Resource Allocation	Mobile 3D Routing and Emergency Evacuation in Dense Urban Environments	2013/06	2015/07	Mobile 3D Routing and Emergency Evacuation in Dense Urban Environments We have developed a mobile application for situationally aware emergency response in dense urban environments that have tall and large buildings. Using an iPhone or other mobile device, an emergency responder can transmit or receive location information , plot 3D routes between locations, and find alternate routes if there are blocked paths. All this can be done, shared among other responders, and received instantaneously. Thus the emergency responders and the command center all have situational awareness and comprehensive, personalized routing. Routing can also be extended from inside the building to the surrounding environment, enabling the system to handle larger scale evacuation along multiple routes in an efficient manner. As a prototype application, we have generated 3D graphs for all the academic buildings on the UNC Charlotte campus and embedded them in the street network. This environment can be used to stand in for a dense urban neighborhood. We are also working with the Charlotte-Mecklenburg Police Department (CMPD) to develop a tabletop exercise using this environment. This exercise will permit us to test our system, our routing capabilities, and our mobile interfaces with real police officers. We will gain valuable feedback and evaluations of our system, which will be used to improve it. Eventually our improved system will be tested with other police departments and will be deployed with CMPD and others.	The University of North Carolina at Charlotte has delivered an evacuation decision support system and Urban Emergency Response search and command center tools to the UNC Charlotte Police and Public Safety Department. The tools have been used in the Canada-US Experiment Resiliency Environment demonstration in Seattle at which DHS managers were in attendance.	Project was completed.	Complete	Research	0	2009-ST-061-CI001	No		FALSE		William Ribarsky	University of North Carolina at Charlotte	NC		2011						
2	Resource Allocation	UKVAC II	2012/10	2013/12	The overall aim of the UKVAC project was to investigate into two grand challenge problems, namely the Nobel Laureates (NL) and the Flight Data (FD) problems. Five universities (Middlesex (lead partner), Bangor, Imperial, Oxford and UCL) tackled these two challenges from different angles. Oxford led work package 1, which focused on the FD Problem that is described below. The flight data problem is about wanting answers to questions that could be contained in or constructed from the interrogation of 120 million records covering all commercial flights in the US from October 1987 to April 2008, about 12Gb of uncompressed data. Questions that could be asked include; when is the best time to fly to minimise delays? Can you detect cascading failures as delays in one airport create delays in others? Are there critical links in the system? The objective for WP1 includes the following sub-objectives: (a) To formulate an information-theoretic framework for visual analytics processes in a context exemplified by these two problems. (b) To develop visual representations that depict information contained in a dataset as well as the uncertainty quantities and other probabilistically-derived qualities such as importance and value. (c) To develop a prototype demonstration system for illustrating the potential use of information theoretic quantities in the process of hypothesis generation and evaluation. (d) To compare the information-theoretic framework with captured user study data (WP4) and to offer an explanation about any correlation and inconsistency. (e) To explore the application of the information-theoretic framework in interaction exploration (WP2), data management and data analysis (Objective 3). hierarchical decision models (WP5)	We have completed the WP1 of the project with a number of concrete achievements. (a) We have formulated an information-theoretic framework for anomaly detection. A relatively comprehensive literature study showed that the idea of using information theory for anomaly detection has been examined by many since the 1980s. No existing scheme was found to be identical as our proposal. It suggests a number of possibilities, including (i) our scheme is novel; (ii) the same scheme was proposed earlier but was not disclosed; (iii) the same scheme was proposed earlier but was discarded due to the lack of big data or a practical implementation (e.g., using visual analytics). (b) We have conducted a study on the visual representations. We have identified the requirements for an effective visual design, including consistent visual cues across multiple views, and supporting both visualization and exploration. The current visual design was formulated based on an existing system that introduces many constraints such as the use of colours. We believe that the visual designs can be improved further if there is a flexibility to redesign the visual representations in different views. (c) With the help of Purdue, we have delivered a prototype demonstration system for illustrating the potential use of information theoretic quantities in the visual analytics process for handling the FD data. This is partly one of the original objectives that were removed due to the budget reduction. (d) We have formulated a high-level visual analytics cycle by dividing visual analytics tasks into three groups, monitoring, analysis and model refinement. This proposed cycle allows us to create, deploy, use, evaluate and improve automated detection techniques (e.g., information-theoretic anomaly detection) in different operational modes, by users at different skill-levels and in different numbers, and through different computational processes with different demands for database access and preprocessing. This high-level thinking was partly supported by the empirical studies carried at UCL (WP4).	The UKVAC II provided University of Oxford with the first funded visual analytics project, which serves as a springboard to other visual analytics projects in the coming years, including in areas of cybersecurity, digital humanities, seismology, and bioinformatics. The interaction between theoretical research in information theory and practical application enabled Oxford to make significant advances in visual analytics theories. The 2016 VAST Best Paper exemplifies the continuing impact of the UKVAC II project. When Joseph Kielman retired in 2016, Min Chen wrote to him "those visionary colleagues, such as Joe Kielman and Jim Thomas, were right more than a decade ago. Now we can mathematically show the value of visual analytics in data intelligence."	Complete	Research	0	2009-ST-061-CI001	No		FALSE		Min Chen		IN		2015		Statistical Analysis	Computer Science	Pilot/Field Testing and Evaluation in an Operational Environment		
1	Law Enforcement	(VALET) Developing a spatial statistics framework in the visual analytics for law enforcement technology suite	2012/07	2017/08	VALET technology provides law enforcement agencies with a suite of tools that allows for the spatiotemporal exploration of multivariate data sets and police records. These tools provide advanced analytic capabilities that allow officers to develop and test hypotheses about law enforcement activities within various areas of their communities.Analyzing high volume criminal, traffic and civil (CTC) incident data is a crucial component for preventing crimes and judiciously allocating resources for the law enforcement community. However, with data sets increasing in size and complexity, and as budgets shrink and departments scale back, the ability of local law enforcement agencies to effectively analyze the data being collected becomes increasingly strained. Valet explores and analyzes multivariate, spatial, and temporal law enforcement data to enable advanced data exploration and analysis of CTC incidence reports. Current work focuses on the early detection of unusual criminal occurrences, as well as predictive analytics.	VALET was deployed at the Lafayette, Jeffersonville and Evansville Police Departments. Further, the Indianapolis Police Department, Tippecanoe County Sheriff's Office, Ohio State Highway Patrol, Illinois State Police, and New York Police Department have used VALET. As the predictive analytics component of the software continues to improve, input and feedback continues to be received to make adjustments to the technology in order to optimize it for use in the field. One of those adjustments is the development of the Officer Performance/Metric/Vis solution to display the performance of police officers in Lafayette Police Department for better performance comparison and for motivating maximized performance. VALET has been utilized to devise novel data guided patrolling strategies and has led to a paradigm operational shift at several police departments. VALET has also supported investigative analysis tasks at the departments who utilize the system. For example, the system played a critical part in the investigation of a string of business burglaries by the Evansville police department. In keeping with the goal of transitioning this software, Purdue Research Foundation has licensed the technology to a startup company, Davista Technologies, LLC, which was born out of the VACCINE center.	Davista is developing a sustainable transition model in order to continue the development and commercialization efforts of the technology. The company is also currently engaged in developing a data driven solution for a large private corporate firm for optimally allocating their safety and security related resources. Davista is leveraging the core VALET technology in the development of this solution.	In Progress	Dynamic, On-demand Data Analysis and Visualization	Research	190380	2009-ST-061-CI001	No	Data Mining	FALSE		David Ebert	Purdue University	Morgan State University	IL; IN; NY; OH	State and Local Emergency Managers; State and Local First Responders	2015	Emergency Preparedness and Response; Risk and Decision Sciences	Case Studies; Risk Assessment; Statistical Analysis	Geographic information sciences; Information Science; Computer Science; Criminology; Biostatistics and bioinformatics	Pilot/Field Testing and Evaluation in an Operational Environment	

2	Resource Allocation	(MADIS) A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data	2012/07	2015/07	Thanks to the availability of mobile devices, emergency responders, supporting agencies and even private citizens can capture imagery of disaster events as they unfold. Once the crisis is contained, however, it's a daunting task for emergency managers to collect, organize and integrate disaster event data from multiple sources into incidence command systems where situation reports, incidence action plans, etc are being held. Therefore, we have developed a semi-autonomous system Multimedia-Aided Disaster information Integration System (MADIS), which uses advanced data integration and visual analysis techniques to associate temporal, spatial and other textual features of a disaster event situation report with event images and related text annotations. Our prototype consists of a preprocessing component that catalogs disaster event related images and identifies relevant subject text in posted situation reports, training modules that establish the systems cataloging and text analysis capabilities, and a web-based database system with RESTful APIs that allow for support of both web or mobile device client applications. Direct Search Engine (DSE) is an extended function of MADIS developed to quickly explore three different data sources: general web pages, latest news and blogs, and tweets, which are crawled by different tools and stored in different formats. To access the data for users, one method is to use the keyword based search, the other is based on data integration, and the results are presented as maps.	We have several research papers published in archival journals including ACM Transactions on Information System and Technology (2015) and World Wide Web Journal (2016, to appear), and in various conference venues including ACM SIGIR International Conference, IEEE International Conference on Information Reuse and Integration (IRI), and International Conference on Web Information and System Engineering (WISE). • A new component for the searching and retrieval of disaster videos was added to the MADIS system, which enables the system to retrieve both videos and images relevant to a specific disaster. Moreover, situation reports which are uploaded by users will be automatically converted to the PDF format and highlighted with the defined keywords.	Build up an automatic workflow that integrates the processes starting from the feature extraction to semantic concept detection into the complete MADIS system; Define an event-based response trigger monitor for periodically model re-training; Utilize the reports that are available on the website (FIUDRT) https://fiudrt.org/ as one of the information resources.	Complete	Research	318125	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		Shu-Ching Chen; Shu-Ching Chen	Florida International University; Florida International University	FL; IN		State and Local Emergency Managers		2016	Advanced Data Analysis and Visualization; Emergency Preparedness and Response; Risk and Decision Sciences		Case Studies; Modeling; Risk Assessment; Sampling; Statistical Analysis	Preparedness training; Computer Science; Risk management; Assessment	Pilot/Field Testing and Evaluation in an Operational Environment
2	Resource Allocation	(iLEAPS) iLaw Enforcement Apps Assistance Program for Students	2012/07	2014/12	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.	Five additional students (1 graduate and 4 undergraduate) have been trained to conduct mobile development. Specifically, the students have learned to continue the development of iLEAPS using the Android Software Development Kit, and XCode for iOS development. Students have also learned how to great hybrid apps that use HTML 5, CSS, JavaScript, JQuery , PHP and MySQL to great the web content that is wrapped in native code for GPS, notification and camera support. Students have added new capabilities to extend the utility of iLEAPS. These capabilities include native notifications (which enable students and police to receive notifications when incidents are sent or resolved even when the phone is off), ability to send pictures, and for dispatch to see the location of all officers on campus. After a demonstration, Police Chief Hatcher called for a meeting in August where the entire police force was introduced to iLEAPS at a meeting where President Wilson was in attendance as well.	We discovered this year that a majority of the police officers on campus utilize iPhones as their primary work phones. As such, we are currently in the process of finalizing the iOS implementation of the app. Furthermore, MSU Police Chief Hatcher also requested that we add geo-fencing functionality so that any requests generated through the app are restricted to individuals currently on or around the vicinity of the campus. Lastly, computing equipment has been secured for the dispatch office so that when the system is fully deployed there is a dedicated station where incoming alerts can be actively monitored.	Complete	Research	118496	2009-ST-061-CI001	No	Survey	FALSE		Tim Akers	Morgan State University	Morgan State University	MD		State and Local Emergency Managers; State and Local First Responders	2015	06/2016	Advanced Data Analysis and Visualization; Emergency Preparedness and Response		Case Studies; Risk Assessment	Computer Science	Pilot/Field Testing and Evaluation in an Operational Environment
1	Law Enforcement	(GARI) Gang Graffiti Recognition and Analysis	2012/07	2017/06	A mobile application that enables a picture taken of graffiti to be analyzed and compared to the other images in a database. The app can connect to the cloud to pull down this data and that geodata is also included. Users can compare the graffiti to similar tags in the area, thus aiding interpretation, and access all previously taken images from the database based on search criteria. The GARI system provides a gang expert's intelligence when it comes to gang graffiti symbols and identification, without having that expert on staff. With the GARI tool, users can quickly and easily capture an image, compare it to the database for similar images, and see what the graffiti signifies. In addition, the user can also report other information for the abatement crew. The goal is to use image analysis techniques to identify, interpret, and index gang graffiti and gang tattoo images. The tool can be used to track gang movements based on the geography of the graffiti images recorded. GARI allows the user to upload an image from their phone or computer to a server where it runs an algorithm to do an image match and determine what other image in the database this symbol most resembles. It then brings up the images that match most closely-which will have annotation describing what they mean-for example, if a particular gang uses a particular color or sign.	GARI was deployed to the Indianapolis Metropolitan Police, Indiana Intelligence Fusion Center Gang Task Force, INGang program, Cook County Sherriff's Department, Navajo Nation, and the Illinois State Police. Additionally, a number of other law enforcement entities (approximately 400) have expressed interest in using and deploying the tool. A community version was developed 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. Unfortunately, the community version was never deployed as a result of privacy concerns. The law enforcement version of GARI 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 is being explored. There are currently 227 users of the system in Indianapolis, and 114 within Cook County and 17 users in Stockton, CA.	Currently, discussions are underway with the Purdue Foundry regarding commercialization efforts of GARI.	In Progress	Research	107941	2009-ST-061-CI001	No	Expert Consultation	FALSE		Edward Delp; Ed Delp	Purdue University; Purdue University	Navajo University	IN; CA; AZ; IL	Center for Visual Analytics for Command, Control, and Interoperability Environments	State and Local Emergency Managers; State and Local First Responders	2016		Advanced Data Analysis and Visualization; Risk and Decision Sciences	Case Studies; Modeling, Qualitative Analysis; Risk Assessment; Statistical Analysis	Geographic Information sciences; Information systems; Computer Science; Criminology	Operational Use
2	Resource Allocation	COAST: Coastal Operations and Analysis Suite of Tools	2012/07	2014/06	Coastal Operations and Analysis Suite of Tools (COAST) aims to analyze all the Coast Guard operations across all districts in the United States. VACCINE has developed a visual analytics component that includes a GIS visualization and a coverage module. The visual analytics system includes linked views and interactive displays that allow the interactive analysis of trends, patterns and anomalies among the U.S. Coast Guard operations. The most recent improvements include the optimization of the computation to assign cases to nearest stations measured by the coastline avoidant distances instead of the straight distances. Finding the nearest station for every case is a time consuming process. The optimization algorithm proposes a spatial structure to organize cases so that cases that are close to each other will share the same nearest station finding process. The optimization also propose a spatial structure to organize stations to speed up the nearest station finding process. Some recent improvements include the calculation of five different metrics that analyze all the stations with one or multiple districts. The metrics provide an understanding about which stations have the greatest load and what will the impact be if the number of assets are reduced in the station. The metrics also take into account the multiple air facilities the Coast Guard operates. Other recent developments include the detailed analysis of the Coast Guard Air Station coverage. Based on the type of aircraft available the system calculates the coverage assuming that the aircraft can land at any point along the coast line instead of having to return to base, such calculation can improve the searching times and coverage of the air stations. Finally, the Rescue 21 dataset was added to the framework, allowing the analyst to visualize the towers and their coverage and using the information available to think and test different hypotheses as well as optimize resources based on the use of the towers. Transitioned to LANTA & USCG 7-72	The most recent improvements include the optimization of the computation to assign cases to nearest stations measured by the coastline avoidant distances instead of the straight distances. Finding the nearest station for every case is a time consuming process. The optimization algorithm proposes a spatial structure to organize cases so that cases that are close to each other will share the same nearest station finding process. The optimization also propose a spatial structure to organize stations to speed up the nearest station finding process. Some recent improvements include the calculation of five different metrics that analyze all the stations with one or multiple districts. The metrics provide an understanding about which stations have the greatest load and what will the impact be if the number of assets are reduced in the station. The metrics also take into account the multiple air facilities the Coast Guard operates. Other recent developments include the detailed analysis of the Coast Guard Air Station coverage. Based on the type of aircraft available the system calculates the coverage assuming that the aircraft can land at any point along the coast line instead of having to return to base, such calculation can improve the searching times and coverage of the air stations. Finally, the Rescue 21 dataset was added to the framework, allowing the analyst to visualize the towers and their coverage and using the information available to think and test different hypotheses as well as optimize resources based on the use of the towers. Transitioned to LANTA & USCG 7-72	USCG to take responsibility to maintain system.	Complete	Research	0	2009-ST-061-CI001	No	Data Mining	FALSE		David Ebert	Purdue University		IN		DHS U.S. Coast Guard	2015				Modeling; Sampling; Statistical Analysis	Computer Science	Verification & Validation
3	Social Media Tools	Multimedia, Social Media, Text, and Emergency Response Analytics	2012/07	2016/12	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. This year new capabilities have been developed to build 3D routing networks for large buildings on the fly without CAD data or architectural plans. A novel capability has been developed to provide decision support to commanders in complex emergency response situations as they evolve. 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. A Web service was set up so that onsite managers could access the results of these large scale simulations on mobile devices such as a laptop or tablet computer, providing the capability to determine what will happen, when and where it will occur, and who and what infrastructures will be affected so that immediate, appropriate action can be taken. Work is being done with European partners and VACCINE colleagues.	A stand-alone version of our critical infrastructure modeling system plus our collection of cascading breakdown results for a large ensemble of hurricane paths has been deployed. The visualization interface is accessible as a Web service by a range of devices anywhere on the Internet. A robust Web server connects the interface in a secure fashion to a compute and data intensive back-end. The ensemble results are organized on the back-end for interactive recall and immediate display in the visual interface. Visual interfaces in use include desktop, laptop, and mobile (iPad). We are running case studies for Charlotte Mecklenburg EMS and NC Public Health and Preparedness. The goal is improved delivery of critical public health services in the face of a wide spread weather disaster. The partnership with the Electric Power Research Institute (EPRI) continues. We have now developed a prototype situationally aware control and analysis system for the distribution system of the future (DSOF). The DSOF will be very sensor-rich with new opportunities to analyze and control at all levels (including at the home or business site). Our critical infrastructure work contributes to this work. We are setting up the prototype to respond to the effects of large storms as they develop. The new sensor data is giving us results to extend our critical infrastructure model deep into the distribution system and to prepare for response under the DSOF. Stand-alone, modular modeling system for time-dependent, cascading critical infrastructure outages at the front of large scale weather events (e.g., hurricanes). This system can also be inserted into a comprehensive system such as the VASA workbench. Urban Emergency Response search and command capabilities developed based on discussions with UNC Charlotte Police and Public Safety Department. Consultation on tools with Charlotte Mecklenburg EMS. A set of social media visual analytics tools to investigate the narrative arc of social movements by following relevant topics, events, and social networks.	Funding from the Department of Energy and other sources is being sought.	Complete	Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		David Ebert; William Ribarsky	Purdue University; University of North Carolina at Charlotte	IN; MN; NC; SC; TX; MD		Banking Industry; DHS Labs; State and Local Emergency Managers; State and Local First Responders; Other State or Local		2016	Advanced Data Analysis and Visualization; Social, Behavioral, and Economic Sciences		Case Studies; Modeling; Statistical Analysis	Computer Science; Sociology	Adopted by End User, Operational Use, Pilot/Field Testing and Evaluation in an Operational Environment
3	Social Media Tools	Spatiotemporal Social Media Analytics for Abnormal Event Detection	2012/07	2013/06	Part of SMART 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. In analyzing social media data, researchers have mainly focused on finding temporal trends according to volume-based importance. Hence, a relatively small volume of relevant messages may easily be obscured by a huge data set indicating normal situations. In this paper, we present a visual analytics approach that provides users with scalable and interactive social media data analysis and visualization including the exploration and examination of abnormal topics and events within various social media data sources, such as Twitter, Flickr and YouTube. In order to find and understand abnormal events, the analyst can first extract major topics from a set of selected messages and rank them probabilistically using Latent Dirichlet Allocation. He can then apply seasonal trend decomposition together with traditional control chart methods to find unusual peaks and outliers within topic time series. Our case studies show that situational awareness can be improved by incorporating the anomaly and trend examination techniques into a highly interactive visual analysis process			Complete		0	2009-ST-061-CI001	No		FALSE		Tom Ertl											

3	Social Media Tools	(GeoTxt) E2E: GeoTxt API	2012/06	2017/06	In recent years, the amount of publicly available spatial data has grown tremendously, due in large part to the proliferation of GPS technologies and the location information integrated into web applications, especially social networking services. Networks like Twitter, Four-Square, and Facebook allow users to provide insights into current events in real time via short form textual updates or statuses. Many modern social networks provide a means to locate the contributor of status updates. The location of a contributor is typically given as geographic coordinates, latitude and longitude, but only a small proportion of users choose to turn "geolocation" on. With Twitter, for example, 98.5% of tweets lack explicit location information. But, there is a wealth of place-relevant information in text that is not explicitly geolocated; that information comes in the form of linguistic references to named places and place-specific features. This spatial information, along with the temporal information inherent to status updates, enables spatial and temporal analysis of contributor patterns. GeoTxt.org is a web service that enables the geolocation of places, people, and organizations described in common status updates from online social networks, as well as from other text sources such as news stories, status reports, and blog posts. It uses techniques from a wide array of research areas - applied linguistics, natural language processing, search engine optimization, and geographic information science - to parse out places, people, and events explicitly or implicitly mentioned in text (e.g., in Twitter Tweets) and then to analyze and contextualize these entities to locate them in geographic space. The API is designed to be integrated into the development of dynamic, map-based, visual analytical interfaces, specifically in the context of	We have improved the throughput of GeoTxt substantially by reengineering the system to take full advantage of both advanced text indexing methods and high-performance computing. We have produced the first Gold Standard corpus of geolocated places in tweets that can be used to test and train any geoparsing tools. This corpus will be made available to other researchers (on publication of the submitted paper documenting creation of the corpus). We have developed a flexible geovisual analytics application to support building geolocation corpra. This application could be easily extended to support other corpus building activities for testing and training text processing tools. In the process of building the Gold Standard corpus cited above, we have generated a range of insights (detailed in our submitted paper) concerning how "places" are referred to in informal text such as microblogs. These insights have the potential to substantially increase the accuracy with which references to places can be captured from unstructured text, something with direct implications for threat assessment, criminal investigations, and crisis response. GeoTxt has been integrated as the backend geographic entity recognition, disambiguation, and co-coding systems to support SensePlace 2, our spatial-temporal twitter analytics environment. The early stages of SensePlace 2 (and its precursor SensePlace) were funded through VACCINE. GeoTxt has been made available to other VACCINE partners. We have worked actively with partners at both Purdue and UNCC to test use of the GeoTxt API from software applications under development by those teams.	A proposal to do subsquent research to build on top of this project will be submitted. Two papers are being written.	In Progress	Research	155665	2009-ST-061-CI001	No	Data Mining	FALSE			Alan MacEachren; Alan MacEachren	Pennsylvania State University; Pennsylvania State University	PA	Academic Community; State and Local First Responders	2016	Advanced Data Analysis and Visualization; Communications and Interoperability	Case Studies; Modeling; Sampling; Statistical Analysis	Information systems; Computer Science; Geography	Laboratory Testing and Evaluation
1	Law Enforcement	Symbology Standardization Support	2012/06	2014/07	A number of agencies within DHS employ maps as part of their daily operations. To facilitate inter-agency communication, cooperation, and consistency with map-based information and tools, DHS has supported research on map symbol standardization by Penn State's GeoVISTA Center since 2009. The goals of this research include: Investigating the use and usability of the ANSI INCITS 415-2006 standard Developing a process to refine mission-specific symbol standards Enabling the sharing of symbols through a feature-rich online "Store" Determining appropriate map symbology for mobile use within DHS The Symbol Store supports map symbol interoperability by allowing users to search, choose, and download symbols from a growing collection that currently exceeds 2,400 map symbols. Each symbol in the database is enriched with detailed metadata that includes category, agency, organization and set, rating, symbol description and user-submitted tags. Once a search is returned, users can browse through results and can add the desired symbols to their carts. The map preview function allows users to see their chosen symbols on a variety of map types before downloading. For convenient use in other mapping projects, symbols are uploaded and downloaded in the Esri style Format. A wider variety of symbol formats, including SVG and PNG images, will be supported in updates in the near future. The web services that make the Symbol Store possible are also open to other developers, enabling a multitude of cross-platform mapping applications. Most DHS mission areas used separate in-house symbol sets for internal standards. With the e-Symbology Portal, a web-based environment where topics can be polled and discussed by remote participants asynchronously, those	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.	More funding is needed for software to be converted from Flash to Java Script.	Complete	Research	972488	2009-ST-061-CI001	No	Expert Consultation	FALSE			Alan MacEachren	Pennsylvania State University	PA	DHS Federal Emergency Management Agency; DHS U.S. Customs and Border Protection; Food and Drug Administration; Other Industry	2013	06/2013	Advanced Data Analysis and Visualization	Case Studies; Sampling; Statistical Analysis	Geographic information sciences; Information Science; Communication (risk, scientific, technical)	Operational Use
2	Resource Allocation	(VASA) – Visual Analytics for Security Applications	2012/06	2014/11	This system provides a visual analysis and decision making environment for severe weather and natural disaster planning and response for several critical infrastructures (e.g., power, computer networks, food distribution). Business officials and local officials can use this tool to evaluate continuity of operation plans, plan for contingencies, prepare for, and respond to a severe weather event or natural disaster. Rerouting suggestions for food distribution centers impacted by a severe weather occurrence to facilitate decisionmaking in emergency situations. The goal is to effectively analyze emergency situations caused by severe weather conditions and natural disasters. Our system presents historical and simulated events where users can instantly consider various scenarios, alternative, operational and simulation attributes. Based on these decisions and parameters, new simulations may be run to explore the effects on multiple critical infrastructures (e.g., power, computer networks, water, transportation, sewer) and the effectiveness of contingency plans and mitigation strategies. One example is a franchise food network where food delivery routes need to be changed based on store and infrastructure damage. In our visual analytics environment, analysts and decision-makers can effectively monitor the situation, understand the impact of these storms on critical infrastructure, and evaluate potential re-routed road paths for the food network with adjusted parameters.	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 exiting environments for decision-making. VASA is a visual analytics platform targeting this setting and consists of a desktop application, a component model, and a suite of distributed simulation components for modeling the impact of societal threats such as weather, food contamination, and traffic on critical infrastructure such as supply chains, road networks, and power grids. Each component encapsulates high-fidelity simulation models that together form an asynchronous simulation pipeline: a system of systems of individual simulations with a common data and parameter exchange format.	Ready to be tailored to specific systems.	Complete	Research	1185816	2009-ST-061-CI001	Yes	Data Mining	FALSE	Public Safety Coalition Project	David Ebert, Isaac Cho	Purdue University	IN; MN; NC; TX	Food Protection and Defense Institute	State and Local Emergency Managers; State and Local First Responders	2015	05/2016	Advanced Data Analysis and Visualization; Infrastructure Protection	Case Studies; Modeling; Risk Assessment; Sampling; Statistical Analysis	Engineering; Computer Science; Risk management/assessment	Pilot/Field Testing and Evaluation in an Operational Environment
1	Law Enforcement	MDRP 18: COE-Explorer (Visual Analytics for the DHS Centers of Excellence)	2012/06	2014/07	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.	The COE Explorer project was delivered and in use. This is 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 capabilities, and the data it is visualizing (a total of some 15 such emails have been received). Furthermore, as evidenced by the below success story, the tool has also been highly successful with its intended audience: investigators, program officers, and policymakers.	Multimodal graph visualization is an ongoing research topic in the visual analytics community. Our work on this is regularly cited and has become a standardized resource for other researchers to build on.	Complete	Research	32170	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE			David Ebert, Nicklas Elmqvist	Purdue University	CA; GA; IL; NJ; IN	Center for Command, Control, and Interoperability; Center for Advanced Data Analysis	Academic Community; DHS Labs; DHS Science and Technology Directorate; Media; U.S. Department of Commerce	2013	Advanced Data Analysis and Visualization	Case Studies; Sampling; Statistical Analysis	Computer Science	Operational Use, Pilot/Field Testing and Evaluation in an Operational Environment
2	Resource Allocation	MDRP 6: Video Surveillance Visual Analytics	2012/06	2014/07	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).	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.	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.	Complete	Research	24874	2009-ST-061-CI001	No	Expert Consultation	FALSE			Brian Fisher		IN; NC		State and Local Emergency Managers	2013	Advanced Data Analysis and Visualization; Border Security; Emergency Preparedness and Response	Case Studies; Modeling; Risk Assessment; Sampling; Statistical Analysis	Geographic information sciences; Computer Science; Sociology	Pilot/Field Testing and Evaluation in an Operational Environment, Prototype Demonstration
1	Law Enforcement	(Crowdsourcing) Combining Crowdsourcing technology with machine learning to do visual analytics on big qualitative data (video datasets).	2012/06	2014/07	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 offenses, 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.	The project to date has been distributed between Prof Delp at Purdue and Prof Kirsh at UCSD. Prof Kirsh's role has been on the design of a user friendly system that is easy to manage at the back-end and easy to work in on the client side. Our pilot work has shown that students find it natural to work in the client. Annotation of intervals of interest – the main output of turkers - is possible and not effortful. We are currently re-implementing the system to increase robustness and to accommodate user feedback. We have also found that small teams of turkers can produce better quality results than single turkers, but the team size needed for adequate reliability varies with the complexity of the targets and turker training/rating. This means that Turker expertise can not always be compensated for by increasing turker team size, as is often assumed. It also means that better tracking of turker expertise is required and more attention to turker team composition is needed. We have also found that small teams of turkers can produce better quality results than single turkers, but the team size needed for adequate reliability varies with the complexity of the targets and turker trainingrating. This means that Turker expertise can not always be compensated for by increasing turker team size, as is often assumed. It also means that better tracking of turker expertise is required and more attention to turker team composition is needed. The impact of the project is that a crowd sourcing based system for identifying regions and intervals of interest in video is a viable method for handling large videosets. More research is needed to better determine the cost structure of scaling up to larger video sets and to real-time analysis and reporting. The practical value of this system depends on the reason a group might want it. Police need to review video to document reports and provide evidence. Crowd sourcing can save time in that task. Our original goal remains to provide real time assistance for monitoring thousands of video in real-time. That application is of value in hundreds of scenarios, including police surveillance, search and rescue and border crossing.	More research is needed to better determine the cost structure of scaling up to larger video sets and to real-time analysis and reporting.	Complete	Research	139700	2009-ST-061-CI001	No	Expert Consultation	FALSE			David Kirsh	University of California San Diego	CA; IN		State and Local Emergency Managers; State and Local First Responders	2014	Communications and Interoperability; Emergency Preparedness and Response; Human Factors Aspects of Technology	Case Studies; Sampling; Statistical Analysis	Computer Science	Laboratory Testing and Evaluation

1	Law Enforcement	Bristle Maps - A Multivariate Abstraction Technique for Geovisualization	2012/06	2014/07	We present Bristle Maps, a novel method for the aggregation, abstraction, and stylization of spatio-temporal data that enables multi-attribute visualization, exploration, and analysis. This visualization technique supports the display of multidimensional data by providing users with a multi-parameter encoding scheme within a single visual encoding paradigm. Given a set of geographically located spatio-temporal events, we approximate the data as a continuous function using kernel density estimation. The density estimation encodes the probability that an event will occur within the space over a given temporal aggregation. These probability values, for one or more set of events, are then encoded into a bristle map. A bristle map consists of a series of straight lines that extend from, and are connected to, linear map elements such as roads, train, subway lines, etc. These lines vary in length, density, color, orientation, and transparency-creating the multivariate attribute encoding scheme where event magnitude, change, and uncertainty can be mapped as various bristle parameters. This approach increases the amount of information displayed in a single plot and allows for unique designs for various information schemes. We show the application of our bristle map encoding scheme using categorical spatio-temporal police reports. Our examples demonstrate the use of our technique for visualizing data magnitude, variable comparisons, and a variety of multivariate attribute combinations. To evaluate the effectiveness of our bristle map, we have conducted quantitative and qualitative evaluations in which we compare our bristle map to conventional geovisualization techniques. Our results show that bristle maps are competitive in completion time and accuracy of tasks with various levels of complexity.	Prototyped and evaluated in VALTET system.	N/A	Complete	Research	0	2009-ST-061-CI001	No		FALSE		David Ebert	Purdue University	AZ; IN														
2	Resource Allocation	IOPAR - Operational Performance Assessment Reports	2012/06	2013/07	The IOPAR system has been designed to assist U.S. Coast Guard decision makers and analysts in understanding and assessing the operational efficiencies of different Coast Guard missions at several different organizational levels. IOPAR has been designed to provide senior level decision makers an interactive mobile display of the Operational Performance Assessment Reports (OPAR) for an interactive assessment of the resource expenditures and performance of different Coast Guard missions across the U.S. This mobile system enables interactive filtering of data by different parameters including resource, mission and region. This system has been developed utilizing a user-centered approach where the expertise of several different Coast Guard analysts and decision makers has been leveraged in the design process of the systems.	Delivered and in use; the prototype is being evaluated.	USCG to take ownership of tool.	Complete	Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		David Ebert	Purdue University	AK; AZ; NY; IN	DHS U.S. Coast Guard	2015		Sampling; Statistical Analysis	Computer Science										
1	Law Enforcement	Mobile 3D Routing, Emergency Evacuation, and In-Field Criminal Investigative Analytics	2012/06	2013/09	Mobile 3D Routing, Emergency Evacuation, and In-Field Criminal Investigative Analytics We have developed a mobile application for situationally aware emergency response in dense urban environments that have tall and large buildings. Using an iPhone or other mobile device, an emergency responder can transmit or receive location information, plot 3D routes between locations, and find alternate routes if there are blocked paths. All this can be done, shared among other responders, and received instantaneously. Thus the emergency responders and the command center all have situational awareness and comprehensive, personalized routing. Routing can also be extended from inside the building to the surrounding environment, enabling the system to handle larger scale evacuation along multiple routes in an efficient manner. As a first application, we have generated 3D graphs for all the academic buildings on the UNC Charlotte campus and embedded them in the street network. This environment can also be used to stand in for a dense urban neighborhood. We participated in the DHS Canada-US Experiment (CAUSE-ERE) based in Seattle for response to a Northwestern earthquake and will participate in follow-up activities. We are also working with the Charlotte-Mecklenburg Police Department (CMPD) to develop a training exercises using this environment. This exercise will permit us to test our system, our routing capabilities, and our mobile interfaces with real police officers. We will gain valuable feedback and evaluations of our system, which will be used to improve it. We have also run an on-campus shooter/emergency evacuation exercise with the UNC Charlotte Public Safety Department. The improved system will be tested with other police departments and is being	Tool was developed.	N/A	Complete	Research	0	2009-ST-061-CI001	No		FALSE		William Ribarsky; William Ribarsky	University of North Carolina-Charlotte; University of North Carolina at Charlotte	NC														
E	Education	Personal Visual Analytics Workshop	2012/03	2012/06		Personal Visual Analytic Workshop Created		Complete	Seminar/Symposium/Workshop	12000	2009-ST-061-CI001	No		FALSE		Melanie Tory	University of Victoria	PA			06/2016									
E	Education	Banff Workshop	2011/09	2011/09	In September 2011, we hosted a workshop in Banff, Canada, for the purpose of further developing interest in visual analytics within Canadian institutions and organizations. We worked closely with a number of Canadian universities and VIVA (Vancouver Institute for Visual Analytics) to organize the agenda around topics of specific interest to Canadian organizations, and 40 participants attended the workshop. As a result, three seed grant awards were given to fund follow-on workshops and networking efforts. The titles of the three workshops/networking events selected are Visualization and Policy Making: Theoretical and Empirical Explorations, Univ. of British Columbia and Simon Fraser University; Financial Systemic Risk Analysis, Univ. of British Columbia; and Personal Visual Analytics, Univ. of Victoria, Univ. of Calgary, and Dalhousie University.	Workshops created	None	Complete	Seminar/Symposium/Workshop	30000	2009-ST-061-CI001	No		FALSE						2011												
1	Law Enforcement	(MERGE) Mobile Emergency Response Guide	2011/08	2014/08	MERGE technology allows for an easy reference for first responders- it's essentially a mobile look-up table with some additional, useful features.This provides an automatic interpretation, response, and evacuation protocols of hazmat placards in the DOT Emergency Response Guidebook. The tool pulls in real-time weather information and the latest census data to provide a plume model and estimate for areas that may need to be evacuated in the case of a HAZMAT accident, based on the placard read into the system. Along with imaging the placard (capturing a photo and having the software automatically read the numbers), a user can also enter the HAZMAT number to look-up the chemical. The goal is to develop a mobile system that uses location-based services and image analysis methods to automatically interpret HAZMAT signs and quickly provide safety information to users. The MERGE tool provides the same information contained in the Emergency Response Guidebook published by the Department of Transportation, but, in a highly-portable, tech-friendly manner. 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	A professional analyst from an industry-leading company that deals with flight delay data evaluated our system and our approaches used in this work. The analyst mentioned that, at this company, they do not have such visual tools that can enable visual analysis of multiple variables at different locations and different times. Therefore, our system is excellent for dealing with challenging data in the flight delay domain, and it is cutting-edge work for the industry. In particular, the information theory based anomaly detection approach is very intriguing, and it has not been applied to analyses in the industry as of today. MERGE has been deployed to several law first responders groups and it has received very positive responses from our targeted user groups which include: the Lafayette, West Lafayette, Indianapolis, and St. Clair, MI Fire Department.	MERGE was recently demonstrated to a manufacturer of detection sensors, who is interested in licensing the MERGE source code.	Complete	Research	41643	2009-ST-061-CI001	No	Field Monitors	FALSE		Edward Delp; Ed Delp	Purdue University; Purdue University	IN; CA; OH	State and Local Emergency Managers; State and Local First Responders ; Other DHS	2014	Emergency Preparedness and Response; Explosives Detection, Mitigation and Response	Data Collection/ Generation	Case Studies; Modeling; Sampling; Statistical Analysis	Engineering; Computer Science	Operational Use							
1	Law Enforcement	SP 10: Physical Extraction & Reconstruction of Evidence from Mobile Phones Using JTAG Test Ports	2011/07	2012/06	Note: Tulsa Cell phones and BlackBerry devices are indispensable to the planning, coordination and execution of criminal acts. As such, they often contain vital evidence, including subscriber and caller information, call-times, locations, text messages, email, images and audio and video recordings. But Law Enforcement (LE) investigators are often unable to use this evidence in investigating and prosecuting crimes. The problem is that most mobile phone forensic tools used by law enforcement perform "logical extractions" of evidence, where a tool queries the operating system of a phone for data. Clearly, the mobile phone being examined must be undamaged and unlocked (i.e., not password protected). However, even when the phone is fully operational, a "logical tool" cannot retrieve hidden and deleted data. The solution is the "physical" extraction and subsequent reconstruction of evidence: (i) acquire the entire contents of mobile phone memory; and (ii) reconstruct the binary data to produce evidence in human-understandable form such as text, images, audio and video. This project will engineer forensically-sound physical evidence extraction and reconstruction solutions for cell phones and BlackBerry devices of interest to the U.S. Secret Service and its partner federal, state and local law enforcement agencies. The physical evidence extraction solution will leverage JTAG test access ports in mobile phones that enable electronics engineers to test and debug the devices. These ports will be used as entry points to extract the entire memory contents rapidly and in a forensically sound manner. The evidence reconstruction solution will convert the raw extracted data to human understandable evidence in the form of text, image, audio and video files. It will parse relevant raw data, parse the			Complete	Research	198565	2009-ST-061-CI001	No		FALSE																		

2	Resource Allocation	Coast Guard Swimmer Deaths	2011/07	2012/06	Number of deaths involving swimming and boating in great lakes rose from 90 in 2009 to 164 in 2010, an 82% increase. This projects aims at analyzing the data related to swimmer deaths in District 9 for year 2010 and help provide an explanation or identify the major factors contributing to this increase in swimmer deaths. This analysis was used in planning and public service campaigns aimed at reducing swimmer deaths for the summer of 2011 season. During analysis, time-of-day, day-of-week and monthly swimmer death patterns were studied. In addition, the geographic distribution of such incidents was also studied. Hotspot maps were created for each of the summer months for 2010 and were compared to previous years. In our analysis, we found that august has the highest frequency of swimmer deaths and if you consider time-of-day then late afternoon was the time when most of these incidents happened. The highest concentration of such incidents was located in Lake Michigan (south and west shore). For boating deaths, mid-July to mid-August was the time when highest frequency of such incidents happened and there was one week where such incidents were significantly high. Friday, Saturday and Sunday accounted for almost all deaths related to boating incidents. We summarized and reported our results to Coast Guard to help inform operational planning for fiscal year 2011. Later on, it was reported that drowning and boating related incidents decreased to 104 in 2011 which was almost a 37 percent decrease.	In our analysis, we found that august has the highest frequency of swimmer deaths and if you consider time-of-day then late afternoon was the time when most of these incidents happened. The highest concentration of such incidents was located in Lake Michigan (south and west shore). For boating deaths, mid-July to mid-August was the time when highest frequency of such incidents happened and there was one week where such incidents were significantly high. Friday, Saturday and Sunday accounted for almost all deaths related to boating incidents. We summarized our findings and Coast Guard used these results in their operational planning for fiscal year 2011 and also in designing the public service message campaigns. There was a drop of almost 37% in swimmer deaths in 2011. Finished.	N/A		Complete	Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		David Ebert	Purdue University		IN; MI			2011					
4	Disease Surveillance	LAHVA: Linked Animal-Human Health Visual Analytics	2011/07	2012/06	The role of public health surveillance is to collect, analyze and interpret data about biological agents, diseases, risk factors and other health events in order to provide timely dissemination of collected information to decision makers. Unfortunately, data sources vary widely in accuracy and reliability, and it is often the case that unusual health trends, such as outbreaks or poisonings, have an incidence profile (signal) that is obscured by the statistical noise. In order to help investigators overcome these issues, we have developed a suite of statistical and visual analytical tools that couple novel data sources with human health data. Our primary data sources include emergency room data from the Indiana State Department of Health, general visits of pets to Banfield the Pet Hospitals, Indiana Board of Animal Health data, and data from public health news feeds, such as ProMed. These analytical tools and datasets are brought together in a visual analytics environment called LAHVA. The LAHVA application provides investigators with the ability to visually search the data for clusters in both a statistical model view and a spatio-temporal view. By providing linked graphical and statistical analysis views for public health officials, we will improve event detection and response, while reducing false positives.	Software product that linked animal and human health records from the state department of health and veterinary clinics. Features of this tool led to statistical analysis of critical livestock diseases and presentations to a variety of stakeholders were performed.	Partnerships with industry need to be further established for the veterinary clinic data, and and analysis of public records (such as state governance animal health board data) needs to be evaluated for use.	Complete	Research	0	2009-ST-061-CI001	Yes	Compiling and Sorting Database	FALSE		David Ebert	Purdue University		NC; IN			2012		Statistical Analysis		Basic Research
1	Law Enforcement	High Risk Alcohol Behavior Analysis	2011/07	2012/06	This project involves geographic information system (GIS) mapping of the Purdue University, West Lafayette, campus and surrounding areas to identify the environments (housing, locations) where alcohol-related incidents (arrests, transports, vandalism, calls) occur which can be targeted for interventions. Mapping of the spatiotemporal locations (specifically addresses/times/dates) has helped identify the hot spots for potential interventions by the university authorities. Multiple datasets including law enforcement, university events and emergency medical services datasets were analyzed and explored to profile high risk drinking behaviors.	The output of the analysis was used to create an awareness presentation for Purdue students, guide intervention activities and to develop intervention policy.	Update analysis periodically.	Complete	Research	0	2009-ST-061-CI001	Yes	Compiling and Sorting Database	FALSE		David Ebert	Purdue University		IN		State and Local First Responders	2011		Statistical Analysis	Computer Science	
1	Law Enforcement	iVALET - Mobile Visual Analytics Law Enforcement Toolkit	2011/07	2017/06	The Visual Analytics Law Enforcement Toolkit (VALET) integrates large volumes of criminal, traffic and civil incident data into a single, interactive user interface to help law enforcement decision makers, analysts and officers identify crime trends and patterns, discover crime anomalies, and perform predictive crime analytics in order to assist in allocating law enforcement resources. With the increasing magnitude and complexity of modern datasets, it is becoming more difficult for analysts to efficiently extract relevant information, specifically in the mobile domain. The goal of this technology is to develop a mobile visual analytics law enforcement toolkit designed to equip law enforcement agencies and citizens with effective situational awareness and risk assessment tools. The system provides users with a suite of interactive tools that allow them to perform analysis and detect trends, patterns and anomalies among criminal, traffic and civil (CTC) incidents. The system provides dynamically linked views that enable the exploration of spatiotemporal CTC incidents data as well as interactive risk assessment tools that allow users to identify regions of potential high risk and determine the risk at any user-specified location and time. With a chemical plume dispersal modeling tool, the system also allows law enforcement officers and first responders to have better awareness in emergency chemical release situations. The system has been designed for the iPhone/iPad environment and is currently being used and evaluated by a consortium of law enforcement agencies.	Our Visual Analytic Law Enforcement Toolkit (VALET) is actively being used at the Lafayette, West Lafayette, Purdue University, and Evansville Police Departments. Further, the Indianapolis Police Department, the Tippecanoe County Sheriff's Office, the Ohio State Highway Patrol, the Illinois State Police, and 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. One of those adjustments is the development of the Officer Performance solution to gamify the performance of police officers in Lafayette Police Department for better performance comparison and for motivating maximized performance. 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. VALET has been utilized to devise novel data guided patrolling strategies and has led to a paradigm operational shift at several police departments. VALET has also supported investigative analysis tasks at the departments who utilize the system. For example, the system played a critical part in the investigation of a string of business burglaries by the Evansville police department. In keeping with the goal of transitioning this software, we have licensed the technology to a startup company called Davista Technologies, LLC that was born out of the VACCINE center.	Davista is developing a sustainable transition model in order to continue the development and commercialization efforts of the technology. The company is also currently engaged in developing a data driven solution for a large private corporate firm for optimally allocating their safety and security related resources. Davista is leveraging the core VALET technology in the development of this solution.	Complete	Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		David Ebert	Purdue University	Morgan State University	IN	Center for Visual Analytics for Command, Control, and Interoperability Environments	State and Local First Responders	2016		Modeling; Sampling; Statistical Analysis	Computer Science	Operational Use
5	Financial Flows Tools	NHANES Exploration	2011/07	2016/07	NHANES Exploration Applied visual analytics for exploring the National Health And Nutrition Examination Survey The United States health sector has deployed many survey programs that produce large datasets with increasing complexity and dimensionality. One such survey program is the National Health and Nutrition Examination Survey (NHANES), which is a population-based survey designed to collect information on the health and nutrition of the U.S. household population. NHANES collects data from physical examinations along with surveys where they ask the responder to recall their ingestion of food for the past 48 hours. The 2-day food recollection survey includes demographic questions such as gender, age and race/ethnicity. In conjunction with the Department of Foods and Nutrition at Purdue we have developed a visual analytics system designed to help researchers explore patterns and form hypotheses within the NHANES dataset. The visualization component of the environment is an extension of traditional scatterplot matrices. Since the upper portion of the scatterplot matrix is a redundant encoding, we utilize this space, to show the projected N-dimensional clustering of points. The rows and columns of the matrix are automatically ordered using information about the cluster projection in each space as a means of showing the most meaningful dimensions. A comparison module has also been included that allows the user to compare groupings of people to the 2010 Dietary Guidelines for Americans. This tool enhances the analysis work by aiding discovery and hypothesis formation.	Delivered to nutrition researcher.	N/A	Complete	Research	0	2009-ST-061-CI001	No		FALSE		David Ebert; Tom Ertl	Purdue University;									
4	Disease Surveillance	Visual Analytics Decision Support Environment for Epidemic Modeling and Response Evaluation; Public Safety Coalition Projects	2011/07	2012/06	In modeling infectious diseases, scientists are studying the mechanisms by which diseases spread, predicting the future course of the outbreak, and evaluating strategies applied to control an epidemic. While recent work has focused on accurately modeling disease spread, little work has been performed in developing interactive decision support tools for analyzing the epidemic catastrophes and evaluating potential disease mitigation strategies. The absence of such tools makes it difficult for researchers, analysts and public health officials to evaluate response measures within outbreak scenarios. As such, our research focuses on the development of an interactive decision support environment in which users can explore epidemic models, mitigation strategies and the impact of both. This environment provides a spatiotemporal view where users can interactively utilize mitigative response measures, such as quarantine and transportation controls and observe the impact of their decision over time. Our system also provides users with doubly linked decision history visualization and navigation tools that support the simultaneous comparison of mortality and infection rates corresponding to different response measures at different points in time. The architecture of our system is flexible enough to model variety of epidemic catastrophes by integrating corresponding epidemiological models. We use hypothetical scenarios and dataset to perform our case studies. As the user inserts decisions points, scrolls through time, and revisits other scenarios, these interactions are tracked and displayed in the decision history view. Our case studies are the following: Pandemic Influenza with airline transportation and Rift Valley Fever, a	There are two software products to date from this project. The first system enables visual analytic decision making and evaluation of interdiction measures for Rift Valley fever (RVF), a zoonotic disease that could have a devastating impact on the US cattle industry. The second system allows visual analytic decision making to respond to and curtail the spread of pandemic influenza. This project has shown the potential of integrated simulation, visual analysis, and linked interactive spatiotemporal displays with decision space displays for evaluating and optimizing multiple interdiction strategies. RVF: Partnered with DHS FAZD Center and delivered to them. PanVis delivered to health departments across U.S.	N/A	Complete	Other (enter short description)	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		David Ebert	Purdue University		AZ; IN			2010		Modeling; Sampling; Statistical Analysis		
E	Education	SP 14 Task 1 - Extend COE Explorer	2011/07	2012/06	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.	The COE Explorer was extended to use live data and was deployed on the VACCINE website and was used for portfolio management of the ongoing research program.	Multimodal graph visualization is an ongoing research topic in the visual analytics community. Our work on this is regularly cited and has become a standardized resource for other researchers to build on.	Complete	Research	62466	2009-ST-061-CI001	No		FALSE		Niklas Elmqvist	Purdue University									

E	Education	Cyber Education	2011/06	2014/07	Leveraging Multidisciplinarity in a Visual Analytics Graduate Course Issue No.03 - May-June (2012 vol.32) pp: 84-87 Niklas Elmqvist , Purdue University David S. Ebert , Purdue University DOI Bookmark: http://doi.ieeecomputersociety.org/10.1109/MCG.2012.55 ABSTRACT Demand is growing in engineering, business, science, research, and industry for students with visual analytics expertise. However, teaching VA is challenging owing to the multidisciplinary nature of the topic, students' diverse backgrounds, and the corresponding requirements for instructors. This article reports best practices from a VA graduate course at Purdue University, where instructors leveraged these challenges to their advantage instead of trying to mitigate them	A graduate course was created.		Visual analytics education is an ongoing project. PI Elmqvist has created a new masters-level course at UMD's iSchool on visual analytics that is even more targeted at practical data analysis.	Complete			100000	2009-ST-061-CI001	No			FALSE		Niklas Elmqvist	Purdue University											
	2	Resource Allocation	Coast Guard PROTECT Visualization	2011/06	2013/07	This is a contract under our Basic Ordering Agreement. Using the previous two years of patrol routes, we are developing statistical models for loiter point visits. Predictions of the loiter point visits will be computed and sent to the Coastguard to compare against actual visits during a time period in which the visits were unknown to the analysts. The predictive efficacy of this model will then be addressed, and determination on the ability of hostiles to predict patrol routes based on current patterns will be assessed. Sparse data will be handled by predicting the number of days between visits. Similarly in utilizing the PROTECT model, two years worth of patrol routes will be generated from the PROTECT model. Similar statistical models will be created and a predictive model will be adapted to the PROTECT routes. Predictions of future loiter point regions will be generated from PROTECT and sent to us and our model will now assess the ability of hostiles to predict patrol routes based on potential PROTECT routes. An interactive visual analytics environment was created that overlays patrol routes and potential RIN numbers for targets. This environment is developed for both desktop the first generation tool looking at historical patrol route logs and critical infrastructure overlays. The first generation tool was deployed to a provisional set of members for analysis and feedback.	VACCINE, in conjunction with the CREATE Center, analyzed the PROTECT model for security patrols in Boston and made recommendations for improvements for deployment in New York City. Summary of Transition and Deployment - PROTECT - Port Resilience Operational / Tactical Enforcement to Combat Terrorism • Collaboration with CREATE • Prototype July 26, 2011. Completed.	N/A	Complete	Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		David Ebert	Purdue University	AZ; IN	Center for Risk and Economic Analysis of Terrorism Events	DHS U.S. Coast Guard	2011		Case Studies; Modeling; Sampling; Statistical Analysis	Geography	Prototype Demonstration
	5	Financial Flows Tools	MarketAnalyzer: An Interactive Visual Analytics System for Analyzing Competitive Advantage Using Point of Sale Data	2011/06	2013/07	Competitive intelligence is a systematic approach for gathering, analyzing, and managing information to make informed business decisions. Many companies use competitive intelligence to identify risks and opportunities within markets. Point of sale data that retailers share with vendors is of critical importance in developing competitive intelligence. However, existing tools do not easily enable the analysis of such large and complex data. therefore, new approaches are needed in order to facilitate better analysis and decision making. In this paper, we present MarketAnalyzer, an interactive visual analytics system designed to allow vendors to increase their competitive intelligence. MarketAnalyzer utilizes pixel-based matrices to present sale data, trends, and market share growths of products of the entire market within a single display. These matrices are augmented by advanced underlying analytical methods to enable the quick evaluation of growth and risk within market sectors. Furthermore, our system enables the aggregation of point of sale data in geographical views that provide analysts with the ability to explore the impact of regional demographics and trends. Additionally, overview and detailed information is provided through a series of coordinated multiple views. In order to demonstrate the effectiveness of our system, we provide two use-case scenarios as well as feedback from market analysts.	Delivered to corporate partner.	N/A	Complete	Research	0	2009-ST-061-CI001	No		FALSE		David Ebert	Purdue University	IN; AZ								
	1	Law Enforcement	SP 8: Disposable Cell Phone Analysis	2010/10	2012/03	Note: Marcus Rogers	A final report was submitted to DHS outlining the findings	No next steps at this point.	Complete	Research	149811	2009-ST-061-CI001	No		FALSE		David Ebert	Purdue University											
E	Education	Justice Institute of British Columbia and VACCINE Collaborative Workshops	2010/09	2010/09		Workshops were created	None	Complete	Seminar/Symposium/Workshop	46000	2009-ST-061-CI001	No		FALSE														
	1	Law Enforcement	SP 2: CCC Tech Support	2010/07	2011/06	Task Statement - Department of Homeland Security (DHS) Command, Control and Interoperability (CCI) Division Technical Suppo:it Tasks: 1. Programmatic, management, and technical support for: I a. Multi-band radio pilot and demonstration efforts I b. Regional information sharing demonstrations (e.g., Virtual USA demonstrations) 1 c. Development of novel anomaly detection techniques 1 d. Command, Control and Interoperability Division Support Narrative: Provide programmatic, management, and technical support to the newly established virtual USA (vUSA) program. Specific projects and tasks include, but would not be limited to, multi-band radio pilot and demonstration efforts, coordination of various multi-level interoperability and compatibility activities, regional information sharing demonstrations, and development of novel anomaly detection techniques. Cross-jurisdictional cooperation requirements, encompassing local, state, regional, and national, as well as international partners, and integration of multiple, diverse, and distributed information sources are to be especially addressed throughout the work. Likewise, enabling multi-disciplinary research collaboration on difficult scientific and technical challenges in threat awareness, understanding, and dissemination is a desired aspect of the support activity. Deliverables include input to plans and development of planning templates; technical reviews and reports; coordination and facilitation of multiple program activities within DHS (including outreach, collection and validation of user requirements, and technical meetings); and leadership of technical collaboration eff011s with domestic and foreign partners. All information will be provided in at least one interim report and one final report 1 Deliverable: 1. Interim Task Report			Complete	Research	98660	2009-ST-061-CI001	No		FALSE		Alan MacEachren; Alan MacEachren	Pennsylvania State University; Pennsylvania State University	PA; IN								
E	Education	SP 7: User Adoption Learning Tool (uLearning)	2010/07	2011/06	Note: Captico Objective Develop an initial uLearning (user learning) platform that incorporates video, text, images, or audio of new technologies and how new technologies can be used in operational scenarios by members of the first responder community. Mission The uLearning Platform allows users to:"Capture once, share [content] with many"; Assign, manage, and monitor their teams training program online; Repurpose, present and share educational materials in real time; Share Subject Matter Expertise (SME) from conferences and events; Access training content easily and affordably; and Share best practices and lessons learned. Findings In addition to formal training materials, first responders regularly create in-house videos, documents, and presentations to educate themselves and their fellow team members. Some counties use private file sharing services to trade materials across departments. Others mail CDs with videos on them back and forth due to privacy concerns. Others upload content to YouTube and hope for the best. There is an astounding amount of educational content that is created and then wasted by limits on	The Department of Homeland Security Science and Technology Directorate (DHS/S&T/CCI) focuses on the development of education and training tools, as well as collaboration space, for the emergency response community. During the early part of Year 3, Captico, a Maryland-based company specializing in internet marketing using web technology, partnered with VACCINE at Purdue University to develop a web-based uLearning prototype for DHS/S&T/CCI to serve the emergency response community. The prototype leveraged content such as videos, presentations, narratives and links to share expert and practitioner-defined content across the emergency response community. The objective of this effort was to develop an initial short, uLearning (user Return 29 learning) tool that incorporates video, text, images, or audio of new technologies and how new technologies can be used in operational scenarios. Deliverables planned in the original proposal included a prototype of a ULearning Tool; assessment of the ULearning tool with a small set of managers/users; and plans/approach for broader uLearning applications (e.g., other technologies and end-users). Captico and Purdue have identified and prioritized learning needs within the emergency response community that may be best supported via the uLearning tool. By gathering input from first responders utilizing various methods, the uLearning tool prototype was developed to incorporate specific features and capabilities found most useful by the emergency response community. Based on availability of funding, the plan was to target the state of Indiana as a large pilot project and give those first responders supported access to the uLearning Platform in exchange for feedback to further the development of the Platform. First responders were interviewed and their input was recorded by Captico. However, in the summer of 2011 the project was postponed due to lack of funding. Summary of Transition and Deployment: Ulearning (Captico)- Training portal for S&T and COE Technologies • Deployed for Test & Evaluation Feedback - March 2011	Need more funds	Complete		83829	2009-ST-061-CI001	No		FALSE				IN			2011					
	2	Resource Allocation	Analytical Visualization of the Port Arthur, TX Economic Impact Study	2010/07	2011/06	The mission of the USCG Marine Safety Program is to ensure environmentally safe operations of all vessels operating in U.S. waters. Disruption of services at individual seaports will have local, regional, and national economic impacts. It is worth noting that according to the 2008 "Maritime Safety Performance Plan", US deep-draft seaports and supporting firms employed more than 8 million people and contributed approximately $2 trillion to the U.S. economy. The USCG Maritime Safety program executes daily activities designed to reduce the likelihood that a catastrophic incident will occur and, should one occur, respond in order to minimize the impact and restore full operations. One question is: How does the cost of Maritime Safety compare with the economic impact due to disruptive incidents occurring in deep-draft seaports and the overall function of the Maritime Transportation System? Therefore, the Maritime Economic Impact Study project examples the economic impact locally and nationally for port closures in the area of Port Arthur Texas. This project has generated a large volume of market sector data for the impact of closures of different durations. It has also explored the impact of mitigation strategies. This large series of tables and numbers is difficult to use by decision makers in analysis consequence and response scenarios and making decisions with trade-offs. Interactive visual analytics can alleviate these problems and provide a powerful tool since the results are more easily interpreted visually. This requires visualization utilizing spatial and temporal analytics (and visualization) blended with a multivariate correlative analysis to form an interactive tool that facilitates interactive display of economic impact by choosing type of vessel, type of inspection program. The user can explore	VACCINE personnel have developed a visual analytics environment for the analysis, exploration and decision making of the effects of a port closure in Port Arthur, TX. The tools created run on Windows PCs and provide users with a graphical user interface with which to explore the economic impact data by market sector and by mitigation strategy. Completed and delivered to USCG.	N/A	Complete	Research	0	2009-ST-061-CI001	No	Expert Consultation	FALSE		David Ebert	Purdue University	AZ; IN	Center for Risk and Economic Analysis of Terrorism Events	DHS U.S. Coast Guard	2011		Case Studies; Modeling; Sampling; Statistical Analysis		Operational Use
	1	Law Enforcement	PlumeViz	2010/07	2011/06	Mission Need As the threat of explosive devices has become more prevalent, the need for in-field analysis of the release of potential nuclear, chemical and biological threats is critical. Our work in PlumeViz provides users with the means to interactively explore the impact of wind speed and direction in terms of plume releases and dispersal. Our interactive environment allows users to explore the impact of these varying plumes in terms of economic loss, death, injury, etc. These overlays are combined in a command and control environment, where data sources are integrated with potential decision points, allowing analysts to quickly determine best and worst case scenarios. Users are interactively able to analyze the loss of life, illness and economic impact across census tracts affected by the plume. Linked statistical views provide insight into the impact over time and provide future predictions in terms of potential impact.	Completed live demonstration in fullscale exercise in Pugent Sound with USCG and DNDO.	N/A	Complete	Research	0	2009-ST-061-CI001	No		FALSE		David Ebert	Purdue University	IN								

2	Resource Allocation	Symbology Map Transition	2010/07	2016/07	A number of agencies within DHS employ maps as part of their daily operations. To facilitate inter-agency communication, cooperation, and consistency with map-based information and tools, DHS has directed attention to standardization of map symbology. With the support of DHS, Penn State has been researching map symbol standardization since 2009. The goals of this research include: (a) Investigating the use and usability of the ANSI INCITS 415-2006 standard; (b) Developing a process to refine mission-specific symbol standards; (c) Enabling the sharing of symbols through a feature-rich online store; (d) Determining appropriate map symbology for mobile use within DHS. The results of this work, in addition to a comprehensive understanding of DHS mapping needs and the many roles for map symbols to meet those needs, is a pair of integrated web applications (Symbol Store and Symbol Reviewer) that this transition project has focused on adapting to work within the Federal Geographic Data Committee managed GeoPlatform: https://geoplatform.gov/. A working system with web-based guides on strategies for using map symbols provided in both web and mobile maps has been completed for implementation in GeoPlatform.	Multiple improvements to the Symbol Store application have been made due to feedback from work with users. Additionally, the Symbol Store API has been enhanced and simplified to allow a developer to easily search and access symbols in the Symbol Store. A set of fully documented examples have been produced of web map (both Esri and an alternative) and mobile map applications that can connect directly to Symbol Store through the extended API along with documentation on the process for implementing the functionality (all posted on Github for wide access). Symbol Store serves hundreds of symbols. To make them accessible, we added query expansion functionality that allows users to find map symbols even if they do not know the official symbol name (e.g., entering "boat" will retrieve not only the symbols with "boat" in their name but also symbols associated with marine incidents and ferries). This was implemented using the concept of semantic distance, and the WordNet database of all English words and their relations. Since computing semantic distance is computationally expensive, we pre-compiled indexes of the best symbol match for every noun in the English language and applied computational strategies that cut the index creation time by a factor of 30. Symbol Store is working on the GeoPlatform.gov Server. We continue to work with the FGDC staff to prepare the system prior to public access; the latter is anticipated within 1 month of this report date. Symbol Reviewer is operational on the www.symbolstore.org web site and will be installed in the GeoPlatform at the convenience of GeoPlatform staff.	Software is built but needs to be converted from Flash to Java.	Complete	Research	0	2009-ST-061-CI001	No	Survey	FALSE		Alan MacEachren; Alan MacEachren	Pennsylvania State University; Pennsylvania State University	IN; PA	DHS Federal Emergency Management Agency; DHS Transportation Security Administration; DHS U.S. Coast Guard; State and Local First Responders; Other Federal Agency	2014	06/2013		Case Studies	Geography	Pilot/Field Testing and Evaluation in an Operational Environment
1	Law Enforcement	Video Surveillance Project	2010/07	2011/06	Video Surveillance Project			Complete	Research	0	2009-ST-061-CI001	No		FALSE		David Ebert	Purdue University	IN										
1	Law Enforcement	Seed 3: Uncertainty in Video Visual Analytics	2010/07	2012/06	This seed project addresses the problem of uncertainty visualization in Video Visual Analytics (VVA). A VVA pipeline differs from a traditional automated video analysis (AVA) pipeline in several ways: (i) VVA focuses on the depiction of important information in the videos, whilst AVA focuses on making analytical decisions using machine intelligence; (ii) VVA provides an integrated analysis and visualization pipeline with feedback loops; whilst AVA usually does not rely on visualization, or provides only primitive visual annotation of videos. In both VVA and AVA pipelines, there are a large number of video processing components, such as filters for morphological operations, convolution, segmentation and recognition. In addition to typical imagery, geometrical and annotative results, these filters also result in a huge amount of information about the uncertainty levels (and processing errors). While some of such information may be part of the decision mechanism (typically through coarse quantization), most information would be discarded at various stages of the pipeline. Without such information, adjusting various parameters for video processing components is almost a black art. Raw uncertainty information can be pixel-based, object based and frame-based, and typically of a time-varying nature. It is thus desirable to make the uncertainty information available to the viewers visually. However, video visualization components in a VVA pipeline usually lack in both information bandwidth and distinguishable visual channels. The former refers to the limited screen resolution to handle a large amount of temporal data. The latter refers to the factor that most effective visual channels usually have already been used by the traditional video visualization without uncertainty information. For example	We have developed a real-time method for transforming video information in quasi-3D to spatial information in a 2D planar visualization, which acts as a live layer on top of a conventional satellite image-based mapping system. To facilitate rapid and reliable camera-map calibration, we make use of a semi-automatic calibration scheme. The scheme allows users to pre-define essential projection attributes for each camera in a set-up stage, and map these video streams onto a live layer of the map. We have also developed several schemes for visually mapping information extracted from videos, including traffic speed and density, and uncertainty in illustration. This form of traffic video visualization can potentially reduce the need for specialized traffic sensory devices and infrastructure, and enable better utilization of the existing video-based traffic sensory network.	N/A	Complete		0	2009-ST-061-CI001	No	Field Monitors	FALSE		David Ebert	Purdue University	IN		2010		Sampling		
2	Resource Allocation	SP 15 Task 2: VASA	2010/07	2011/06	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. In order to provide awareness of current and forecasted impact caused by the natural events, our system presents historical and simulated events (e.g., hurricanes, tornadoes, blizzards) where users can instantly consider various scenarios, alternative and operational and simulation attributes. Based on these decisions and parameters, new simulations may be run to explore the effects on multiple critical infrastructures (e.g., power, computer networks, water, transportation, sewer) and the effectiveness of contingency plans and mitigation strategies. One example is a franchise food network where food delivery routes need to be changed based on store and infrastructure damage. In our visual analytics environment, analysts and decision-makers can effectively monitor the situation, understand the impact of these storms on critical infrastructure, and evaluate potential re-routed road paths for the food network with adjusted parameters	Hypothetical stores in North Carolina damaged by Hurricane Irene were looked at. In our visual analytics environment, analysts and decision-makers can effectively monitor the situation, understand the impact of these storms on critical infrastructure, and evaluate potential re-routed road paths for the food network with adjusted parameters.	N/A	Complete		74918	2009-ST-061-CI001	No		FALSE		William Ribarsky, Isaac Cho, Kelly Gaither, David Ebert	Office of University Programs, Science & Technology Directorate	CA; NC; PA; SC; VA		2010				
2	Resource Allocation	SP 16 - VASA	2010/07	2011/06	The goal of VASA (Visual Analytics for Security Applications) is to apply visual analytics to disaster prevention and crisis response, with a focus on critical infrastructures in logistics, transportation, food safety, digital networks and power grids at the national levels. The connectedness and dependency of these critical infrastructures make the problem of monitoring and understanding their functioning and dependencies one of the most complex analytical tasks faced by our societies. Their proper functioning is crucial for the well-being of the population, economic viability, and most of all to prevent loss of life. The VASA project proposes the application of visual analytics to the problems of monitoring and understanding critical infrastructures, cascading infrastructure effects, and to the management of crisis response. While, for example, there exist detailed models for individual types of infrastructures such as electric power grids, these do not encompass the various interconnections and interdependencies one needs to be aware of to make risk estimation decisions and for performing operational risk management. What is therefore required is a mechanism for conjoining the information available for individual infrastructure sectors and providing unified views and analytical tools for planning and decision support. VASA is conceived as a three-year German-US collaboration project from science through prototypes and demonstrations to evaluations for transitions into practice which leverage other investments from both countries. The VACCINE team will continue requirements analysis and project definition for deliverables as well as begin acquisition of appropriate datasets and models for the project Deliverables - Based on the submitted proposal	Hypothetical stores in North Carolina damaged by Hurricane Irene were looked at. In our visual analytics environment, analysts and decision-makers can effectively monitor the situation, understand the impact of these storms on critical infrastructure, and evaluate potential re-routed road paths for the food network with adjusted parameters.	N/A	Complete	Research	1085896	2009-ST-061-CI001	No		FALSE		William Ribarsky, Isaac Cho, Kelly Gaither, David Ebert								
2	Resource Allocation	(CgSARVA) Coast Guard Search and Rescue Visual Analytics	2010/06	2014/09	cgSARVA is a vital component for analyzing and assessing operational efficiencies of different Coast Guard missions across the United States. The system aids with the risk assessment of potential staffing changes by using visual analytics to help understand networks and currently demonstrates relationships within the DHS Centers of Excellence (Centers, People, Institutions, Projects). The analyst will be able to understand the distribution of incidents, the risk, and the benefits involved with the reallocation or reduction of resources. The goal is to aid in a more effective decision making process by looking at the current resources allocated across mission areas and geographic locations for the U.S. Coast Guard. This is accomplished by analyzing trends, patterns and anomalies associated with distributing the cases in both space and time conducted by the USCG. Additionally, this assessment tool enables the determination of potential increase or decrease in risk with a reallocation of resource; as well as known increases or decreases in response time. The system has been developed utilizing a user-centered approach where the expertise of several different Coast Guard analysts and decision makers has been leveraged in the design process of the system.	cgSARVA is deployed and in use by the United States Coast Guard.	USCG to take maintenance responsibility for system.	Complete	Research	87600	2009-ST-061-CI001	No	Expert Consultation	FALSE		David Ebert	Purdue University	IN	DHS U.S. Coast Guard	2013	Advanced Data Analysis and Visualization; Risk and Decision Sciences	Case Studies; Modeling; Risk Assessment; Sampling; Statistical Analysis	Engineering; Geographic information sciences; Computer Science; Risk management/assessment; Biostatistics and bioinformatics	Operational Use
1	Law Enforcement	Hazmat Placards	2010/06	2010/08	Rolled into MERGE Introduction: Over the past ten years there have been thousands of incidents involving hazardous material carrier that have caused or had the potential to cause human injury and property damage. A substantial portion of these damages and anxieties may be prevented by having a quick and accurate representation of response information available to first responders. In MatLab, we use the Image Processing Toolkit to process our images through detection, filtering, etc. We are currently still developing the algorithm to accept various input from the user and in the future the feature of using the camera to perform image processing will be added. Initiative: We are developing an algorithm that detects a placard by its color, symbol, and ID/class number. Methods involved in this process are edge detection, morphology, filtering, which are featured in the MatLab Image Processing Toolkit. First, we will have to detect the edges around the placard. By detecting these edges, one the purposes of image processing is to get rid of the any background images. Inside the placard, we detect the color of the sign by using basic morphological algorithms for connected components and hole filing. Our next approach will be detecting the placard's symbol and ID/class number. Results: The application is still in development, however, once it is completed we expect the application to be capable of receiving user input about the HazMat placards such as class number, ID number, and symbol displaying images of placards matching the user's specifications, and displaying emergency response information on a selected placard. Conclusions From the work that we have done so far, we believe that in the future this application could help first responders shorten their response time which could	Placards were created for research use with application.	As the next step of this project, MERGE (Mobile Emergency Response Guide) system was developed. 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.	Complete	Research	94139	2009-ST-061-CI001	No		FALSE		Edward Delp	Purdue University	IN						

E	Education	RECONNECT Workshop 2010 - Extracting and Visualizing Information from Natural Language Text	2010/06	2010/06	Automatic identification and extraction of desired information from natural language text is increasingly used as a way to improve general purpose search and has a range of applications in medical informatics, business applications, and for the intelligence community. The input is one or more texts in the domain in question, and the output is a database containing just the desired fields of information, extracted from the source material and formatted appropriately. Information extraction (IE) techniques have been developed since the early 1980s, and include finite state technology, pattern-based extraction, and appropriate machine learning methods. This week-long workshop will take participants from the early, simpler, methods through the modern ones, and will include theoretical and practical topics as well as hands-on exercises using software packages. The material is very relevant to the undergraduate classroom and to many applications. The lectures are renowned experts in the various aspects of IE and its visualization, and have a long history of giving informative, engaging, and fun lectures.	CCICADA/VACCINE Summer Reconnect Workshops exposed faculty teaching undergraduates to the role of the mathematical sciences in homeland security and provided an opportunity to researchers in government or industry to learn about recent techniques in data analytics. John Stasko participated in teaching RECONNECT 2009 that was held at Rutgers University. RECONNECT 2010 was held at USC. Midge Cozzens and John Stasko taught at RECONNECT during the summer 2010. Planning is currently underway for a workshop with public safety professionals to be hosted by VACCINE and the Justice Institute of British Columbia in September 2010. Planning is underway for a September workshop on visual analytics for public safety professionals. The workshop will be held at the Justice Institute of British Columbia. Participants will include first responders from Canada and the US as well as VACCINE partners. The purpose of the workshop is to define the requirements that will lead to developing academic programs and relevant technology utilizing visual analytics in the public safety environment.	VACCINE has had several meetings with FLETC to discuss training needs and ways that FLETC and VACCINE can work together. Some initial discussions include: FLETC faculty partnering with VACCINE faculty for research, developing a basic course on visual analytics and how it can be an essential tool for law enforcement, and continuing development of mobile applications.	Complete	Information-driven Visualization, Modeling and Simulation of Data	Seminar/Symposium/Workshop	0	200	No	Data Mining	FALSE		Eduard Hovy	University of Southern California	CA; NJ		Academic Community; Federal Bureau of Investigation; Intelligence Community; U.S. Department of Defense	2010	06/2010	Advanced Data Analysis and Visualization; Communications and Interoperability; Social, Behavioral, and Economic Sciences	Data Collection/Generation	Biometrics; Qualitative Analysis; Sampling	Information Science; Informatics systems; Mathematical and Computational Modeling; Rhetoric	Adopted by End User
1	Law Enforcement	TRIP: Trip Response Investigative Profiler	2010/06	2013/07	Technology allows law enforcement personnel to geospatially and temporally visualize and analyze residential location patterns for individuals who are required to provide law enforcement with their places of residence. As individuals' movements could have correlations with social and/or geo-temporal factors, it is critical to understand the movement behaviors and spatio-temporal patterns of individuals. Moreover, needs for integrated visualization and analysis of the spatio-temporal movement history motivated the development of our tool. TRIP enables spatio-temporal visualization, exploration and analysis among individual movements as well as individual movement and infrastructures. Given individual movement history, various geo-spatial and temporal cues are visualized. As geo-spatial cues, locations markers including newest/oldest indicators, driving routes, reachable areas along the routes and county boundary are overlayed on the map. The routes and reachable areas are also used to present possible relationships and shared areas among individuals' movement as well as individuals and infrastructures. As temporal cues, each location is numbered in temporal order. Route connecting locations changes its thickness to show that an individual moved towards the direction increasing the thickness. Furthermore, the duration of stay at each location is highlighted using ring shaped glyphs.	Collaboration with end-user; Delivered and in use.	N/A	Complete		0	No		FALSE		David Ebert	Purdue University	IN; CA	Center for Visual Analytics for Command, Control, and Interoperability Environments		2007					
2	Resource Allocation	A Data Integration Framework for Enhancing Emergency Response Situation Reports with Multi-Agency, Multi-Partner Multimedia Data; Public Safety Coalition Projects	2010/04	2011/03	In this project, we propose to use advanced data integration and visual analytics techniques to systematically augment situation reports which include pictures and text with relevant multimedia content obtained in the field. Our proposed framework implements the offline Multimedia Analysis Framework (MAF) to associate situation reports with relevant multimedia content. The MAF framework includes a Hierarchical image classification component developed based on multi-source data fusion and some data mining techniques, such as multiple correspondence analyses (MCA). The situation report is pre-processed by using the GATE system and WordNet to associate location-subject pairs. We also provide the prototype with applications to emergency response. Specifically, an iPad application based on the proposed framework has been developed using the pre-defined ontology with the incorporation of domain knowledge. Furthermore, a system improvement mechanism based on user feedback is designed to refine the association between situation report and multimedia data. Finally, the proposed system was evaluated by collaborating with EOC department of Miami-Dade, where the personnel have expressed interest in the application and encouraged us to further develop the system into an operational pilot.	A Disaster Multimedia Search Engine is developed as an iPad application and can be used for retrieving and visualizing the categorized disaster multimedia data. The underlying key techniques include various multimedia semantic analysis and retrieval methods developed by our group. We also develop web-based systems for storyline generation and disaster susceptibility comparisons among cities based on text mining and visualization techniques. The developed methods will greatly improve situation awareness during or after disasters.	Build up an automatic workflow that integrates the processes starting from the feature extraction to semantic concept detection into the complete MADIS system; Define an event-based response trigger monitor for periodically model re-training; Utilize the reports that are available on the website (FIUDRT) https://fiudrt.org/ as one of the information resources.	Complete	Research	0	2009-ST-061-CI001	No	Data Mining	FALSE		Shu-Ching Chen	Florida International University	FL; IN		DHS Federal Emergency Management Agency; State and Local First Responders	2014		Case Studies; Modeling; Sampling; Statistical Analysis	Computer Science	Pilot/Field Testing and Evaluation in an Operational Environment
2	Resource Allocation	SP 15-Task 3: Event Evacuation Planning; Public Safety Coalition Projects	2010/04	2011/03	In collaboration with the Department of Justice, and several police departments, we have created a situationally-aware evacuation modeling and decision-making capability. This capability is developed in conjunction with the mobile 3D routing client-server system described in our report for MDRP 3. The evacuation model gives optimal evacuation routes based on number and distribution of building occupants. It can be applied to multiple urban buildings and the surrounding street network. The evacuation plan can be updated based on new events such as blocked exits or unexpected evacuee traffic. Since the thousands of times steps produced in a typical model run will be of limited immediate use to emergency responders, we are developing a method to automatically extract the key events in the evacuation model results (e.g., where and when key points of congestion occur around stairwells and exits) so that they can clearly see where to deploy responders and what to do. Through the command post of the client/server system multiple first responders can send location, search, images, evacuation status, and other information. Thus the system provides a detailed, comprehensive view of a large evacuation as it unfolds. Our goal is to show the constantly evolving, large scale first response and emergency evacuation scenario in an understandable way with key events identifiable. We are developing models for large arenas, conference facilities, and stadia that will be embedded in urban models.	Situationally-aware evacuation model with several building examples and ability to expand to new buildings. The model is available for use by DHS S&T stakeholders, customers, and to partners such as PNNL. We have begun to prepare for an evacuation exercise built around a scenario of a nuclear emergency at the McGuire Nuclear Power station, about 15 miles from the UNC Charlotte campus. Emergency planners and responders, including UNCC Police, Charlotte Mecklenburg Emergency Management, and FEMA observers, will use the on-campus field house as an evacuation site. The exercise will take place in Summer, 2011, and we will provide a report of results to DHS.	N/A	Complete	Research	23748	2009-ST-061-CI001	No	FALSE		William Ribarsky; William Ribarsky	University of North Carolina-Charlotte; University of North Carolina at Charlotte	NC	State and Local First Responders	2010				Operational Use
E	Education	SP 14 Task 3: Technical Integration into ExPOD at JIBC	2010/04	2011/03	The JIBC has been developing and conducting simulations for more than 30 years. Introduced by the JIBC, ExPod (Exercise Point of Delivery) is a virtual simulation-based learning tool that can be used to enhance any training or exercise program. And with its web-based format, ExPod can deliver immersive, interactive scenario-based training exercises anywhere, anytime. Over the past six years, the JIBC's computer simulations have become an integral and key delivery method for provincial, national, and international organizations ExPod can be integrated into any course, exercise or training program across the learning spectrum. This allows public safety teams participating in exercises to practice, test and critique operational plans and procedures as well as promoting interagency cooperation and group dynamics. ExPod works in the following manner: 1. Participants are divided into small pod groups and receive information via video/audio clips and computer communications. 2. Subject Matter Experts control exercises through web chat and video conferencing. 3. Pod groups work through scenarios by completing tasks and making decisions. 4. Individual pods can interact with each other or work independently, depending on the design and objectives of the exercise. 5. Key decisions are shared and discussed through virtual plenary sessions. 6. All activities are monitored and decisions/rationales are stored for future review.	Completed.	N/A	Complete	Research	5000	2009-ST-061-CI001	No	FALSE		David Ebert; Alan MacEachren	Purdue University; Pennsylvania State University	PA; IN							
1	Law Enforcement	Visual Analytics Law Enforcement Technology; Public Safety Coalition Projects	2010/01	2017/06	The exploration of criminal incident reports for detecting trends, discovering anomalies and evaluating resource usage is an ever-expanding issue for law enforcement agencies. As such, tools need to be developed that assist law enforcement officials in their analysis in order to take preventive measures and judiciously allocate available resources. In order to better facilitate crime incident analysis, we have developed a comprehensive visual analytics system for both PCs and mobile devices which provides police officials with access to their data on the fly. The application was developed for both the Windows PC environment and the Apples iOS platform and can run on any compatible devices including the iPhone, iPod, and iPad. Our system allows users to visualize data geo-spatially on a map and provides filtering tools that filter crime by the type of offense committed. The crime being visualized can additionally be filtered by time to analyze the correlation of different crimes with time. These set of tools enable the users to analyze data more efficiently and accurately wherever they are with limitations only to places without mobile signal coverage. Our system enables users to view a history of previous crime incidents and forecast a pattern of crime using automated algorithms. Moreover, the users have the ability to receive immediate feed of events. This is especially beneficial to first responders and allows them to better deal with any catastrophic situation.	On Friday, September 30, a demonstration of two new enhancements to the Visual Analytics Law Enforcement Toolkit (VALET) was provided to the Lafayette Police Department, West Lafayette PD and others. This presentation showcased how VALET filters through crime-related activities within various areas of our community and selects officers to be sent to the corresponding locations based upon their performance ranking. In general, these luncheons provided a forum to provide tool/technology updates and they were an opportunity to learn about the challenges of public safety officials.	N/A	In Progress		0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		David Ebert	Purdue University	AZ; IN		State and Local First Responders	2016		Modeling; Sampling; Statistical Analysis	Biostatistics and bioinformatics; Computer Science	Operational Use

1	Law Enforcement	MDRP 3: (GeoViz & CrimeViz) Situational Surveillance & In-field Criminal Investigative Analytics	2009/07	2013/06	GeoVISTA CrimeViz (Geovisual Analytics for Spatiotemporal Crime Analysis) is a web-based map application that supports exploration and analysis of criminal activity in space and time. The over-arching goal for the first year was to develop methods for combining syndromic surveillance data with detailed synthetic social network based epidemic simulations for improved state assessment, support of insight building and consequence analysis for decision makers. VACCINE developed novel methods for enabling event animation in map mashups and for more efficient web-map client server interaction. In addition, advances in spatio-temporal analysis methods have been achieved and integrated into the GeoVisToolkit. Discussions have been initiated with the Harrisburg Department of Police about transitioning our CrimeViz web mapping tool for representation and tracking of crime incidents. Work in this project focused on development and application of new exploratory visual analytic (EVA) mapping methods to support criminal investigative analytics. The team developed situational surveillance visual analytics tools to process large volumes of geographically referenced data searching for events of interest. This work will integrate the Visualization Sciences teams work into the Data Analytic teams work for the Port Authority of New York/New Jersey (PA NY/NJ). Emphasis was on methods and tools for making sense of and analyzing numerical and categorical data that contain geographic and temporal references, thus on understanding and visualizing the space-time dynamics on the phenomena investigated and on identifying and tracking change over time. Methods developed will be implemented in component-based software that support the mixing and matching of the	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).	N/A		Complete	Research	229728	2009-ST-061-CI001	No	Data Mining	FALSE		David Ebert, Alan MacEachren	Purdue University	IN; PA; VA; NJ	Academic Community; Center for Disease Control and Prevention; DHS Labs; DHS Science and Technology Directorate; State and Local First Responders		2013	Advanced Data Analysis and Visualization; Biological Threats and Countermeasures; Social, Behavioral, and Economic Sciences	Case Studies; Econometrics; Modeling; Molecular Biology/Genomics; Risk Assessment; Sampling; Statistical Analysis	Preparedness training; Computer Science; Risk management/assessment; Geography	Operational Use
1	Law Enforcement	MDRP 5: Cybersecurity Visual Analytics	2009/07	2010/03	While the frontline of cybersecurity is likely to always be computer-driven – leveraging pattern recognition, machine learning, and other highly automated techniques, these approaches are not sufficient. The adversaries in network security are intelligent and highly-motivated humans who continuously evolve new attack techniques to avoid any fixed defense. Network security analysts play a key role in proactively identifying and designing responses to new attacks or exposed weaknesses. Here, engaging the powerful pattern recognition abilities of the human visual system is essential in the analysis of the massive amounts of data involved. Thus, a focus of this project has been on developing tools for the frontline analysts. However, the complexity and scope of cybersecurity analytics requires the development of tools which move beyond simply visualizing the network traffic data. Successful tools must also provide a framework for developing higher-level semantic models to provide a simplifying level of abstraction, enabling greater analytic sophistication. To that end, VACCINE is coupling our tools to insights gained from basic research on network traffic data elements.	There are two major results for this year. First, VACCINE has made substantial progress in deploying one of their tools, Isis, at US-CERT Operations by convincing the group to acquire the necessary database infrastructure for interactive visual analytics (details below). The team has acquired independent funding for much of this transfer work, and hopes to have it completed within another year's time. If this effort is successful, they hope not only to have transferred technology to a DHS frontline unit, but also, and perhaps more importantly, to have learned what is involved in making such a transition from research to operations. The second result is the first fruit of our effort to understand the fundamentals of network traffic. The team has been able to use visual analytics and statistics to develop a principled understanding of SSH traffic. From that understanding, they have been able to develop an algorithm, which identifies packets carrying SSH keystrokes even though all SSH traffic is encrypted. This algorithm operates on the packet dynamics of any TCP connection. It has been constructed in a streaming fashion in order to make it practical for use on high-speed links.	N/A		Complete		308619	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		David Ebert	Purdue University	CA; IN	Academic Community; Critical Infrastructure Owners and Operators; DHS Labs; Intelligence Community		2010	Advanced Data Analysis and Visualization; Infrastructure Protection; Risk and Decision Sciences	Case Studies; Modeling; Statistical Analysis	Biostatistics and bioinformatics; Computer Science	Laboratory Testing and Evaluation
1	Law Enforcement	MDRP 7: Introducing Sustainable Visual Analytics into Command Center Environments	2009/07	2013/06	MDRP7 focuses on the development, fielding and maintenance of next-generation command and control environments. In their current stages of development, DHS command and control system initiatives such as Virtual USA and Watchkeeper focus primarily on delivering a common operating picture, a common communication platform and, occasionally, analytic support for key decisions. MDRP7 develops strategies and field demonstrations that extend these evolving capabilities by placing them in the context of two additional capabilities: (1) support for the ways the multi-stakeholder security community has chosen to work together (in the case of DHS systems, the NIMS Incident Command System) and (2) the sustainability of these systems based on stakeholder ownership, trust and, most importantly, the ability to achieve continuous improvement through actual use. The critical strength of NIMS/ICS is that it supports the integrated efforts of a community of diverse stakeholders managing a complex, evolving situation from diverse perspectives involving many different roles, responsibilities, decisions and actions. While NIMS/ICS provides a blueprint, the necessary level of coordination and communication can be difficult to achieve, especially given the many different agencies, organizations and units involved, each with its own mission, jurisdiction, processes, databases, systems and cultures. MDRP7 is working on next-generation CCI systems (what some call Precision Information Environments) that will provide critical information and communication capabilities within an environment that supports the unique, yet coordinated efforts of the diverse safety and security community. To support the many perspectives and roles within the security	Under an SBIR led by Truestone, Inc., we teamed with FAZD (Texas A&M) and VACCINE (Purdue) to deliver and assess the second iteration of a next-generation CCI system. Thanks to our ongoing collaboration with the Puget Sound Port Readiness Committee (PRC), we were able to plan and conduct a computer supported "worst-case" table-top exercise in the Fall using a "Truevue dashboard" to present the scenario and share information among the participants. There was general agreement within the PRC that there would be significant benefit from such an exercise, especially considering that there would be a change of command within the Army's 833rd Transportation Battalion during the summer. Completed.	N/A		Complete	Research	5080	2009-ST-061-CI001	No	Expert Consultation	FALSE		David Ebert	Purdue University	IN; TX; WA	Center for Disease Control and Prevention; Critical Infrastructure Owners and Operators; DHS U.S. Coast Guard; Federal Bureau of Investigation; State and Local First Responders		2010	Communications and Interoperability; Emergency Preparedness and Response; Human Factors Aspects of Technology	Case Studies; Modeling; Sampling; Statistical Analysis		
2	Resource Allocation	MDRP 9: (Rosetta Phone) Mobile Imaging, Rosetta Phone, and Light-Weight Visual Analytics for In-Field Analytics	2009/07	2013/06	The Rosetta Phone is a hand-held translation device for foreign text currently being developed by Purdue in collaboration with Next Wave Systems, LLC. The goal of this device is to enable an individual with little or no prior knowledge of foreign languages to recognize and translate foreign text in real time and without the use of a network connection. This particular project focuses on developing the methodology and software needed to enable the Rosetta Phone to automatically read and translate Spanish documents.	The project resulted in the DHS report we wrote that is available at: https://www.dhs.gov/publication/chicago-ltr-video-pilot-report. Completed.	N/A		Complete	Research	0	2009-ST-061-CI001	No	Bench Tests	FALSE		David Ebert	Purdue University	IN	Academic Community; Center for Disease Control and Prevention; Critical Infrastructure Owners and Operators; DHS U.S. Coast Guard; DHS U.S. Customs and Border Protection		2012	Advanced Data Analysis and Visualization; Biological Threats and Countermeasures; Border Security	Biometrics; Case Studies; Econometrics; Genomic Testing; Modeling; Molecular Biology/Genomics; Risk Assessment; Sampling; Statistical Analysis		
5	Financial Flows Tools	MDRP 11: Financial Fraud Visual Analytics	2009/07	2014/06	This projects goal is to develop and evaluate new visual analytics tools to explore and discover behaviors (suspicious behavior, emerging risk behavior) in financial transaction data. To uncover suspicious behavior, we are developing a set of tools based on a hierarchical data model for interactive exploration even with millions of transactions over up to a years time period. This approach uses multiple views of the transactional data to pinpoint suspicious behavior that would not be apparent with just one view. The analyst can then drill down to the particular account or related accounts (having the same keyword signatures) for detailed investigation. Emerging risk analysis is a much broader area that seeks to uncover emerging risk in the banks transactional, credit card, and loan portfolios that may not be adequately accounted for. The effect of the economic downturn and job losses in specific industries on unsecured loans for specific groups of customers is an example of such emerging risks. Tools such as those used for fraud analysis, geographic analysis tools, and tools to include and correlate multiple dimensions of behaviors and ratings are being developed or applied to this analysis. Emerging risks are important factors for resilience of financial institutions and the financial system.	A procedure for creating simulated bank transaction datasets has been developed. The WireVis tool for analyzing bank transactions over extended periods of time is available to DHS partners and customers. We are expanding its capabilities to analyze the unstructured text fields that accompany transactions and that describe the purpose of a transaction, identify payees, and give other information. There are currently no automated methods to study these fields and connect them to the transactional records.	Potential licensing to a government contractor.		Complete	Research	417775	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		William Ribarsky	University of North Carolina at Charlotte	IN; NC; MA	Academic Community; Consumers; Critical Infrastructure Owners and Operators; Federal Bureau of Investigation; Intelligence Community		2010	Advanced Data Analysis and Visualization; Infrastructure Protection; Social, Behavioral, and Economic Sciences	Case Studies; Econometrics; Modeling; Risk Assessment; Statistical Analysis	Computer Science	
4	Disease Surveillance	MDRP 12: Foreign Animal and Zoonotic Disease Visual Analytics	2009/07	2013/06	This work focuses on developing and applying new exploratory visual analytics (EVA) methods for spatial and space-time foreign animal and zoonotic disease data (e.g., data related to avian influenza, rift valley fever, swine flu, West Nile virus). The VACCINE team will extend their methods for spatial cluster and pattern analysis and their implementation. A key goal is to provide tools that help analysts clarify the spatial (and spatio-temporal) structure of foreign animal and zoonotic disease phenomena, thus leading to better disease outbreak prediction. In complementary work they will explore use of geographic information systems (GIS) to integrate disease, environmental, demographic, and other geographic data necessary to understand disease-environment and disease-human relationships. Initial work will focus on creating an initial prototype visual analytic system for Rift Valley Fever (RVF) tailored to two user groups: epidemiological modelers and decision makers. VACCINE efforts resulted in a suite of spatial analysis methods implemented in the GeoViz Toolkit that will lead to better understanding of diseases of zoonotic origin. These methods include interactive cluster detection, interactive spatial structure exploration (using Morans I), and space-time spatial structure exploration (using LISTA-Viz). These methods will be applied against the West Nile virus dataset to investigate virus distribution over space and time. Grant activities also included sorting and aggregating Pennsylvania mosquito data to allow for efficient data viewing through web-based application at weekly/monthly/yearly intervals. This has also been done for daily climate information. The year with the worst WNV-positive mosquitoes as well as the most number of reported human cases was used for preliminary testing of a web	The team has developed a new strategy for visualization coordination through the combination of several recent advances in software engineering: automatic introspection of objects, software design patterns, and reflective invocation of methods. This strategy is called Introspective Observer Coordination and demonstrates how this method can allow end users to create their own visualization toolkits on the fly, solve challenges associated with coupling spatial analysis methods to geovisualization methods, and make geovisualization applications sharable between users.			Complete	Research	19320	2009-ST-061-CI001	Yes	Compiling and Sorting Database	FALSE		David Ebert	Purdue University	TX; IN; PA	Academic Community; Center for Disease Control and Prevention; Critical Infrastructure Owners and Operators; Food and Agriculture Industries; State and Local Transportation		2009	Advanced Data Analysis and Visualization; Biological Threats and Countermeasures; Risk and Decision Sciences	Biometrics; Case Studies; Econometrics; Genomic Testing; Modeling; Molecular Biology/Genomics; Risk Assessment; Sampling; Statistical Analysis	Risk management/assessment	Operational Use
1	Law Enforcement	MDRP 13: GeoJunction: Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	2009/07	2013/03	This project focuses on developing, implementing, assessing, and transitioning methods and tools to (a) help analysts, crisis managers, and policy makers find and contextualize relevant multimodal information quickly and (b) to support the situation awareness (SA) that is required to interpret evidence and make decisions in a continually changing environment. Specifically, GeoJunction is conceived as a knowledge-enabled, place-time aware, and computationally enhanced web-based environment that supports visually-enabled: (a) document query filtered by place, time, person/organization, and concept, (b) collaborative information foraging, entity and relation extraction, and contextualization, (c) exploration of connections between social and geographic networks, and (d) situation assessment and monitoring with continually updating information	1. Scalable visual analytic toolkit SensePlace2. a. Scalability ensured by innovative database design, indexing that allows large-scale storage and retrieval of social text streams such as those obtained Twitter. b. Improved algorithms to geo-code mentions of location names in social text streams in the presence of limited contextual information. 2. Timeline functionality that allows for range queries for temporal attributes. 3. Improved user interaction functionality 4. Clustering of similar tweets in order to enable improved examination of topics being tweeted. 5. With complementary funding from USACE, we developed methods to flexibly access geographic information using the standard Geonames hierarchy of place names for the world.	N/A		Complete	Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		David Ebert, Alan MacEachren	Purdue University	IN; CA; PA	Center for Command, Control, and Interoperability Center for Advanced Data Analysis	U.S. Army Corps of Engineers	2011		Case Studies; Sampling; Statistical Analysis	Computer Science	Laboratory Testing and Evaluation

1	Law Enforcement	MDRP 14: Multimedia Visual Analytics for Investigative Analysis	2009/07	2014/06	The project applies visual analytics methods to a range of problems of significance to DHS. In each case one or more tools or products are produced. In several instances, the tools are deployed to stakeholders. Capabilities produced include: Multimedia analytics methods applied to unstructured collections of images, video, and text. In some cases, a full multimedia fusion is attained. Texts in any language can be handled. Topic streams are identified and events within the stream of text or other media are indicated. Narratives can be constructed. Tens of thousands of documents can be organized and their interrelations and trends understood in this way. The methods have been applied to document collections, media streams, online news, social media, blogs, and other content. Mobile emergency response and emergency evacuation tools for urban environments have been developed and deployed. These tools are situationally aware; they can be updated immediately based on blocked exits, blocked paths, unexpected distribution of people, etc. Search, apprehension, and rescue tasks can be carried out where the command center and deployed officers are in full communication as to position and actions. A novel capability has been developed to provide decision support to commanders in complex emergency response situations as they evolve. Risk analytics capabilities have been applied to large and multi-faceted financial resources, such as at a major bank or under the jurisdiction of a major government agency. A fast access data structure has been set up for exploratory risk analysis involving several financial and geographic attributes of the users choosing. A system of systems model has been set up for understanding an urban electric smart grid infrastructure	Our image analytics and exploration tools and source code are released to users at PNNL. They are available to customers in DHS S&T, if desired. Our automatic object detection and classification tools and source code are released to Vufind.com. They are available to customers in DHS S&T, if desired. Our multimedia analytics tools including StreamIt, Newdle, and PIWI are available to DHS S&T stakeholders and customers. Our systems on multimedia analytics have been demonstrated at multiple leading conferences and institutes.		Complete		Research	0	2009-ST-061-CI001	No	Data Mining	FALSE	David Ebert	Purdue University		IN; NC		Academic Community; DHS Labs; DHS Science and Technology Directorate; Federal Bureau of Investigation; Intelligence Community	2010	Advanced Data Analysis and Visualization; Biological Threats and Countermeasures; Border Security	Case Studies; Modeling; Sampling; Statistical Analysis	Computer Science	
2	Resource Allocation	MDRP 18: Visual Analytics for the DHS Centers of Excellence	2009/07	2012/06	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 thoughts. 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. The VACCINE team will 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. This project will develop 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. These visualizations will be easy to expand with future data without requiring redesign or rebuilding.	Journal articles and presentations were completed.	N/A	Complete		Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE	David Ebert	Purdue University		CA; IL; IN; GA; NJ		Academic Community	2010		Case Studies; Statistical Analysis		
1	Law Enforcement	MDRP 17: START Center Visual Analytics	2009/07	2010/03	The START Center of Excellence at the University of Maryland has collected large amounts of data on terrorism and terrorism response, such as incident event timelines, social networks of terrorist organizations, and studies on international terrorism and preparedness, but these datasets can be difficult to overview and analyze effectively. This complexity and scale pose a barrier when exposing these datasets to the intelligence and defense communities, as well as the general public. In this project, the VACCINE team collaborated with START members in applying visual analytics techniques to their data in a user-centered design methodology intended to elicit their particular needs and requirements for visualizing this data. Particular objectives included entity resolution for detecting duplicates in the Global Terrorism Database (GTD), as well as spatiotemporal visualization for the Minorities at Risk database	Journal articles were completed. Demonstrated collaboration between COEs.	N/A	Withdrawn		Research	5429	2009-ST-061-CI001	No	Bench Tests	FALSE	David Ebert	Purdue University		MD; NC; IN; NJ	National Consortium for the Study of Terrorism and Responses to Terrorism	Academic Community; DHS Labs; DHS Science and Technology Directorate; DHS U.S. Customs and Border Protection; Federal Bureau of Investigation	2009	Advanced Data Analysis and Visualization; Human Factors Aspects of Technology; Social, Behavioral, and Economic Sciences	Case Studies; Modeling; Statistical Analysis	Computer Science	
E	Education	EP 1: Leadership and Coordination	2009/07	2014/06	This project has been intentionally closed because it is considered an umbrella project that encompasses the general education program. The other education projects in progress reflect the current status of the education program**** The main objective during the initial period was to develop an innovative and coherent education plan that spans across the individual members schools of the VACCINE center that also work in coordination with the Rutgers-led Data Analysis Center. The team sought to develop curricula and courses for visual analytics that could be used as examples and templates at different schools. Working together with colleagues at Purdue, Dr. Stasko oversaw the strategic mission and efforts in the educational programs of the VACCINE Center. He was involved with all of the educational programs and missions, and represents the Center at various activities. His particular responsibilities during the period included participating and teaching in the RECONNECT summer school session led by the CICCADA Center, oversaw the Affinity Education Research Groups, maintained the Visual Analytics Digital Library, and participated at the education meeting of the DHS University Summit	1. The Project PI and support faculty member visited Purdue University in November to work on the Education Plan. 2. The Project PI and support faculty member participated in monthly education conference calls as well as the collaboration calls with Rutgers University. 3. The 2010 ADMI/A4RC conference was held on April 8-11, 2010 in Jackson, MS. VACCINE was spotlighted in two conference sessions and the evening Social Networking Event.	N/A	Complete		Research	0	2009-ST-061-CI001	No	Bench Tests	FALSE	David Ebert	Purdue University		NJ; GA; IN; MS; TX			2009	Advanced Data Analysis and Visualization; Biological Threats and Countermeasures; Border Security	Biometrics; Case Studies; Econometrics; Genomic Testing; Modeling; Molecular Biology/Genomics; Risk Assessment; Sampling	Computer Science	
E	Education	EP 2: MSI Collaboration	2009/07	2016/06	The VACCINE Center is deeply engaged in developing several successful programs for Minority Serving Institutions (MSI). VACCINE fosters an education program to expand the teaching of visual analytics at Minority Serving Institutions (MSI). The program focuses on preparing MSI faculty to incorporate visual analytics courses into their programs. Learning topics and activities in the workshops focus on: understanding the theory and foundation of visual analytics, integrating visual analytics into course curriculum, developing learning communities for interdisciplinary courses, hands-on instructor-supported tutorials on extracting various forms of big data, and a unique group-designed application learning assignment. In an effort to engage faculty and students from minority serving institutions with the science of visual analytics, VACCINE also participates in the DHS sponsored Summer Research Team (SRT) program which offers summer research opportunities that allows a faculty/student team to conduct research on campus at the VACCINE research lab. VACCINE also provides a 1-2 week visual analytics boot camp for a group of undergraduate students from our partner school Morgan State University. VACCINE student-led demonstrations of our tools and technology gave the MSU students the opportunity to get hands-on with VACCINE resources and the ability to ask questions about the center's research.	2015 Visual Analytics Faculty Workshop - Bethune-Cookman University - June 18, 2015 - June 19, 2015 - MSI Summer Research Workshop for Morgan State University undergrads - July 19, 2015 to July 25, 2015 - VACCINE center was host to six undergraduate students from MSI partner Morgan State University (MSU). The students were housed on-campus at Purdue University and engaged in activities and presentations that helped them to better understand visual analytics and its real-world applications. DHS - Summer Research Team (SRT) for Minority Serving Institutions (MSI). - May 25, 2015 - July 31, 2015 - Dr. Louis Ngamassi, a College of Business professor at Prairie View A&M University, successfully completed the SRT Program in the summer of 2015.	With the support of the VACCINE Center, Ngamassi is incorporating visual analytics into a new course he is developing entitled "Crisis Informatics."	Complete	Big Data Visual Analytics	Research	264029	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE	David Ebert	Purdue University	Bethune-Cookman College; Jackson State University; Morgan State University	FL; MD; MS; IN; NJ; TX; CA		Critical Infrastructure Owners and Operators; Department of Energy National Labs; Federal Bureau of Investigation; Food and Agriculture Industries; State and Local First Responders	2015	Advanced Data Analysis and Visualization; Biological Threats and Countermeasures; Chemical Threats and Countermeasures	Biometrics; Case Studies; Econometrics; Genomic Testing; Modeling; Molecular Biology/Genomics; Risk Assessment; Sampling; Statistical Analysis	Computer Science	
E	Education	EP 4: SURF Program (Summer Undergraduate Research Fellowships)	2009/07	2016/06	VACCINE hosts a group of students every summer as a part of Purdue University's SURF Program. This program helps undergrad students across the various disciplines of science, technology, engineering and math discover once in a lifetime opportunities available through research. The program allows students to conduct their research and work closely with our graduate students and research assistants in the VACCINE research laboratory, and it gives them the ability to explore, discover, and transform ideas into reality. The selected students go through an in-depth application process in which once accepted, are then actively engaged during the 10 week program, which not only offers them hands on research experience, but prepares them in other areas such as professional development, research seminars, and how to present their findings in a professional manner. The SURF program has produced invaluable assets to our lab and its research. Once the program reached completion, several outstanding students throughout the years have stayed on as research assistants, winning awards and even becoming a VACCINE Center Research Scientist.	VACCINE was host to 5 undergraduate students for the Purdue led SURF program which ran from May 26, 2015 - August 7, 2015. Since the time the summer program began, the students' understanding of visual analytics was greatly enhanced, and the students were able to learn about the vast uses and applications of the field. The SURF students were given the opportunity to immerse themselves in the VACCINE laboratory and research environment and work closely with other VACCINE HS-STEM and research assistants. Students worked on VACCINE projects and technology throughout their summer fellowship, which concluded with a poster presentation of their summer's research at the annual SURF Symposium on August 6th. For Mahesh Babu Gorantla, this poster presentation proved rewarding, as his poster was selected among the top ten posters of all the Purdue SURF research projects. Gorantla worked closely with other students in the VACCINE lab to come up with a solution for the VAST Challenge, a competition that involves finding visual analytic approaches to solve to hypothetical, real-world problems. Once the program was complete, two of the SURF students stayed on as RA's continuing to work in the VACCINE lab.	N/A	Complete	Big Data Visual Analytics		183686	2009-ST-061-CI001	No		FALSE	David Ebert	Purdue University	Jackson State University	MS; IN		Academic Community	2015	Advanced Data Analysis and Visualization		Classroom Education	
E	Education	EP 5: Graduate Programs	2009/07	2015/12	For reporting purposes, this work is reflected in and has been combined with the HS STEM project.**** This component of the education mission involves graduate programs and education at the VACCINE Center. One specific goal of this project was to promote and coordinate graduate courses and programs at the VACCINE member universities and beyond. The Center gathered and maintained a list of related courses already being taught at our universities. Also, together with colleagues from the FODAVA Center and NVAC, the team created and publicized a Body of Knowledge for visual analytics.	The team gathered an initial list of courses and education programs at our member universities, but they have not made this into web pages for the VACCINE website yet. In the current educational climate of limited budgets and expansion, the team decided not to spend time developing a new visual analytics course or Masters degree. We created the body-of-knowledge and posted it on a website at Georgia Institute of Technology for members of the visual analytics community to comment on. It is unclear what next steps this project will take. We are planning to hold a one-day workshop on visual analytics courses and curricula in conjunction with the NVAC Consortium Meeting on August 30, 2010.		Complete		Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE	David Ebert	Purdue University		GA; IN		Academic Community	2009	Advanced Data Analysis and Visualization	Case Studies	Computer Science	
E	Education	EP 6: HS-STEM Career Development Program	2009/07	2017/07	The HS-STEM Career Development program is a competitive program funded through DHS that was established at Purdue in 2007. This program is designed to support graduate students in developing the skills to become preeminent scientists in the homeland security and technical communities. This United States Department of Homeland Security funded program offers career development scholarships and fellowships, as well as forgivable loans with summer research opportunities and one year service commitments. The goal is to aid students in professional development by offering assistance in grant writing, resume prepardness, poster presentations, and leadership skills. We also encourage our students to participate in internship opportunities within the DHS Components.	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 Dr. David Ebert. Monthly HS STEM lunches are provided in order to offer learning and networking opportunities for students with various disciplines, but who all share an interest in Homeland Security. This is a time for students to discuss their career aspirations and status, and determine if their plans are consistent with a career in homeland security. Additionally, students are required to submit semester reports and updates on their research and any service in which they are participating. The VACCINE team, encourages the HS STEM Fellows to serve as research assistants in the VACCINE lab if they are qualified. This initiative began in the fall of 2014, and it is expected they will have a more direct understanding of Homeland Security as a result of their participation on VACCINE projects. The following is a brief description of each HS STEM Fellow: Phillip Forsberg successfully completed the program and graduated in August of 2016. His year of service was fulfilled by working full-time at Pacific Northwest National Laboratory (PNNL) at the Department of Energy in Washington DC. He worked within NA-14, the Office of Decision Support, within Defense Programs (NA-10). They are responsible for directing the safe, secure, and effective operation of nation's nuclear stockpile. At the end of his year of service, he was offered a permanent position as a federal employee at the Department of Energy. Scott Carr passed his preliminary exams. He is currently working on his thesis, and Scott is on track to graduate in December 2016. His accomplishments include a paper accepted to Network and Distributed Systems Security Symposium, a top tier cybersecurity conference, and he submitted a paper to Computer and Communications Security Symposium 2016. Scott was awarded the Network and Distributed Systems Security Symposium Travel Grant. During the spring semester, Scott interned at Mozilla in San Francisco, CA where he worked on the Rust programming language compiler. Rust is a system programming language designed to increase the security and	None. Last HS-STEM student funding has been transferred.	In Progress		Research	431090	2009-ST-061-CI001	No		FALSE	David Ebert	Purdue University		IN	Center for Visual Analytics for Command, Control, and Interoperability Environments	Academic Community	2016	Advanced Data Analysis and Visualization; Biological Threats and Countermeasures; Border Security		Classroom Education	Basic Research

E	Education	EP 7: Professional Development	2009/07	2017/06	VACCINE continues to work on professional training strategies for local, state, tribal and federal emergency responders and officials by providing on-line training programs, workshops and short courses on data and visual analytics. VACCINE and American Military University collaborate to present a bi-monthly webinar series which are in coordination with the framework of The National Conversation on Homeland Security Technology created by DHS S&T. Webinars will focus on a specific structured dialogue topic related to homeland security technology in an effort to get people talking about problems, challenges, and solutions to keep our country safe. VACCINE also fosters an education program to expand the teaching of visual analytics at Minority Serving Institutions (MSI) which prepares MSI faculty to incorporate visual analytics courses into their programs. Learning topics and activities in the workshops focus on: understanding the theory and foundation of visual analytics, integrating visual analytics into course curriculum, developing learning communities for interdisciplinary courses, hands-on instructor-supported tutorials on extracting various forms of big data, and a unique group-designed application learning assignment. VACCINE continues to support the DHS MSI SRT program which offers summer research opportunities for an MSI faculty/student team to conduct their research at the VACCINE lab. VACCINE and the United States Air Force Academy (USAFA) are working together to develop a workshop to create scientific visual analytics learning modules that can be integrating into core curriculum at USAFA with the intent to expand to the United States Coast Guard Academy as well. VACCINE and its scientific researchers will work closely with faculty from USAFA and	VACCINE Center/American Military University Bi- Monthly Webinar Series The webinar series launched July 31, 2015 and we currently have over 500 Registrants. Previous webinar topics include: 1. Decision Making and Counter Terrorism: How the Visual Analytics of Data Can Help Save Lives, presented by VACCINE Center PI Dennis Thom, Ph.D., The Institute for Visualization & Interactive Systems, University of Stuttgart, & James Hess, Ph.D., Faculty Director & Associate Professor, School of Security & Global Studies, AMU. 2. Visual Analytics: A Case for Ethical Decision Making, presented by Abish Malik, Ph.D., Research Scientist, VACCINE Center, & Charles M. Russo, Intelligence Analyst & Certified Adjunct Faculty Member, FBI, AMU. 3. Maritime Smuggling: How Technology Can Disrupt the Network, presented by Dr. Edward Delp, Professor of Electrical and Computer Engineering, Purdue University, & Dr. Joe DiRenzo, Professor of Intelligence Studies, AMU. MSI Visual Analytics Faculty Workshop The 2015 MSI Faculty Workshop was hosted at Bethune-Cookman University in Daytona Beach Florida on June 17th and 18th with 24 faculty in attendance. A welcome reception was held the night before on the 17th. The workshop was also attended by Stephanie Willett from DHS. The 2016 MSI Faculty Workshop will be hosted at Florida International University in May with planning in progress. DHS MSI Summer Research Team Program (SRT) Dr. Louis Ngamassi, a College of Business professor at Prairie View A&M University, successfully completed the SRT Program in the summer of 2015. With the support of the VACCINE Center.	Ngamassi is incorporating visual analytics into a new course he is developing entitled "Crisis Informatics."	In Progress	Big Data Visual Analytics	Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		David Ebert	Purdue University	Jackson State University; University of Houston-Downtown; Bethune-Cookman College	IN; NJ; GA	State and Local First Responders ; State and Local Public Health Agencies		2015	Advanced Data Analysis and Visualization	Case Studies; Qualitative Analysis; Risk Assessment	Classroom Education	Basic Research
E	Education	EP 8: (VADL) Educational Materials	2009/07	2010/12	The project status has been changed to "complete." It is no longer an active project. Please see executive summary for details.**** Georgia Institute of Technology presently maintains the Visual Analytics Digital Library (VADL) for storing and presenting educational materials in visual analytics. The VADL includes a wide variety of materials including lectures, lecture notes, lecture slides, related papers, exams, exercises, course outlines, etc. In this project, the team will continue to maintain and enhance the VADL and the materials contained within. http://vadl.cc.gatech.edu	The Visual Analytics Digital Library (VADL) provided a website that contained a variety of resources for the visual analytics education community including class syllabi, sample exams, video lectures, lecture notes and so on. The project helped boot-strap a variety of educational program efforts across different universities by providing a shared resource repository that could be tapped for assistance. As the area matured and more information about visual analytics became prevalent across the web, the need for the VADL lessened, and we eventually stopped updating and supporting the site.	N/A		Complete		Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		David Ebert	Purdue University		GA; IN	Academic Community		2010	Advanced Data Analysis and Visualization	Statistical Analysis	Classroom Education	
1	Law Enforcement	Video Surveillance Visual Analytics	2009/07	2012/06	The goal of this project is to automatically determine the threat behavior exhibited by individuals or groups of people by observing them via surveillance video. We will accomplish this by extending some of our previous work in real-time object tracking. We will first track the individual(s) and observe how they move in the scene. For example are they walking patterns such as circling a particular position? Are they trying to minimize their cross sectional area by squatting? Are they turning their heads a lot to see if someone is looking at them? We will catalog a group of these types of behavior patterns to be used to analyze the video. One other issue that needs to be addressed is the determination of the quality and type of the video surveillance system that is required to be able to do this type of analysis.		This project was concluded.		Complete			0	2009-ST-061-CI001	No		FALSE		Ed Delp	Purdue University		IN							
1	Law Enforcement	MDRP 1: Geovisual Analytics	2009/07	2010/03	The goal of Pennsylvania State University with this work was to enable analysts to forage for and make sense of place-relevant information extracted from text documents linked to formal geographic information. The visual analytic system developed can retrieve and process text documents, identify information of interest, present the information via an interactive visual interface, interactively record analyst-provided information and update the visually presented information to assist the analyst. Applications include monitoring the news media to track mass movement of people in response to events and monitoring Twitter feeds as input to investigative analysis. One component of the research has resulted in a prototype web application, SensePlace. The scientific goal of SensePlace is to visually and computationally support analyst sensemaking with text artifacts that have potential place, time, and thematic relevance to an analytical problem through identification and visual highlighting of named-entities (people, places, times, and organizations) in documents, automated inference to determine document relevance using stored knowledge, and a visual interface with tightly coupled geographic map, timeline, and concept graph displays used to contextualize potentially relevant documents. The team developed techniques and tools for investigative analysis on large collections of documents including both unstructured text and structured documents (e.g., spreadsheets). They developed systems that use interactive visualizations to help analysts with performing exploration, sense-making, and understanding tasks. If they could help analysts determine which documents to read first and to also find important, connected documents, then they could help them to make timelier and accurate assessments	The team developed techniques and tools for investigative analysis on large collections of documents including both unstructured text and structured documents (e.g., spreadsheets). They developed systems that use interactive visualizations to help analysts with performing exploration, sense-making, and understanding tasks. If they could help analysts determine which documents to read first and to also find important, connected documents, then they could help them to make timelier and accurate assessments of the situations described within those documents. The project builds upon the Jigsaw system, and explores how new capabilities can be added to it. They also planned to disseminate the system for use by real clients, people, and organizations in various domains.	N/A		Complete		Research	399808	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		John Stasko	Georgia Institute of Technology		GA; IN; PA; CA				Advanced Data Analysis and Visualization; Human Factors Aspects of Technology	Case Studies; Sampling; Statistical Analysis		
1	Law Enforcement	ISIS - Infovis System for Investigating Intrusions	2009/07	2011/06	ISIS - Infovis System for Investigating Intrusions represents new interactive visualization techniques for analyzing, organizing, and presenting network event data at multiple levels of detail for the purpose of forensic analysis - tracking down causal sequences of importance. Isis allows analysts conducting network security investigations to construct narratives of an incident.	Summary of Transition and Deployment: ISIS - Infovis System for Investigating Intrusions (Stanford) • Awaiting deployment to US CERT A California-based proof of concept application of the TransNEMO modelling approach was prompted by interest from the California Department of Transportation in concert with the National Center for Metropolitan Transportation Research (METRANS).	N/A		Complete	Information-driven Visualization, Modeling and Simulation of Data	Research	0	2009-ST-061-CI001	No		FALSE		Patrick Hanrahan; Pat Hanrahan	Office of University Programs, Science & Technology Directorate		CA			2011				
E	Education	VACCINE Affinity Research Groups	2009/07	2012/06	VACCINE Affinity Research Groups	Twenty-six undergraduate students, including 14 supported students, from Univ. of Houston-Downtown, Navajo Tech and Cal State-Dominguez Hills participated in the VACCINE Affinity Research Groups organized by Richard Alo. These were students from a combination of statistics, math and computer science. As a result of participation in this project, students gained research and collaboration experience and submitted posters and publications for the Student Research Day Conference at Cal State-Dominguez Hills.	N/A		Complete		Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE		Richard Alo; Richard Alo	University of Houston-Downtown; University of Houston-Downtown	University of Houston-Downtown	IN; TX; CA			2011		Statistical Analysis	Biostatistics and bioinformatics; Computer Science; Mathematics
2	Resource Allocation	Developing a Sustainable Visual Analytics for Command Center Environments	2009/07	2011/03	Mark Haselkorn, University of Washington MDRP7 focuses on the development, fielding and maintenance of next-generation command and control environments. In their current stages of development, DHS command and control system initiatives such as Virtual USA and WatchKeeper focus primarily on delivering a common operating picture, a common communication platform and, occasionally, analytic support for key decisions. MDRP7 develops strategies and field demonstrations that extend these evolving capabilities by placing them in the context of two additional capabilities: (1) support for the ways the multi-stakeholder security community has chosen to work together (in the case of DHS systems, the NIMS Incident Command System) and (2) the sustainability of these systems based on stakeholder ownership, trust and, most importantly, the ability to achieve continuous improvement through actual use. The critical strength of NIMS/ICS is that it supports the integrated efforts of a community of diverse stakeholders managing a complex, evolving situation from diverse perspectives involving many different roles, responsibilities, decisions and actions. While NIMS/ICS provides a blueprint, the necessary level of coordination and communication can be difficult to achieve, especially given the many different agencies, organizations and units involved, each with its own mission, jurisdiction, processes, databases, systems and cultures. MDRP7 is working on next-generation CCI systems (what some call "Precision Information Environments") that will provide critical information and communication capabilities within an environment that supports the unique yet coordinated efforts of the diverse safety and security community. To support the many perspectives and roles within the security		N/A		Complete		Research	0	2009-ST-061-CI001	No		FALSE		Mark Haselkorn; Mark Haselkorn	University of Washington; University of Washington		WA							
2	Resource Allocation	Enhancing Interactive Visual Analysis and Decision Making Environments	2009/07	2010/06	Visual analytic and decision making environments can best be enhanced by placing the work and information flow at the center of design and development. We worked with the U.S. Coast Guard, Sector Puget Sound, to understand and model their emergency response workflow and apply that to the design and development of visual analytic tools to support that workflow. With only $5K of funding during this period, we could only begin the trust building and knowledge acquisition phases of this work. There have been no expenditures of VACCINE funding since June of 2011. We leveraged our role in VACCINE to establish our role with the National Center for Cognitive Informatics and Decision Making in Healthcare, under the DHHS SMART Program. Therefore, our effort during this period focused on workflow modeling and decision making in healthcare environments.	We have gained significant understanding of Coast Guard workflow and decision making and have established a trust relationship with Coast Guard Sector Puget Sound Leadership. We are positioned to engage in a visual analytic demonstration project should funding be available. Under separate, leveraged, funding, our current focus is in the area of healthcare. We have successfully modeled workflow in a clinical environment and used that to work with practitioners in the design and development of a mobile application that enhances communication between patients and healthcare providers. That application, called Priority Contact, is being piloted in the sandbox environment of the Veterans Healthcare Administration. Under separate, leveraged, funding, our current focus is in the area of healthcare. We have successfully modeled workflow in a clinical environment and used that to work with practitioners in the design and development of a mobile application that enhances communication between patients and healthcare providers. That application, called Priority Contact, is being piloted in the sandbox environment of the Veterans Healthcare Administration.	More funding is needed.		Complete		Research	0	2009-ST-061-CI001	No	Expert Consultation	FALSE		Mark Haselkorn	University of Washington		WA	DHS U.S. Coast Guard		2011		Modeling	Engineering	
4	Disease Surveillance	PariViz	2009/07	2011/06	PariViz provides public health officials with a suite of visual analytic tools for analyzing the spread of a pandemic influenza. Mission Need On November 1st, 2005 the National Strategy for Pandemic Influenza was issued as a guide for our nation's preparedness and response to an influenza pandemic with the intent of (1) stopping, slowing or otherwise limiting the spread of a pandemic to the United States; (2) limiting the domestic spread of a pandemic, and mitigating disease, suffering and death; and (3) sustaining infrastructure and mitigating impact to the economy and the functioning of society. In order to help public health officials better understand these charges, we have developed the PariViz toolkit. Through the application of the Indiana State Pandemic Influenza Planning Tool developed by partners at the Pacific Northwest National Laboratory, we simulate a pandemic outbreak originating in Chicago, IL with attack and mortality rates similar to the 1918 pandemic. Our PariViz tool allows officials to track the spread of influenza across the state of Indiana and implement various decision measures at any time during the pandemic. These decision measures can be toggled on and off to allow users to better understand their effects on different county populations. Demographic filtering is also available for various age ranges, and interactive manipulation of model parameters allow users to create various levels of pandemic severity in order to assess various situations. By using this tool, officials can analyze resources and decision outcomes in order to prepare more effective measures for potential pandemics.	VACCINE developed an interactive pandemic preparedness, surveillance, and training tool for the Indiana State Department of Health and adapted this tool for use by the State of Washington, New Jersey, and New York. This has been used for all health districts in Indiana and at least two county exercises in the state of Washington.	N/A		Complete		Research	0	2009-ST-061-CI001	No		FALSE		David Ebert	Purdue University		IN; NC; PA; WA			2011				
E	Education	PURVAC RVF	2009/07	2011/06					Complete		Research	0	2009-ST-061-CI001	No		FALSE		David Ebert	Purdue University									

1	Law Enforcement	MDRP 2: Integrate Automated Analytical Reasoning into Jigsaw	2009/07	2010/06	The objective of this project is to develop and integrate more automated analysis and reasoning capabilities into the Jigsaw system. Presently, as a visual analytics system, Jigsaw is heavy on the visualization aspect and the analyst explores the document collection manually. While VACCINE believes there is much value in this, the team would like to integrate more automated reasoning and analysis capabilities into the system as well. So, for instance, the system might suggest hypotheses about the documents, it might help the analysts confirm/refute hypotheses they have developed, or it might simply suggest avenues to explore more. The team will explore how Jigsaw can be combined with the STAB system also created at Georgia Institute of Technology, which provides these types of automated analysis capabilities. Such a task will be challenging, because the two systems were implemented in completely different environments and with very different data models. Here, the team plans to see if these two approaches can be combined, and then will use an example document collection as a case study.	This project produced a system prototype that combined the Jigsaw system with capabilities from the STAB system. We experimented with this prototype to learn more about its possibilities. Unfortunately, the prototpye system never reached a level of quality in terms of its automated analysis suggestions for us to consider releasing it with the regular Jigsaw system.	N/A	Complete	Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE	John Stasko	Georgia Institute of Technology	GA		Academic Community; DHS Science and Technology Directorate; Federal Bureau of Investigation; Intelligence Community	2009	Advanced Data Analysis and Visualization	Case Studies; Sampling	Computer Science	
1	Law Enforcement	SP 1: Improving Query Performance in Large Scale Analytic Databases	2009/07	2011/06	United States Customs and Border Patrol need to cope with an ever-increasing volume of cargo data. This data was derived from sources such as shipping manifests and United States Coast Guard Notice of Arrival documents, which contain details on the who, what, when, and where of shipments and are stored in a large Oracle database. This database was and is used by intelligence analysts to detect suspicious cargoes. As the size of the database continues to grow rapidly, the queries which are used to extract the data have slowed down. Since the analysts need timely responses in order to be effective, our projects goal is to improve this query performance by applying visual analytic techniques to illuminate its causes and then developing remedies		N/A	Complete	Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE	Patrick Hanrahan; Pat Hanrahan	Stanford University; Stanford University	CA		DHS National Protection & Programs Directorate; DHS U.S. Coast Guard	2009	Advanced Data Analysis and Visualization; Border Security; Maritime and Port Security	Case Studies	Computer Science	
1	Law Enforcement	Situation Surveillance & In-field Criminal Investigative Analytics; Public Safety Coalition Projects	2009/07	2010/03	In collaboration with the Department of Justice, PNNL, David Ebert and his group, and several police departments, we have been building new capabilities on a mobile application that is being used for urban routing (taking into account blockages), remote data gathering, communication between emergency responders, and emergency evacuation. A complete GIS-based, client-server system has been developed with a command center interface and multiple mobile devices. A situationally aware evacuation model has also been developed that can be updated based on new obstacles and current conditions. We have developed semi-automated methods to derive routing graphs for large buildings from CAD files, and have now built 3D routing graphs for the entire UNC Charlotte campus (and other buildings with our collaborators). We have developed evaluations of the mobile routing system in action and are now working on multiple testbed exercises with Police partners, nuclear evacuation planners, and PNNL. We have developed a first version of a visual analytics tool for management, understanding, and action for collections of surveillance videos. As with our other visual analytics methods, this tool is a tight integration of automated methods and interactive displays. It identifies boundary frames at the beginning or end of events, provides a level of understanding of events, and permits tracking of moving individuals or objects. We are building towards better automation and better ways of inserting human understanding and direction so that an operator act upon large surveillance video collections. We will share these tools with and get feedback from DHS managers and law enforcement personnel.	We worked on incorporating our urban routing and emergency response system into the Canada- US Experiment Emergency Resiliency Environment (CAUSE –ERE) scenario set for demonstration at the end of June. Joe Kielman and other DHS managers will be in attendance for the experiment. The initial experiment involves an earthquake in the Pacific Northwest spanning the U.S.-Canada border. Our system will be used for mobile emergency routing and situational awareness in a downtown Seattle building. We prepared a shooter exercise for a campus building. In this exercise, a person with a gun takes hostages in a campus building. Ultimately, the person is cornered and barricaded in the building. A campus lockdown results from the incident. This is a re-running of a similar exercise that took place 1.5 years ago in which UNCC Police, Charlotte Police, emergency medical responders, hostage negotiators, and the university executive team took part. One objective of the current exercise is to use the new capabilities of the mobile urban emergency response and evacuation system to address some of the shortcomings uncovered in the previous exercise. Among the issues uncovered were the lack of situational awareness by the executive team (which must make campus-wide decisions) and the lack of a process to manage lifting of the campus-wide lockdown. The UNCC Police will participate in the current exercise and Charlotte Police will be invited as observers.	N/A	Complete	Research	0	2009-ST-061-CI001	No	Compiling and Sorting Database	FALSE	William Ribarsky	University of North Carolina at Charlotte	NC; IN; NJ; PA; VA		State and Local First Responders	2010		Biometrics; Case Studies; Econometrics; Modeling; Molecular Biology/Genomics; Risk Assessment; Sampling; Statistical Analysis	Geography; Information Science	
1	Law Enforcement	(Jigsaw) Visual Analytics for Investigative Analysis on Text Documents	2009/06	2017/06	The goal of this project was to develop techniques and tools for investigative analysis on large collections of documents including both unstructured text and structured documents (e.g., spreadsheets). The research team developed systems that use interactive visualizations to help analysts with performing exploration, sense-making, and understanding tasks. By helping analysts determine which documents to read first and to also find important, connected documents, then it would be possible to help them make timelier and more accurate assessments of the situations described within those documents. The project builds upon the Jigsaw system, and explores how new capabilities can be added to it. The researchers intended to disseminate the system for use by real clients, people, and organizations in various domains.	Jigsaw is a large Java-based desktop application system. It contains just under 100,000 lines of code. The system is available for anyone to download via http://www.cc.gatech.edu/gvu/ii/jigsaw. Jigsaw was used by the Indianapolis Police Department, West Lafayette Police Department, Rock Hill Police Department (SC), and the Lafayette Police Department. It is being used in various university classes on visual analytics and intelligence analysis and has been downloaded by a wide variety of organizations in government and industry. There have been approximately 8000 downloads of the Jigsaw system in its history. Examples of organizations that have downloaded JIGSAW are; Air Force Intelligence, AFRL Wright Patterson, Army Counterintelligence, Boeing Deloitte, Naval Research Lab, National Crime Information Center, PayPal, Thomson Reuters, United Nations Investigators Office, US Attorney's Office Organized Crime Taskforce, as well as numerous newspapers and police departments. The research team published 11 full papers and 5 abstracts about the project. Additionally, Dr. Stasko presented numerous invited lectures at universities, companies, and government research labs throughout the project. This grant also has supported research of a PhD student exploring geospatial visual analytics including pen- and touch-based interaction. In particular, we have created a system that allows police officials to sketch on a visualization showing crime hotspots, as a way to assist with planning and patrols. We presented a paper about this work at the HICSS 2017 Conference.	Jigsaw was very influential in the field of visual analytics on text documents. We continue to distribute the system and make it available to analysts and researchers in the public, government, education, and private sectors. We recently have made available a new version of the system that runs directly through a web browser. We will gather feedback about this system and enhance its capabilities based upon the things that we learn from the deployment.	In Progress	Research	637772	2009-ST-061-CI001	No	Expert Consultation	FALSE	John Stasko	Georgia Institute of Technology	GA; IN; PA	Center for Visual Analytics for Command, Control, and Interoperability Environments	State and Local First Responders; Other State or Local	2016	Advanced Data Analysis and Visualization; Risk and Decision Sciences	Case Studies; Sampling; Statistical Analysis	Information Science; Communication (risk, scientific, technical); Computer Science	Operational Use
2	Resource Allocation	MDRP 13: (SensePlace 2) Collaborative Visual-Computational Information Foraging and Contextualization to Support Situation Awareness	2009/06	2010/06	This project focuses on developing, implementing, assessing, and transitioning methods and tools to (a) help analysts, crisis managers, and policy makers find and contextualize relevant multimodal information quickly and (b) to support the situation awareness (SA) that is required to interpret evidence and make decisions in a continually changing environment. Specifically, GeoJunction is conceived as a knowledge-enabled, place-time aware, and computationally enhanced web-based environment that supports visually-enabled: (a) document query filtered by place, time, person/organization, and concept, (b) collaborative information foraging, entity and relation extraction, and contextualization, (c) exploration of connections between social and geographic networks, and (d) situation assessment and monitoring with continually updating information	GeoTxt has been integrated as the backend geographic entity recognition, disambiguation, and co-coding systems to support SensePlace 2, our spatial-temporal twitter analytics environment. The early stages of SensePlace 2 (and its precursor SensePlace) were funded through VACCINE.	N/A	Complete	Research	100000	2009-ST-061-CI001	No	Data Mining	FALSE	Alan MacEachren; Alan MacEachren	Pennsylvania State University; Pennsylvania State University	PA		State and Local First Responders	2016	Advanced Data Analysis and Visualization; Communications and Interoperability; Emergency Preparedness and Response	Case Studies; Risk Assessment; Statistical Analysis	Geographic information sciences; Computer Science	Pilot/Field Testing and Evaluation in an Operational Environment
E	Education	EP 3: K-12 Programs	2009/02	2013/09	Discovery Middle School - VACCINE's mission is to educate the next generation of talent through the VACCINE K-12 programs which include; the development of middle school and high school teacher workshops, a high school teacher tutorial for the high school visual analytic module, and the development of middle school modules. In addition, outreach for the K-12 programs included; the attendance at conferences and events, as well as classroom and organization presentations.	VACCINE limited its interaction in K-12 activities at the suggestion of DHS at the end of Year 2. Students from the HS-STEM program visited Principles of Engineering classes at a local high school and presented information on their research, visual analytics and connections to homeland security. As a follow-up, 30 students from the school came to campus for half a day to tour our visual analytics labs and learn about the research taking place through VACCINE. The teacher was very impressed.	N/A	Complete	Research	0	2009-ST-061-CI001	No		FALSE	David Ebert	Purdue University	NJ; IN		Academic Community; Consumers; DHS Science and Technology Directorate; Media	2011	Advanced Data Analysis and Visualization		Classroom Education	
2	Resource Allocation	Scatterblogs				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.	N/A		Research	0		No		FALSE	David Ebert									
1	Law Enforcement	Measuring & Visualizing Information Trustworthiness Using Visual Analytics			Note: Oxford U.	A paper was written.	N/A			113750	2009-ST-061-CI001	No		FALSE										
1	Law Enforcement	Malware on Smartphones: Collection, Analysis and Defensive Measures			The U.S. Department of Homeland Security (DHS) is committed to using cutting-edge technologies and scientific talent in its quest to make America safer. The DHS Directorate of Science and Technology (S&T) is tasked with researching and organizing the scientific, engineering and technological resources of the United States and leveraging these existing resources into technological tools to help protect the homeland. VACCINE will work with the University of California Santa Barbara to pursue the Malware on Smartphones: Collection, Analysis and Defensive Measures project. VACCINE is strategically positioned to support the homeland security community in confronting the challenges of safeguarding our nation by providing advanced visual analytic capabilities in areas such as criminal investigations, health surveillance, fraud detection, cyber security, emergency response and management, intelligence analysis, and border and infrastructure security. VACCINE'Ss primary goal is to enable homeland security personnel, specifically the public safety community, to 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. To do this, VACCINE integrates data and analysis into interactive visual displays that allow users to make discoveries, decisions, and plan actions.				Research	0	2009-ST-061-CI001	No		FALSE			CA; IN							
1	Law Enforcement	Co-Located Collaborative Analysis on Large, High-Resolution Displays using Multiple Input Devices; Public Safety Coalition Projects			We set out to study how co-located collaborative analysis is conducted on large, high-resolution displays in order to evaluate how current visualization tools can be used by outside institutions in a collaborative manner. We conducted a user study to evaluate Jigsaw, a visualization tool developed at Georgia Tech, benchmarked against analytical tools. The study set-up included a large, high-resolution display (108.5 in. x 35 in.; 10,240 x 3200 pixels) with two users seated in front of it with their own mouse and keyboard that could interact independently and simultaneously with the display. We collected data from the study through solution reports, semi-structured interviews, mouse-log data, and screenshots taken in 15-second intervals. After analyzing this data, we found that analytical tools greatly affect collaboration styles as well as how they interact with the space. We also investigated the display space usage, user roles, territoriality, and the effectiveness of multiple input devices. Using these findings, we made recommendations for improvement to the Jigsaw team.	Virginia Tech's project on —Collocated Collaborative Visual Analytics involved two undergraduate female and one graduate female computer science students who were involved with the research on the project. As a result, the two undergraduates plan to pursue graduate 27 research opportunities and the graduate students received an offer for a summer internship at PNNL to continue research related to the project	Technology transitioned to NSA, where further research on the methods is being conducted. Graduate student on the project is now employed at NSA to continue this research.	Complete	Research	0	2009-ST-061-CI001	No	Survey	FALSE	Chris North	Virginia Tech University	GA; VA		State and Local First Responders	2011		Case Studies; Statistical Analysis	Computer Science	
1	Law Enforcement	Navajo Nation Graffiti Project			The Navajo Nation lies in Arizona, New Mexico, and Utah. It covers more than 25,000 square miles, making it bigger than the State of West Virginia. 50% of the population is under age 21; 41% are under age 18; and 25% are under age 9. The purpose of this project is to begin documenting locations of recent gang-related activity by monitoring gang graffiti in various reservation communities. NTU students will learn programming, applications, data collection, and mapping, as they map gang-related activity throughout their communities. Working with local law enforcement we plan to develop curriculum so that we can develop and successfully maintain effective intervention and prevention initiatives.	Withdrawn	N/A	Withdrawn	Research	0	2009-ST-061-CI001	No	Field Monitors	FALSE	Mark Trebian	Navajo Technical University	NM; UT; IN; AZ		DHS Federal Emergency Management Agency; DHS Transportation Security Administration; DHS U.S. Coast Guard; State and Local First Responders	2014		Modeling; Sampling	Geography; Computer Science; Mathematics; Sociology; Information systems	

2	Resource Allocation	Critical Infrastructure Integration Modeling and Simulation Project	N/A		Research	0	2009-ST-061-CI001	No		FALSE	William Ribarsky	University of North Carolina at Charlotte	NC

Category Codes

1 Law Enforcement
2 Resource Allocation
3 Social Media Tools
4 Disease Surveillance
5 Financial Flows Tools
E **Education**

X. Student Successes

GEORGIA INSTITUTE OF TECHNOLOGY	STUDENT NAME	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010		
Graduates funded - 2	Adity Dokania, Georgia Tech, School of Interactive Computing	unknown
	Zhicheng Liu, Georgia Tech, School of Interactive Computing	Adobe Research
Undergraduates funded - 0		
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011		
Graduates funded - 2	Zhicheng Liu, Georgia Tech, School of Interactive Computing	Adobe Research
	Youn-ah Kang, Georgia Tech, School of Interactive Computing	Yonsei Univ., Korea
Undergraduates funded - 0		
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012		
Graduates funded - 2	Zhicheng Liu, Georgia Tech, School of Interactive Computing	Adobe Research
	Mengdie Hu, Georgia Tech, School of Interactive Computing	Facebook
Undergraduates funded - 0		
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013		
Graduates funded - 1	Hannah Pileggi, Georgia Tech, School of Interactive Computing	AirBnB
Undergraduates funded - 0		
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014		
Graduates funded - 1	Anand Sainath, Georgia Tech, School of Interactive Computing	Tableau
Undergraduates funded - 0		
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015		
Graduates funded - 2	Alex Godwin, Georgia Tech, School of Interactive Computing	Georgia Instititue of Technology
	Anand Sainath, Georgia Tech, School of Interactive Computing	Tableau
Undergraduates funded - 0		
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016		
Graduates funded - 2	Alex Godwin, Georgia Tech, School of Interactive Computing	Georgia Institute of Technology
	Sakshi Pratap, Georgia Tech, School of Interactive Computing	Georgia Instititue of Technology
Undergraduates funded - 0		
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017		
Graduates funded - ?		
Undergraduates funded - ?		

VIRGINA TECH	STUDENT NAME	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011		
Graduates funded - 1	Lauren Bradel (Virginia Tech, Computer Science)	NSA
Undergraduates funded - 1	Katherine Vogt (Elon University, Computer Science)	Carnegie Mellon
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012		
Graduates funded - 1	Lauren Bradel (Virginia Tech, Computer Science)	NSA
Undergraduates funded - 1	Kristen Koch (Tulane University, Computer Science)	Cornell
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	

JACKSON STATE UNIVERSITY	STUDENT NAME	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010		
Graduates funded - 3	Jotham Greer – U.S.	
	Chicora Chandler – U.S.	
	Ashley Rhodes – U.S.	
Undergraduates funded - 0	NA	
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	

PENNSYLVANIA STATE UNIVERSITY	STUDENT NAME	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010		
Graduates funded - 1	Thomas Auer – U.S	
Undergraduates funded - 0	NA	
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011		
Graduates funded -6	Robert Roth, Penn State, Geography	
	Raechel Bianchetti, Penn State, Geography	
	Elaine Guidero, Penn State, Geography	
	Alexander Savelyev, Penn State, Geography	
	Xiao Zhang, Penn State, Computer Science	
	Anuj Jaiswal, Penn State, Information Sciences and Technology	
Undergraduates funded - 3	Benjamin Finch, Penn State, Geography	
	Matthew Murdock, Penn State, Geography	
	Nicholas Maziekas, Penn State, Geography	
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012		
Graduates funded - 4	Robert Roth, Penn State University, Dept. of Geography	
	Ying Chen, Department of Computer Science and Engineering	
	Ishan Behoora, Department of Computer Science and Engineering	
	Alexander Savelyev, The Pennsylvania State University, Geography	
Undergraduates funded - 2		
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013		
Graduates funded - 13	Alexander Savelyev, Penn State, Geography	
	Sujatha Gollapalli, Penn State, Information Sciences & Technology	
	Ryan Mullins, Penn State, Geography	
	Wenyi Huang, Penn State, Information Sciences and Technology	
	Morteza Karimzadeh, Penn State, Geography	
	Siddhartha Banerjee, Penn State, Information Sciences and Technology	
	Jennifer Smith, Penn State, Geography	
	Joshua Stevens, Penn State, Geography	
	Raechel Bianchetti, Penn State, Geography	
	Eun-Kyeong Kim, Penn State, Geography	
	Peter Koby, Penn State, Geography	
	Ying Chen, Penn State, Computer Science and Engineering	
	Ishan Behoora, Penn State, Information Sciences and Technology	
Undergraduates funded - 0	NA	
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014		
Graduate - 4	Morteza Karimzadeh, Geography	
	Chong Zhou, Computer Science	
	Siddhartha Banerjee, Information Sciences and Technology	
	Ryan Mullins, Geography	Software Engineer at Aptima, Inc.
Undergraduate - 0	NA	
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015		
Graduates funded - 1	Morteza Karimzadeh (Penn State, PhD candidate, Geography)	
Undergraduates funded - 0	NA	
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016		
Graduates funded - 1	Morteza Karimzadeh (Penn State, PhD candidate, Geography)	
Undergraduates funded - 2		
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017		
Graduates funded -		
Undergraduates funded -		

STANFORD UNIVERSITY	STUDENT NAME	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010		
Graduates funded - 3	Justin Talbot – U.S.	
	Leslie Wu – U.S.	
	Sharon Lin – U.S	
Undergraduates funded - 0	NA	
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011		
Graduates funded - 1	Justin Talbot – U.S.	
Undergraduate funded - 0	NA	
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	

UNIVERSITY OF WASHINGTON	STUDENT NAME	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010		
Graduates funded - 2	Alena Benson – U.S.	Product Manager at Gini GmbH
	Bruce Campbell – U.S.	Brown & Rhode Island School of Design
Undergraduates funded - 0	NA	
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011		
Graduates funded - 2	Robin Mays, HCDE Masters Program	PhD Candidate, U of Washington
	Alena Benson, HCDE M.S.	Product Manager at Gini GmbH
Undergraduates funded - 0	NA	
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012		
Graduates funded - 1	Robin Mays, HCDE Masters Program	PhD Candidate, U of Washington
Undergraduates funded - 0	NA	
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	

FLORIDA INTERNATIONAL UNIVERSITY	STUDENT NAME	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010		
Graduates - 0	NA	
Undergraduates - 0	NA	
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013		
Graduates funded - 0	NA	
Undergraduates funded - 1	Jesse Domack, School of Computing and Information Sciences	State Farm
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014		
Graduates funded - 2	Li Zheng, School of Computing and Information Sciences	self-employment
	Chao Shen, School of Computing and Information Sciences	Google
Undergraduates funded - 0	NA	
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015		
Graduates funded - ?	Li Zheng, School of Computing and Information Sciences	self-employment
Undergraduates funded - ?	Chao Shen, School of Computing and Information Sciences	Google
	NA	
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016		
Graduates funded - 1	Wubai Zhou, School of Computing and Information Sciences	Ph.D. student
Undergraduates funded - 3	NA	
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017		

SWANSEA UNIVERSITY	STUDENT NAME	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	

UNVIERSITY OF HOUSTON DOWNTOWN	STUDENT NAME	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011		
Graduates funded - 2	Nathan Nikotan, California State University Domiguez Hills	
	Hooman Hemmati, University of Houston Downtown, Post Baccalaureate	
Undergraduates funded - 11	Duber Gomez Fonseca	
	Lilian Antunes	
	Tia Pilaroccia	
	sarah Jannisca	
	melissa greenlee	
	Brian Holtkamp	
	William Holtkamp	
	Antoine Wiliams-Baisy	
	Vanessa Hernandez	
	joseph Jonson	
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012		
Graduates funded - 13	Antoine Williams- Baisy	
	Adetomiwa Oguntuga	
	Sarah Jannisca	
	Lilian Antunes	
	Hooman Hemmati	
	Duber Gomez- Fonseca	
	Tia Pilaroscia	
	Melissa Greenlee	
	Jessie Uchendo	
	Joseph Jonson	
	Maxwell Goedjen	
	Brian Holtkamp	
	Vanessa Hernandez	
Undergraduates funded - 4	Paola Martinez	
	Deepika Dhadral	
	Kartik Gopavaram	
	Yesenia Salazar Tamez	
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	

UNIVERSITY OF NORTH CAROLINA @ CHARLOTTE	STUDENT NAME	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010		
Graduate funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011		
Graduates funded - 16	John Merritt, Ph.D., Computer Science, UNCC	
	Onyewuchi Obirieze, Ph.D., Earth and Geographic Sciences, UNCC	
	Jack Guest, M.S., Computer Science, UNCC	
	Praveen Tripathi, Ph.D., Computer Science, UNCC	
	Xiaoyu Wang, Ph.D., Computer Science	
	Matthew Hawkins, M.S., Computer Science	
	Chunlei Yang, Ph.D., Computer Science	
	Yi Shen, Ph.D., Computer Science	
	Yang Chen, Ph.D. Computer Science	
	Yujie Liu, Ph.D., Computer Science	
	Dongning Liu, Ph.D., Computer Science	
	Scott Barlowe, Ph.D., Computer Science	
	Khaldoon Dhou, Ph.D. student, UNCC	
	Osarieme Omokaro, Ph.D. student, UNCC	
	Jack Guest, M.S. student, UNCC	
	Seth Clark, M.S. student, UNCC	
Undergraduates funded - 0	NA	
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012		
Graduates funded - 4	Wenwen Dou	
	Yi Shen	
	Yujie Liu	
	Yang Chen	
Undergraduates funded - 3		
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013		
Graduates funded - 2	Todd Eaglin UNCC Computer Science	
	Thomas Kraft UNCC Computer Science	
Undergraduates funded - 2		
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014		
Graduates funded - 4	Todd Eaglin UNCC Computer Science	
	Thomas Kraft UNCC Computer Science	
	Jeffrey Delawder UNCC Computer Science	
	Hossein Hematialam UNCC Computer Science	
Undergraduates funded - 1		
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015		
Graduates funded - 3	Todd Eaglin UNCC Computer Science	
	Thomas Kraft UNCC Computer Science	
	David Burlinson, UNC Charlotte, Computer Science	
Undergraduates funded - 1		
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016		
Graduates funded - 1	Todd Eaglin UNCC Computer Science	
Undergraduates funded - 0	NA	
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017		
Graduates funded - ?		
Undergraduates funded - ?		

UNIVERSITY OF TEXAS AT AUSTIN	STUDENT NAME	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	

SIMON FRASIER	STUDENT NAME	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010		
Grauated funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011		
Grauated funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012		
Grauated funded - 3	RIchard Arias Hernández,School of Interactive Arts and Technology (postdoc)	
	Nadya Calderon Romero Alexandra, School of Interactive Arts and Technology	
	Sabrina Hauser, School of Interactive Arts and Technology	
Undergraduates funded - 0	NA	
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013		
Grauated funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014		
Grauated funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015		
Grauated funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016		
Grauated funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017		
Grauated funded - 0	NA	
Undergraduates funded - 0	NA	

ARIZONA STATE UNIVERSITY	STUDENT NAME	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013		
Graduates funded - 2	Yifan Zhang, Computer Science	ESRI
	Feng Wang, Computer Science	GE Research
Undergraduates funded - 0		
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014		
Graduates funded - 3	Yifan Zhang, Computer Science	ESRI
	Feng Wang, Computer Science	GE Research
	Yafeng Lu, Computer Science	ASU Postdoc
Undergraduates funded - 4	Adam Fairfield	Microsoft
	Jose Ibarra	General Motors
	Daniel Martin	ASU
	Alexandra Porter	Stanford Graduate School
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015		
Graduates funded - 1	Yafeng Lu, Computer Science	ASU Postdoc
Undergraduates funded - 4	Jose Ibarra	General Motors
	Sagarika Kadambi	Intel
	Brett Hansen	ASU Postdoc
	Rolando Garcia	Berkeley Graduate School
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016		
Graduates funded - 2	Yifan Zhang, Computer Science	ESRI
	Feng Wang, Computer Science	GE Research
Undergraduates funded - 2	Rolando Garcia	Berkeley Graduate School
	Brett Hansen	ASU
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	

MORGAN STATE UNIVERSITY	STUDENT NAME	Summer Training at VACCINE	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010			
Graduates funded - 0	NA		
Undergraduates funded - 0	NA		
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011			
Graduates funded - 0	NA		
Undergraduates funded - 0			
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012			
Graduates funded - 0	NA		
Undergraduates funded - 15	Dalyn Allen	Summer VACCINE Training at Purdue	Received Masters Degree (Psychology/Counseling)
	Chance Brown	Summer VACCINE Training at Purdue	Applying to Medical School. Methodone clinician for urinalysis and training in phlebotomy
	Vladimir Celestin	Summer VACCINE Training at Purdue	Pharmaceutical company (clinical services for drug addicts)
	Raechelle Floyd	Summer VACCINE Training at Purdue	Unable to Contact at this time
	Jeffrey Haley	Summer VACCINE Training at Purdue	Matriculating MSU Student/Time off Re-Admission, Summer Session 2017
	Corey Harper	Summer VACCINE Training at Purdue	PhD, Civil Engineering : Carnegie Mellon University, Pittsburgh, PA
	Ashley A. Jones	Summer VACCINE Training at Purdue	Grad Sch: Sch of Architecture & Planning/Landscape Architecture
	Eliane Quintana	Summer VACCINE Training at Purdue	Elecrical Engineer at Naval Air Systems Compound Grad School JHU M.S. computer Science
	Anthony A. Davis	Summer VACCINE Training at Purdue	Working toward M.S. degree in History
	Nathan T. Scott	Summer VACCINE Training at Purdue	Classified Agency
	Travis Clement	Summer VACCINE Training at Purdue	Pharmacy Student at University of Mayland
	Kendric Squire	Summer VACCINE Training at Purdue	Matriculating MSU Student
	Emmanuel Onafeko	Summer VACCINE Training at Purdue	Systems Engineering Newport News Ship Building
	Kristen Seals	Summer VACCINE Training at Purdue	Unable to Contact at this time
	Lauren Williams	Summer VACCINE Training at Purdue	Human Resources in Connecticut
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013			
Graduates funded - 0	NA		
Undergraduates funded - 8	Alfred Shoetan		Unable to Contact at this time
	Vladimir Celestin		Pharmaceutical company (clinical services for drug addicts)
	Nathan Scott		Classified Agency
	Benjamin Hall		Matriculating MSU Student
	Kendric Squire		Matriculating MSU Student
	Lashaunda Johnson	Summer VACCINE Training at Purdue	Graduate MSU May 2015; Medical Scribe at Bon Secours & JHU Hospitals. She has been accepted Meharry Medical College MS Program
	Derek Riley	Summer VACCINE Training at Purdue	Graduate MSU May 2015; State of MD Engineer and Grad Sch MSU, Engineering Program
	Benjamin Hall	Summer VACCINE Training at Purdue	Matriculating MSU Student
	Astrid Garrison	Summer VACCINE Training at Purdue	Matriculating MSU Student
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014			
Graduates funded - 0	NA		
Undergraduates funded - 5	Alfred Shoetan		Unable to Contact at this time
	Vladimir Celestin		Graduate MSU May 2015
	Nathan Scott		Classified Agency
	Benjamin Hall		Matriculating MSU Student
	Kendric Squire		Matriculating MSU Student
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015			
Graduates funded - 0			
Undergraduates funded - 2	Benjamin Hall		Matriculating MSU Student
	Kendric Squire		Matriculating MSU Student
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016			Matriculating MSU Student
Graduates funded - 1	Roberta Virgil		Unable to Contact at this time
Undergraduate funded - 8	Benjamin Hall	Summer VACCINE Training at Purdue	Matriculating MSU Student
	Leonardo Pimentel		Unable to Contact at this time
	Chinedu Ilobinso	Summer VACCINE Training at Purdue	Grad 12/2016: Employed at JP Morgan Chase Co.
	Cherif Haidara	Summer VACCINE Training at Purdue	Matriculating MSU Student
	Simphiwe Denalane	Summer VACCINE Training at Purdue	Matriculating MSU Student
	Bridgit Kioko	Summer VACCINE Training at Purdue	Grad 5/2017: Grad Sch MSU 2017
	Alvin Ilechie	Summer VACCINE Training at Purdue	Matriculating MSU Student
	Christian Young	Summer VACCINE Training at Purdue	Matriculating MSU Student (working on NASA projects)
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017			
Graduates funded - 0	NA		
Undergraduates funded - 7	Julian Faulkner	Summer VACCINE Training at Purdue	Matriculating MSU Student
	Mosopefoluwa Ayantola	Summer VACCINE Training at Purdue	Matriculating MSU Student
	Marcia Shepperson	Summer VACCINE Training at Purdue	Potential VAST Intern (Fall 2017)
	Krystal Alston	Summer VACCINE Training at Purdue	Potential VAST Intern (Fall 2017)
	Ginikachi Eburuoh	Summer VACCINE Training at Purdue	Potential VAST Intern (Fall 2017)
	Ta'Kesihia Barnes	Summer VACCINE Training at Purdue	Potential VAST Intern (Fall 2017)
	Olanza Badger	Summer VACCINE Training at Purdue	Potential VAST Intern (Fall 2017)

Work on iLEAPS APP and particpally support by VACCINE

Attended VACCINE Summer Training as students

Note: some names appear multiple times due to cross training and projects

NAVAJO TECHNICAL COLLEGE	STUDENT NAME	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010		
Graduates funded - 0	NA	
Undergraduates - 0	NA	
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011		
Graduates funded - 0	NA	
Undergraduates - 0	NA	
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012		
Graduates funded - 0	NA	
Undergraduates - 0	NA	
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013		
Graduates funded - 5	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	
Undergraduates funded - 5		
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014		
Graduates funded - 5	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	
Undergraduates funded - 5		
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015		
Graduates funded - 0	NA	
Undergraduates - 0	NA	
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016		
Graduates funded - 0	NA	
Undergraduates - 0	NA	
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017		
Graduates funded - 0	NA	
Undergraduates - 0	NA	

UNIVERSITY OF CALIFORNIA - SAN DIEGO	STUDENT NAME	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013		
Graduates funded - 3	Daniel Frysinger, UCSD, Cognitive Science	
	Khalid Tahboub , Purdue, Computer Science	
	Neeraj Gadgil, Purdue, Computer Science	
Undergraduates funded - 0	NA	
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014		
Graduates funded - 0	NA	
Undergraduates funded - 9		
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	

UNIVERSITY OF OXFORD	STUDENT NAME	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014		
Graduates funded - 0	Dr. Simon Walton, University of Oxford, Oxford e-Research Centre	
Undergraduates funded - 0	NA	
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016		
Graduates funded - 0	Dr. Simon Walton, University of Oxford, Oxford e-Research Centre	
Undergraduates funded - 0	NA	
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	

OAK RIDGE NATIONAL LABS	STUDENT NAME	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016		
Graduates funded - ? 1/2 summer	Jessie Jamieson	UNL Graduate School and ORNL Intern
Undergraduates funded - ? 1/2 summer	Chris Harshaw	Yale Graduate School
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017		
Graduates funded - 0	NA	
Undergraduates funded - 0	NA	

PRAIRIE VIEW A&M UNIVERSITY	STUDENT NAME	WHERE ARE THEY NOW?
YEAR 1 - JULY 1, 2009 - MARCH 31, 2010		
Graduates funded - 0	NA	
Undergraduates - 0	NA	
YEAR 2 - APRIL 1, 2010 - MARCH 31, 2011		
Graduates funded - 0	NA	
Undergraduates - 0	NA	
YEAR 3 - APRIL 1, 2011 - MARCH 31, 2012		
Graduates funded - 0	NA	
Undergraduates - 0	NA	
YEAR 4 - APRIL 1, 2012 - JUNE 30, 2013		
Graduates funded - 0	NA	
Undergraduates - 0	NA	
YEAR 5 - JULY 1, 2013 - JUNE 30, 2014		
Graduates funded - 0	NA	
Undergraduates - 0	NA	
YEAR 6 - JULY 1, 2014 - JUNE 30, 2015		
Graduates funded - 0	NA	
Undergraduates - 0	NA	
YEAR 7 - JULY 1, 2015 - JUNE 30, 2016		
Graduates funded - 0	NA	
Undergraduates - 0	NA	
YEAR 8 - JULY 1, 2016 - JUNE 30, 2017		
Graduates funded - 0	NA	
Undergraduates - 0	NA	

VISUAL ANALYTICS FOR COMMAND, CONTROL, AND INTEROPERABILITY ENVIRONMENTS
A U.S. Department of Homeland Security Center of Excellence

VACCINE

Disease Surveillance/Epidemic Modeling

Decision-making tool for mitigation actions, resource allocation

PRODUCT

What it Does

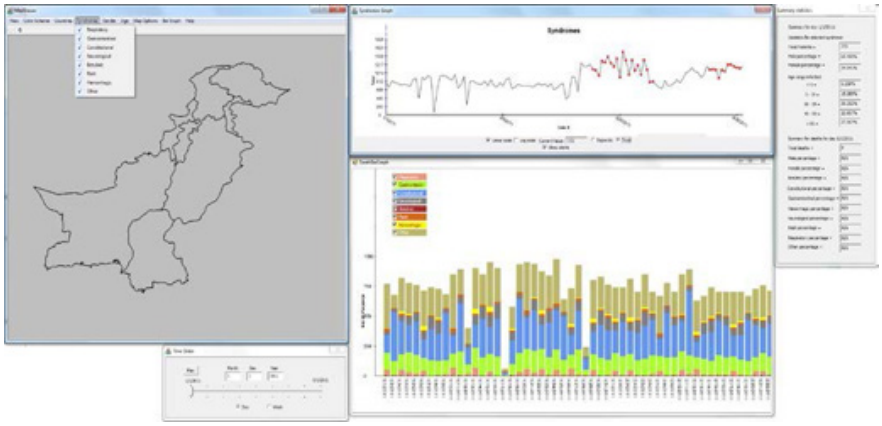
With the potential for a large loss of life from health outbreaks, public health officials must prepare, exercise and evaluate complex mitigation plans. That planning relies on knowledge gained from training or information provided through complex modeling. The plans are developed with a few specific scenarios in mind and can ignore that the solutions dealing with an outbreak depend on the disease's underlying traits and characteristics, which may not be known a priori.

Using a visual analytics health surveillance tool developed through VACCINE, health officials are prepared to better identify, analyze and respond to emerging health threats in a geographic area using data collected by health officials and hospitals. The goal: to mitigate the spread of a public health emergency and to assist in reallocating resources to combat the crisis.

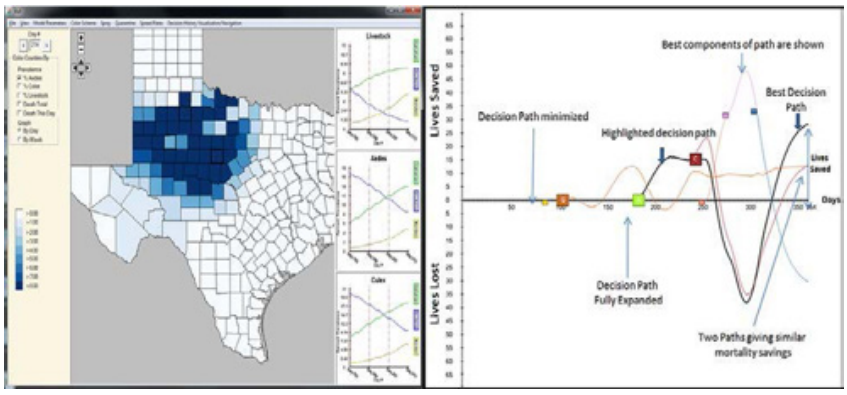
Why it is Useful

This computer software system can detect anomalies in temporal patterns of health surveillance data. Users also can interactively explore different models and corresponding spread data in a spatiotemporal map view. It also helps scientists understand the characteristics of syndromic diseases and improve their models.

Patient hospital admittance records are classified into 7 syndromes (botulinic, constitutional, gastrointestinal, hemorrhagic, neurological, rash and respiratory). Data is passed to different linked components of the system. Control charts help identify anomalies in the data represented by red dots in the temporal plots. Hospital admittance data is geocoded to identify any spatiotemporal patterns.



(Upper Right) Line graph view showing health alerts for selected condition and region. Alerts shown fall within the 99% confidence level. Stacked graph view shows the contribution of each type of syndrome. (Right) Summary statistics view provides details about illnesses with respect to age, gender and chief complaint. (Left) Map view with time slider links all views.

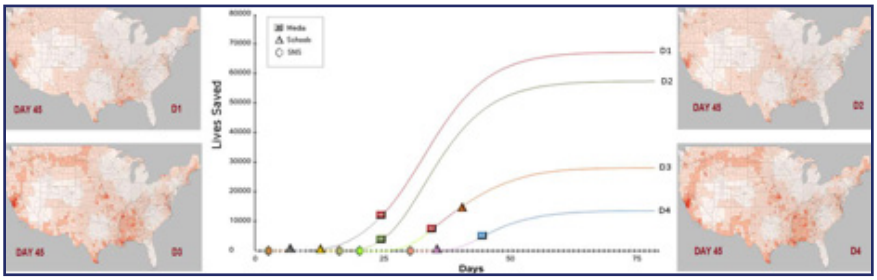


(Left) The spatiotemporal model view. Users can watch the spread of the model over space and time and introduce changes to the simulation as well as incorporate mitigative response. (Right) The decision history tree view. As users interact in the model view, the different paths the simulation can take are calculated and visualized, showing the effect of user action in disease spread. The decision paths are plotted over time on the X-axis, with the Y-axis representing the cumulative deviation from the baseline simulation.

continued . . .

Case Study 1 – Pandemic Influenza

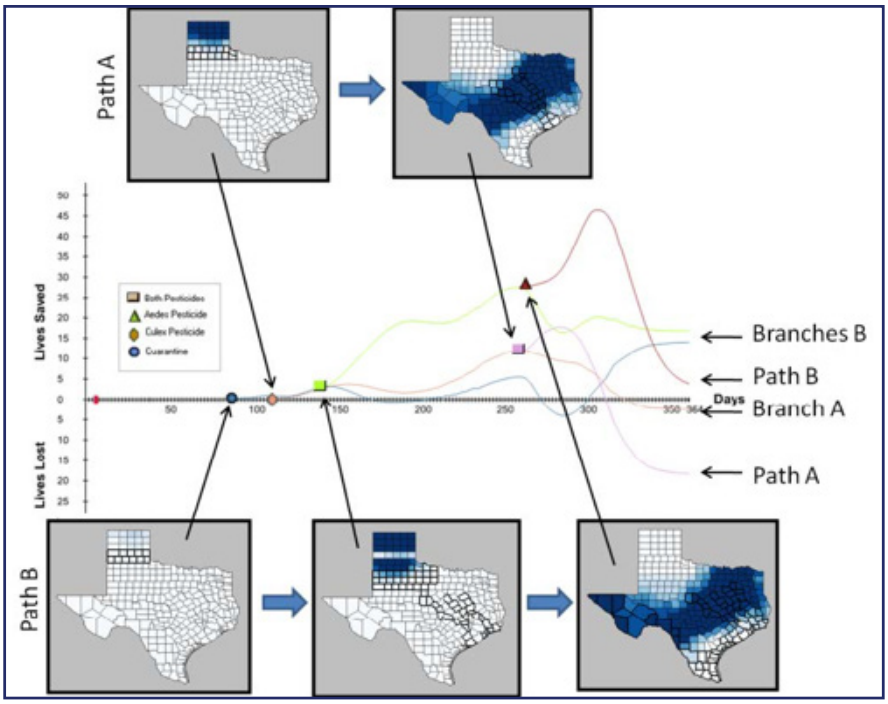
This case uses the Gaussian mixture model, which simulates the spread of a pandemic influenza across the United States starting from a user-defined point source location and incorporating airport traffic models. With this tool, analysts can choose from three global decision measures: school closures, media alerts and strategic national stockpile deployment (SNS). All decision measures are designed to mitigate the spread, and each response measure can be deployed only once. Applying these decision measures in different combinatorial order can yield different mortality and infection rates.



Here, the user has introduced a variety of different decision measures at various points in time and in different order. We explore the result and simulation spaces in the geographical space with the maps surrounding the central image. Each map corresponds to a different decision tree branch as denoted by the corresponding label.

Case Study 2 – Rift Valley Fever (RVF)

This case study utilizes a differential equation model that simulates the spread of Rift Valley Fever through a simulated mosquito and cattle population in Texas. Users can choose from two mitigative response measures: pesticides and quarantine. Users can interactively apply a quarantine or pesticide spray to any individual county or multiple counties at once during the simulation. Analysts can combine Aedes and Culex mosquito pesticides for a combined spray.



In this Rift Valley Fever case study, the user has introduced a variety of different decision measures at various points in time and in different order. Each map corresponds to a different decision tree branch as denoted by the corresponding label.

Collaborators

- Distributed Multimedia Systems Laboratory, Purdue University
- King Edwards Medical University, Lahore, Pakistan
- University of Engineering and Technology, Lahore, Pakistan
- VADER Lab, Arizona State University
- Foreign Animal and Zoonotic Disease Defense Center
- Georgetown Medical Center

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Science of Interaction

Studying a User's Interaction with Programs

The Research

Information visualization, or Infovis, systems have two main components: representation and interaction. The interaction component involves the dialog between the user and the system as the user explores the dataset to uncover insights. Since very little attention from the Infovis community has focused on the interaction of users with systems, VACCINE has supported several projects establishing discussion parameters with which to explore the Science of Interaction.

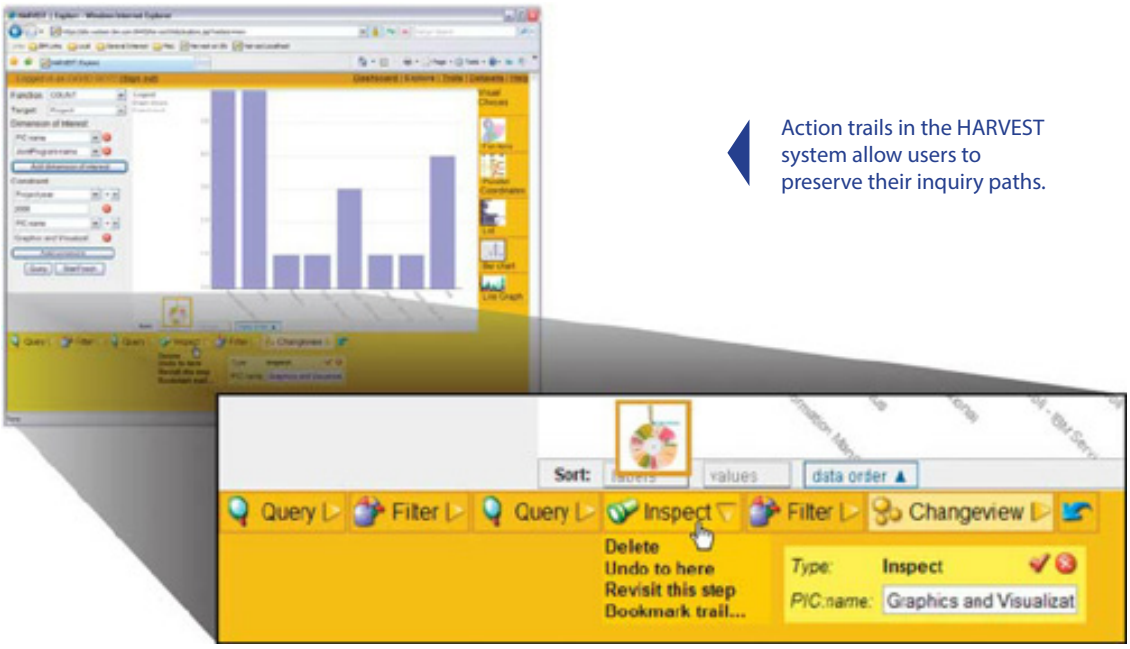
One study uncovered seven different types of interaction: Select, Explore, Reconfigure, Encode, Abstract/Elaborate, Filter and Connect. Identifying these helps novel user intent-based categorization to discuss and characterize interaction techniques in Infovis. Another study specifically focused on whether a prototype could be created for mobile devices, which would maximize the size of each visualization while minimizing the occlusion of visualizations by tools or fingers.

Multiple Coordinated Visualizations for Tablets prototype.

What the Science of Interaction Does

The Science of Interaction is concerned with the study of methods by which humans create knowledge through the manipulation of an interface. A true Science of Interaction must include theories and testable premises about the most appropriate mechanisms for human-information interaction. The research and prototype development in this area seeks to explore the relationship between interaction and cognition.

continued . . .



Action trails in the HARVEST system allow users to preserve their inquiry paths.

Why it is Useful

Interaction is an essential part of Infovis and decision making with computer assistance. Without it, an Infovis technique or system becomes a static image – which users tend to interact with anyway by looking closer, rotating it or jotting down notes. Seeking to better understand interaction, therefore, will ultimately answer the question: What does interaction contribute to the analytic process? By learning the answer, researchers can develop applications and tools that will more effectively contribute to the way users research and learn.

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Spatiotemporal Correlation

RESEARCH

The Research

Spatiotemporal research involves the analyses of space and time information, often producing datasets that are complex due to the high-volume, detailed information pieces used to create them. VACCINE has created a suite of spatiotemporal tools to enable users to more effectively understand such datasets and use them outside typical research environments.

One subset of this suite of tools focuses on using spatiotemporal research to find patterns or other indicators that may be used to predict future behaviors or outcomes. Visual analytics — or the use of graphical or interactive visual analysis of the data — typically are employed to help users better see the interaction of data in various spaces and at different levels.

Why it is Useful

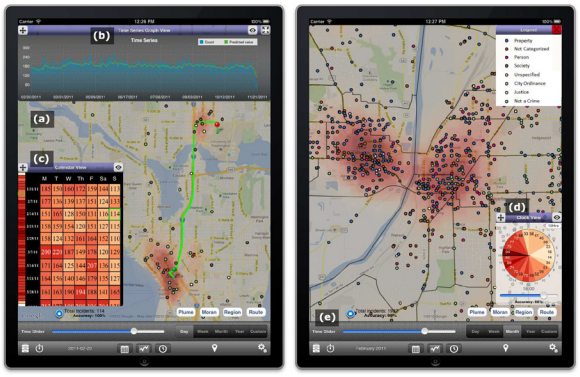
Both novice and advanced spatiotemporal data consumers are often faced with the difficult task of trying to sort through the complex and high-volume datasets. Without clear ways to interpret and understand the datasets, users may feel the research results are of little value.

VACCINE's predictive/correlative and other analytics research within its spatiotemporal suite of tools enables users to better:

- Explore and understand complex datasets.
- Understand potential patterns at different scales and in different spaces/environments.
- Employ the outcomes from the datasets for effective decision-making.

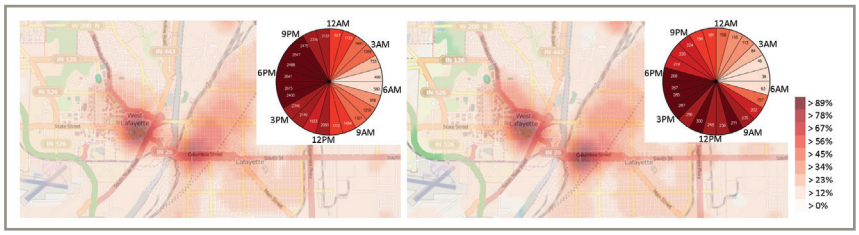
How it is Used

Law Enforcement



VACCINE developed risk profile tools to give time and location information using law enforcement data. The mobile visual analytics suite of tools allows police departments and other agencies to detect trends and patterns among criminal, traffic and civil incidents. The system also provides interactive risk assessment tools to allow users to identify regions of potential high risk and determine the risk at any user-specified location and time. One goal is to eventually modify the system for use by the general public.

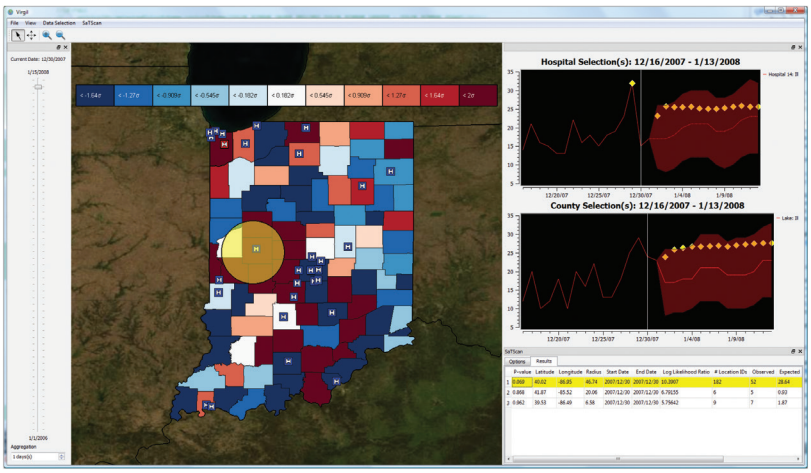
The mobile visual analytics law enforcement system plots incidents as color-coded map points to help users analyze trends.



The forecasting tool shows spatiotemporal distribution of historical crime incidents to help detect patterns.

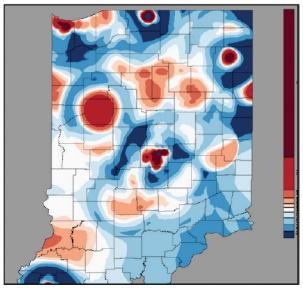
VACCINE also created a forecasting technique using research methods to predict criminal activity in specified times and geographic areas. The technique uses data patterns to help law enforcement agencies increase patrols in areas and times that have historically seen higher rates of crime. Such information provides more effective decision-making through this hot spot policing and resource allocation strategies.

Healthcare



VACCINE created a predictive visual analytics toolkit for users to discover regions of space and time with unusually high incidences of events (hot spots) such as specific medical issues. For instance, Indiana health officials can use the tools to analyze respiratory ailments (e.g. influenza) across the state. Users can predict how hot spot regions may grow in order to plan resource allocation and preventative measures. Users can also study the data to predict where future hot spots may occur.

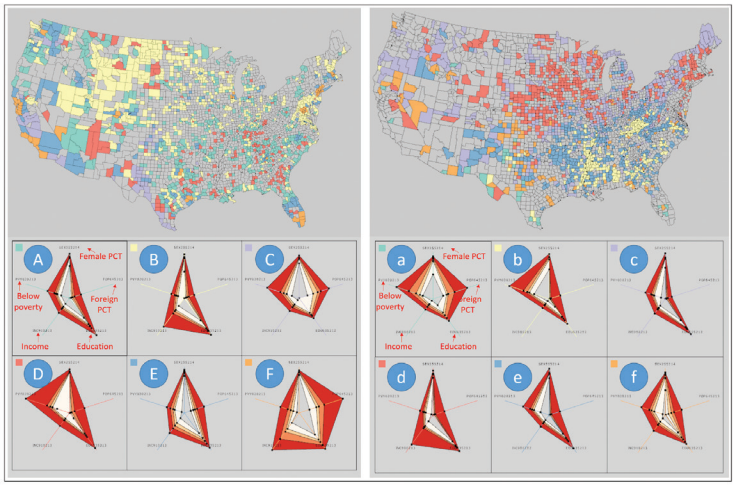
The predictive visual analytics toolkit can map various data, such as respiratory syndrome counts across Indiana.



The University also developed a suite of tools to allow health officials to combine datasets from hospitals across the state to pinpoint public health emergencies. The tools use time and space data to detect small deviations in patient cases to indicate public health emergencies before such an event is confirmed by diagnoses or overt activity.

The suite of healthcare tools includes heatmaps to indicate potential hot spots of patient activity.

Population



VACCINE created a system to allow decision-makers to use geographical datasets and apply them to population growth. Users can pinpoint areas of growth and decline to understand the reasons behind the changes and how to predict future opportunities.

The mapping tool allows users to pinpoint areas of population growth and decline to predict future outcomes.

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Miscellaneous Spatiotemporal Papers

An Introduction to Visual Analytics

PRODUCT

The Research

VACCINE has supported several research projects that seek to develop visual analytics prototypes. These prototypes are being developed into software tools that collect and sort data and arrange them visually, so users can interpret a situation and react accordingly. Visual analytics has applications in law enforcement, city planning, disaster prediction and response, public transportation and others.

What Spatiotemporal Visual Analytics Does

Spatiotemporal visual analytics combine data from time and physical spaces and allow users to interact with and explore both. Some VACCINE-supported examples of this research are:

- **HotSketch:** A prototype that explores crime hotspots and provides rapid route planning and analysis for police officers. Historical records of high-frequency criminal activity are used to predict areas where crime is likely to occur again, and the user can draw various routes through a city map at different times of the day to see what types and frequency of crime typically occur.
- **SpaceSketch:** A software prototype based on the use of a stylus to draw a route on a map and get back a) the shortest route from one point to another, b) the shortest route closest to the one sketched by the user or c) show all possible paths within a radius. Users can also define regions by drawing a boundary around any given space on the map. The program will shade the region with a hue according to the number of events occurring inside. The paths through these affected areas also will be shaded a different hue, allowing the user to determine if alternate paths are available to reach affected destinations.
- **Social Media Analysis:** A system that retrieves topics from Tweets and other social media, filters the data according to relevance, detects and confirms anomalies before turning the data into a visualization — whether it's a map with color-coded plots of Tweet origins, a bar graph or a line graph.
- **GeoVISTA CrimeViz:** A web-based map application prototype that users can explore to make sense of crime activity.

GeoVista CrimeViz

SpaceSketch, radial exploration mode

continued . . .

Why it is Useful

The immense amounts of data that come through on social media or other news sources creates a bottleneck of information that becomes impossible to interpret or act on when dealt with manually. Visual analytical programs sort all that information and display it in an easy-to-interpret format, which makes the vast store of minute-by-minute information into a usable source.

- **HotSketch:** Many police officers will spend a large portion of their day responding to 911 calls, pulling them off their beat. A predictive crime system like HotSketch can help reduce the response time for these calls by attempting to position officers in close proximity to areas that receive calls.
- **SpaceSketch:** Anyone stuck in traffic due to a collision — citizens and police officers alike — can use SpaceSketch to view the event with touch controls and view possible alternate routes with a stylus.
- **Social Media Analysis:** By plotting points of relevant Twitter messages on a map, one group was able to calculate the epicenter of an earthquake by analyzing the delays of the first messages reporting the shock.
- **GeoVISTA CrimeViz:** Despite the potential to identify and explain clusters and trends in crime, many police departments lack adequate analytical tools and training to explore and make sense of their crime incident datasets. This is particularly problematic in medium to small municipalities that are unlikely to have crime analysts on staff. CrimeViz provides understaffed departments with an easy-to-use tool for conducting spatiotemporal crime analysis and mapping.

HotSketch

Social Media Analysis

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Spatiotemporal Resource Allocation

RESEARCH

The Research

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One subset of this suite of tools focuses on using spatiotemporal research to find patterns or other indicators that may be used to predict future behaviors or outcomes. Visual analytics — or the use of graphical or other visual representations of the data — typically are employed to help users better see the interaction of data in various spaces and at different levels.

Why it is Useful

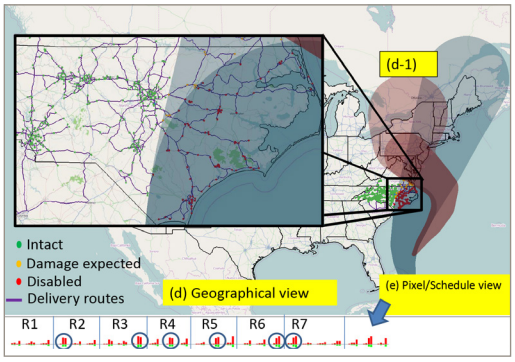
Both novice and advanced users of spatiotemporal research are often faced with the difficult task of trying to understand the operations and usefulness of complex and high-volume datasets. Without clear ways to interpret and understand the datasets, users may feel the research results are of little value.

Purdue's resource allocation research within its spatiotemporal suite of tools enables users to better:

- Explore and understand complex datasets.
- Understand potential patterns at different scales and in different spaces/environments.
- Employ the outcomes from the datasets to more effectively allocate limited resources.

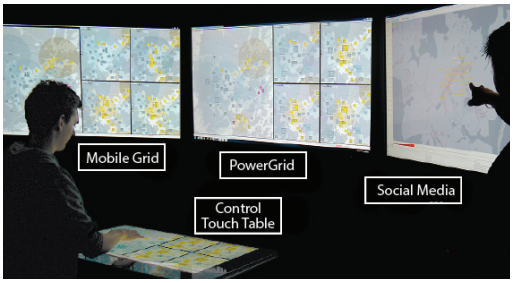
How it is Used

Societal Infrastructure



VACCINE's novel visual analytics platform allows users to perform big data simulations related to critical infrastructure.

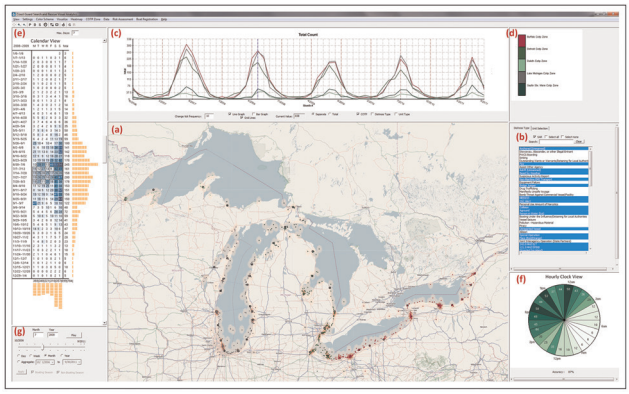
VACCINE designed a novel visual analytics platform for modeling the impact of natural and human-made societal threats such as weather, food contamination, traffic, crime and terrorist attacks on critical infrastructure such as supply chains, road networks and power grids. This type of big data simulation allows users to compare the interaction of large datasets with space and time components to determine the potential effects of the reallocation of resources related to critical infrastructure. Our platform helps answer two important societal questions: How can society protect its critical infrastructure against a diverse range of threats? How can we design for resilience and preparedness when a change in one seemingly minor aspect of our infrastructure may have vast and far-reaching impacts on society as a whole?



The unique visual analytics control room setup developed by Purdue consists of three displays and a touch table.

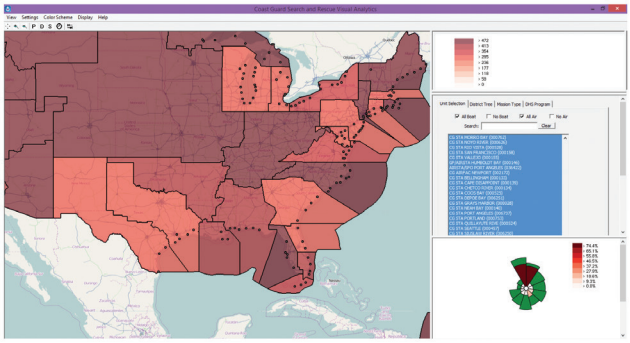
VACCINE devised a unique visual analytics control room system to help users monitor critical societal infrastructures, detect cascading effects among multiple infrastructures, perform root cause analyses and manage the crisis response with the most effective resource allocation. Our system uses datasets of time and space information to model the various interconnections and interdependencies of critical infrastructures to other networks.

Maritime Operations



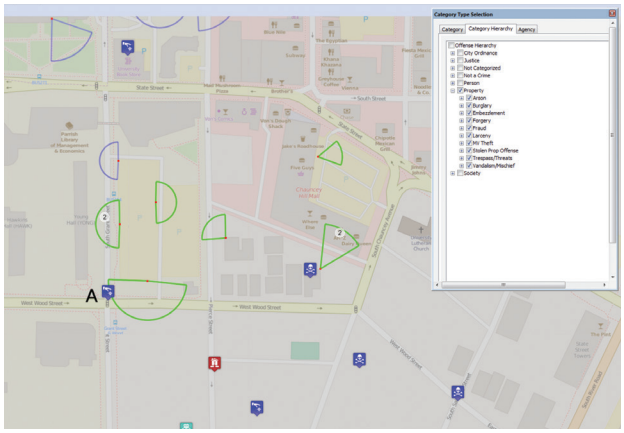
VACCINE collaborated with the U.S. Coast Guard to develop a visual analytics system to analyze historical response operations and assess the potential risks associated with the hypothetical allocation of Coast Guard resources. The system uses datasets to allow users to discover trends and patterns among search and rescue operations and determine the change in risks associated with certain resource reallocations, such as closing certain maritime stations.

Users can interact with the risk assessment visual analytics system to discover trends and potential risks associated with the hypothetical allocation of resources such as Coast Guard stations.



VACCINE created several visual analytics components to assist the Coast Guard with risk-based decision-making. The components are interactive tools that use graphical depictions to allow users to visualize and identify areas of high risk based on time and space historical data. The tools use heatmaps to help users identify risk priority areas, understand possible safety changes based on moving resources, and analyze the potential need for resource reallocation or assets upgrades.

Purdue's visual analytics system assists users with risk-based decision-making, based on time and space historical data.



Public Safety

VACCINE developed an analytics system to improve public safety by utilizing the visual data from network cameras. The public cameras are discovered from heterogeneous sources. Data such as camera locations and viewing angles are determined using the visual content from the cameras. The system allows users to analyze space and time data for crime trend analysis, and the cameras can then be used to increase public safety through integration with current surveillance systems.

The analytics system created by Purdue uses visual data from network cameras to improve public safety.

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Trajectory and Human Movement

A Visualization System of Abnormal Movements

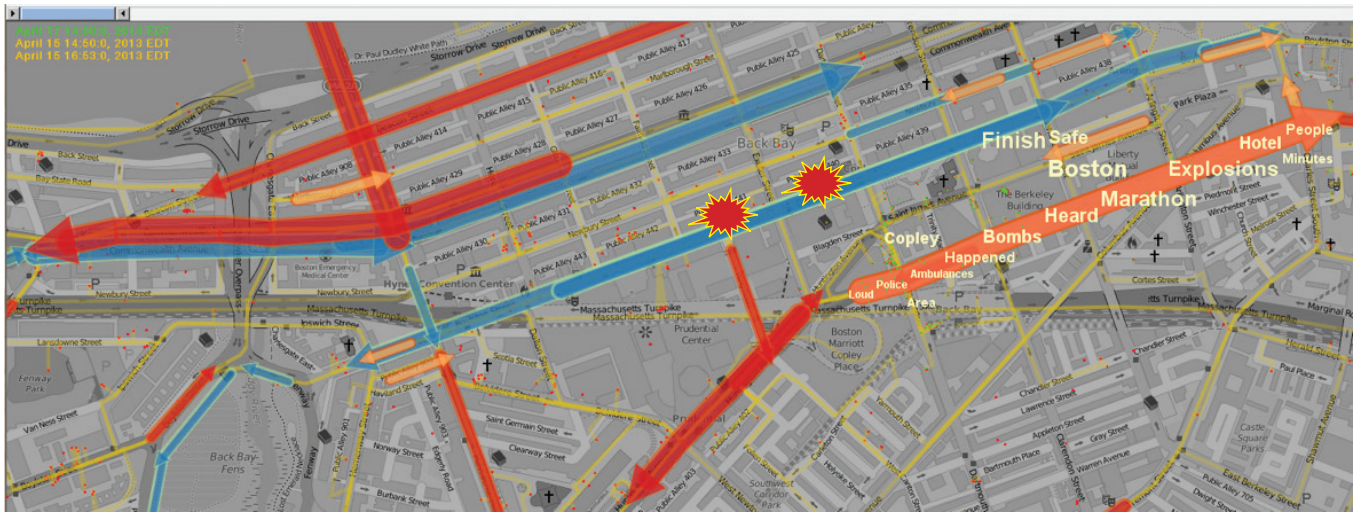
PRODUCT

The Research

Research on human movement patterns using location-based social networks has largely focused on daily activities. But during crisis events, people move from place to place in unusual patterns. This research focuses on those anomalous patterns and proposes a new trajectory-based approach for tracking and analyzing human movement data.

What Trajectory and Human Movement Does

Since it is an option on social media for the user to reveal location, these check-ins can serve as useful data, but it's an overwhelming amount of data. The Trajectory and Human Movement system creates a visualization for easy observation and analyzing. It generates two different sets of trajectories: target (unusual) and normal trajectories. Then it finds subtrajectories by clustering common paths. Finally, it detects abnormal movement and produces a visualization of the anomaly.



The trajectories (red and orange) show the human movement patterns around the finish line at the 2013 Boston Marathon during the two hours after the explosions. The blue trajectories represent the movements for the normal situation (the same time period of the same event in 2014). The two markers indicate the locations of the two explosions.

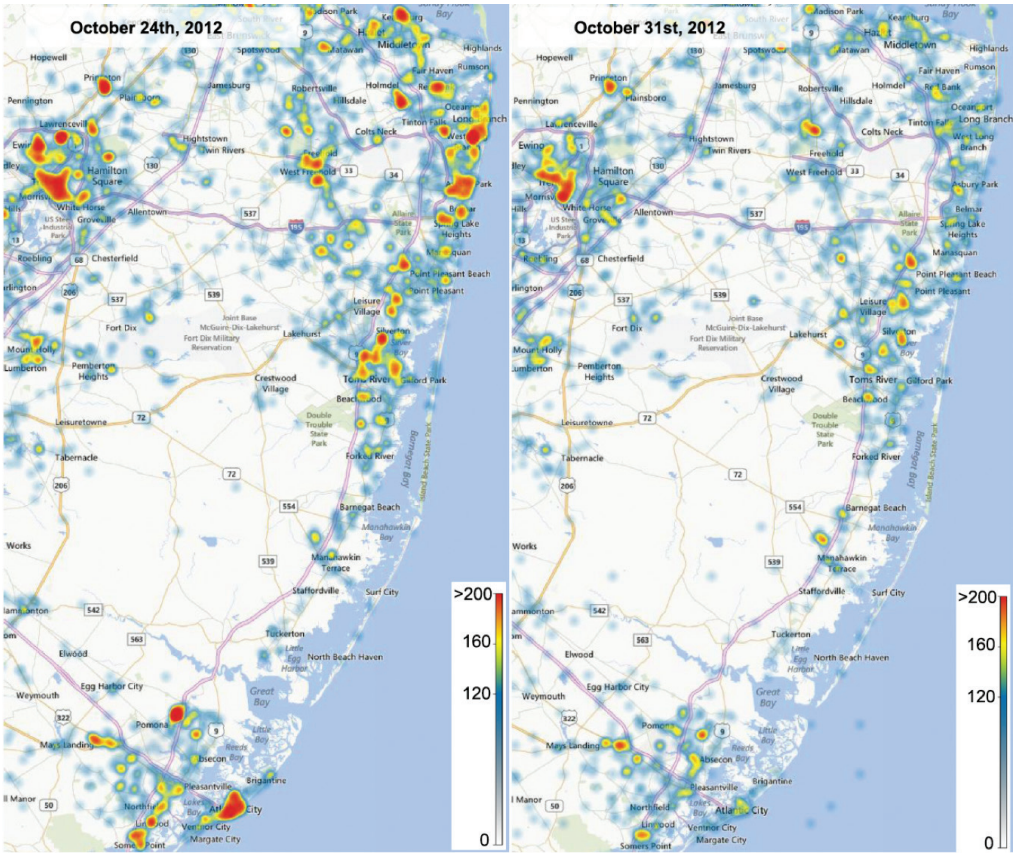
continued . . .

Why it is Useful

A study commissioned by the American Red Cross found that roughly half of the respondents would mention emergencies and events on their social media channels, and more than two-thirds agree that response agencies should regularly monitor postings on their websites. Moreover, a growing number of people are using location-based social network services such as microblogs, where they create time-stamped, geo-located data, and share this information about their immediate surroundings using smartphones with GPS capabilities.

This data of human mobility patterns is important for evacuation planning, urban planning, traffic management and understanding the pandemic spread of diseases. Unfortunately, the extraction of such a massive amount of data can be costly and will bottleneck without an efficient system for filtering, sorting and visualizing.

The trajectory approach system generates easy-to-read map visualizations, which makes the overwhelming amount of data useable.



Twitter user distribution on the coast of New Jersey before (left) and after (right) Hurricane Sandy hit the area in October 2012.

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cgSARVA (Coast Guard Search and Rescue Visual Analytics)

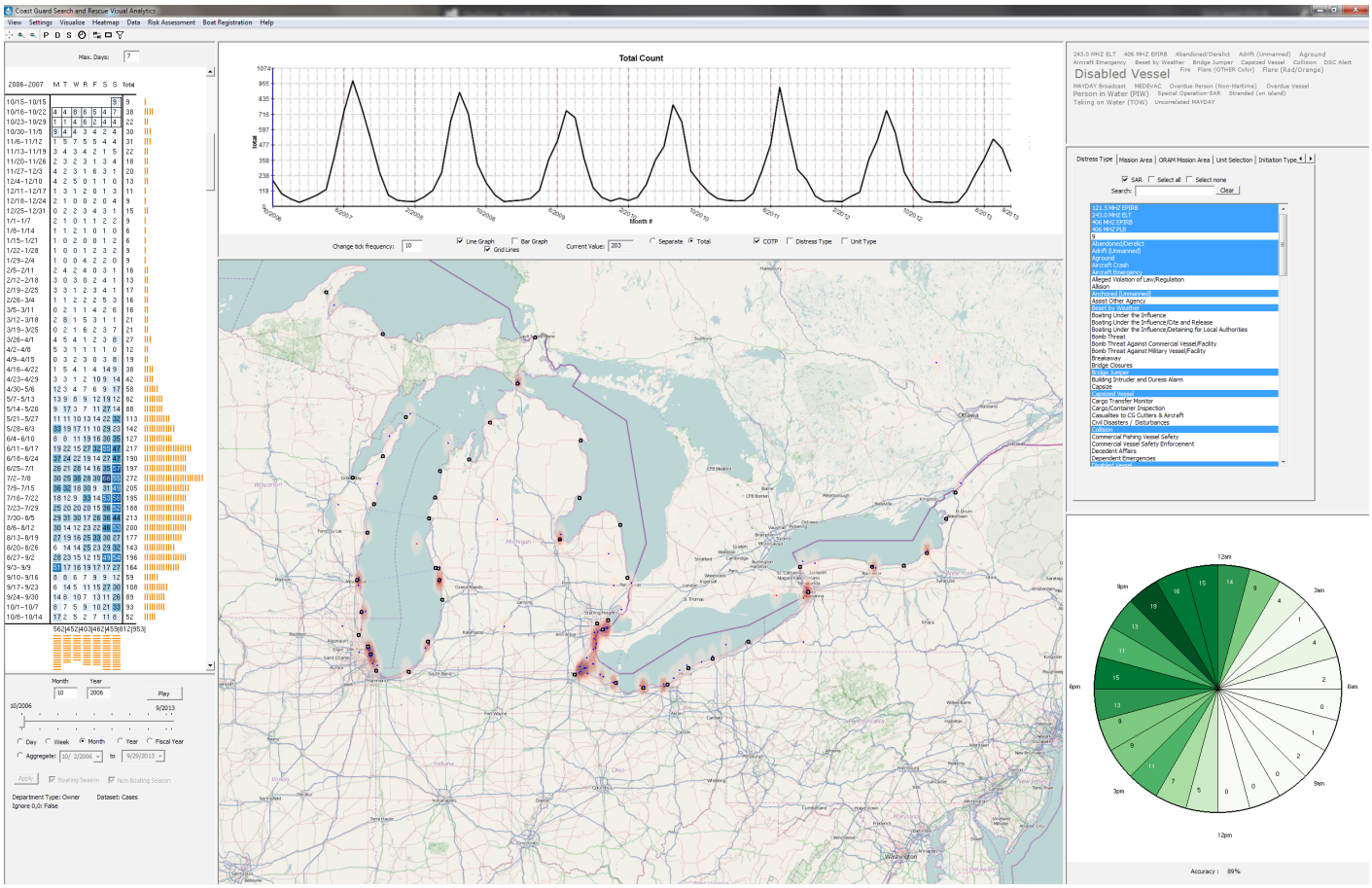
PRODUCT

What cgSARVA Does

The Coast Guard Search and Rescue Visual Analytics, cgSARVA, is an interactive system designed to assist U.S. Coast Guard decision-makers and analysts in understanding and assessing operational efficiencies of different Coast Guard missions at different organizational levels.

A computer software tool, cgSARVA provides a user interface and a suite of tools. The system allows the consideration of station closures through an analysis of the potential risks to the maritime environment related to response time as well as the potential for lives lost and property damage. The cgSARVA tool also provides optimal direction to the nearest available station in case of station closures.

In addition, cgSARVA enables the analysis of trends, patterns, and anomalies associated with the distribution of cases in both space and time conducted by the Coast Guard throughout the United States. The system has been developed with a user-centered approach, tapping the expertise of several different Coast Guard analysts and decision-makers in the design process.



Screen shot of cgSARVA showing analysis of the Great Lakes region.

continued . . .

Why it is Useful

The cgSARVA tool enables analysts to better see and understand where incidents are occurring and how resources can be reallocated when stations are forced to close because of inclement weather. The tool also allows analysts to see the risks involved in each scenario.

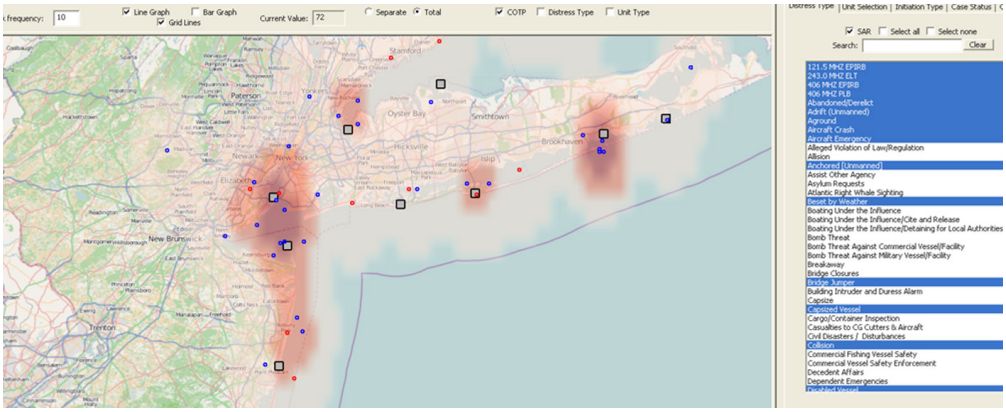


Image of cgSARVA analyzing Superstorm Sandy, and assessing how to reallocate resources in light of damage to stations in New Jersey.

Consensus

"The cgSARVA model formulation proved to be tremendously insightful for the Coast Guard as it began to prioritize the repair of its stations. Even upon receiving full funding for all damages, the Coast Guard is unable to execute all repairs at the same time, and the outputs from cgSARVA have been instrumental in assisting senior leadership in prioritizing work."

— Commander Kevin Hanson, analysis team leader

"The accreditation is the first time anything produced by a DHS Center of Excellence has been verified and validated for use by the Coast Guard. The cgSARVA tool can help DHS agencies and law enforcement agencies across the country."

— David Ebert, VACCINE Director and Silicon Valley Professor of Electrical and Computer Engineering at Purdue University

"The cgSARVA tool is especially helpful in guiding operations and resource decisions by carefully analyzing data in a way that ensures the best return on investment. This project serves as a great example of positive partnerships that are being forged between the Coast Guard, the DHS Center of Excellence and academia."

— Retired Vice-Admiral Robert C. Parker, Commander U.S. Coast Guard Atlantic Area (LANTAREA)

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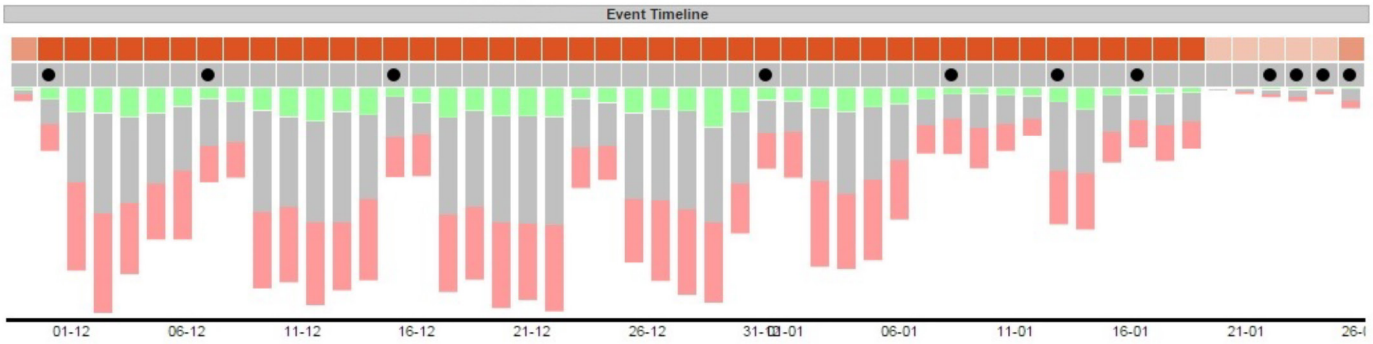
FAVA (Visual Analytics System for Exploring Financial Data) PRODUCT

What FAVA Does

Financial Anomaly Visual Analytics (FAVA) is a visual analytics system that detects and explores financial anomalies and compares it to news media context. Financial analysts responsible for monitoring abnormal financial market behaviors can use FAVA to quickly find and extract relevant information, which would otherwise be a time-intensive task.



FAVA's Polarity Distribution Stacked Bar Graph with green being positive sentiment, gray being neutral and red being negative.

Why it is Useful

Anomalies in financial trends need current news context to be properly understood because not all of them are relevant or require action. Conversely, not all context is relevant either, which makes the information even more difficult to sift through. Additionally, line graphs that get cluttered and difficult to read are typically used to chart all data. Analysts need easy-to-read tools to probe these anomalies and to identify, explore, and understand their causes and behaviors.

Using input collected from focus groups of different types of analysts, FAVA was designed with an automated anomaly detector with different types of graphs that represent data and provide users with different approaches to analyze it. This eliminates the need for significant time spent researching and building hypotheses.

Case Studies

FAVA has been used to analyze:

- The airline sector (October 2015-March 2016)
- The oil sector (October 2015-March 2016)
- The technology sector (August-October 2011)

continued . . .

Main Components of FAVA

One of the major advantages of FAVA is its multiple representations of financial data, making it useful for different types of analysts and helping them put their information into context. The main components are:

Time Series View: Presents ticker prices and anomalies over time and provides users with display and configuration options.

Horizon Graph View: Presents ticker prices, anomalies and trends for individual stocks, market/sector indices and the overview trends.

Calendar View: Presents count of anomalies in the format of a calendar in order to explore seasonal and cyclical trends.

Stacked Zoom View: Presents ticker prices over time in detail and its relation to the overview.

Topic Stream View: Presents related news stories for each topic/ticker over time.

News Events Timeline View: Presents potential contextual evidences of financial anomalies from news articles.

FAVA's various views — showing line graph, Stacked Zoom Graph, Horizon Graph, Calendar, Topic Stream and News Events Timeline.

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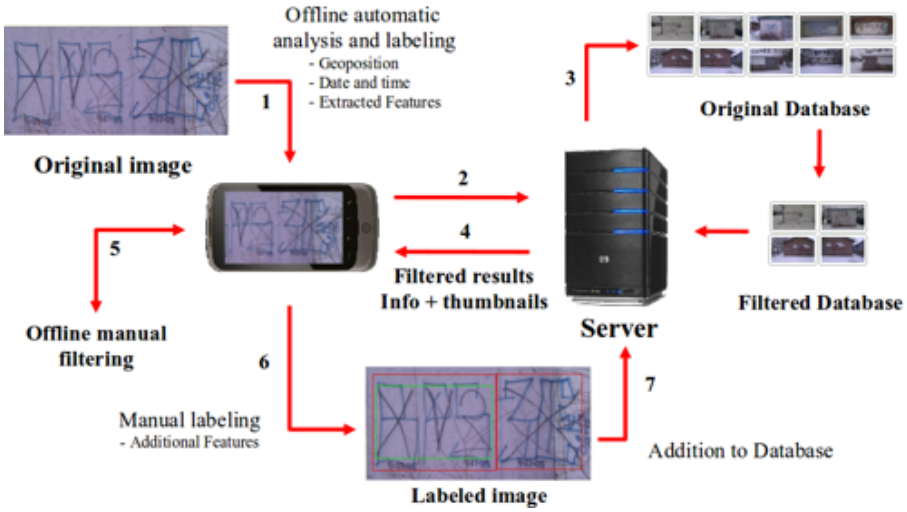
GARI (Gang Graffiti Automatic Recognition and Interpretation) PRODUCT

What GARI Does

GARI, which stands for Gang Graffiti Automatic Recognition and Interpretation, is a mobile application and cloud-based system that allows law enforcement and criminal justice personnel to capture, input, and search images of gang graffiti and tattoos using an Android or iOS (iPhone) device.

The images are analyzed, stored and indexed by time, location (GPS coordinates) and content. Users can browse images up to a 20-mile radius of their current location as well as search the database for similar images.



The user can take images which the application will analyze and filter. Images also can be added to the database.

How it Works

The image analysis includes obtaining the user's geoposition, date and time, and extracting relevant features (e.g., color, shape) from the gang graffiti image. The information is sent to a cloud-based server and compared against the graffiti image database. The matched results are sent back to the device where the user then can 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.

Why it is Useful

In many communities, criminal gangs commit as much as 80% of the crime, according to law enforcement officials throughout the nation. Street gangs most commonly communicate through graffiti — including challenges, warnings or intimidation to rival gangs. Through GARI, officials can track gang affiliation and growth or even obtain membership information.

GARI also helps users determine when a new gang moves into an area and identify what gangs are active in an area. From that information, the tool can assist in predicting potential outbreaks of gang violence. GARI also can assist users in connecting with youth at risk of gang recruitment.

continued . . .

Used By

- Indianapolis Metropolitan Police
- Indiana Intelligence Fusion Center Gang Task Force
- INGangNetwork
- Cook County Sheriff's Department
- Illinois State Police
- Navajo Nation
- Approximately 400 additional law enforcement entities have expressed interest

Awards

Second place in the 2015 Tatt Challenge, sponsored by the National Institute of Standards and Technology (NIST) and the Federal Bureau of Investigation (FBI).

Use for Citizens

A community version is available that functions in the same way, but only allows the user to report graffiti and does not make any information visible to the individual uploading and reporting the graffiti image.

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GeoTxt

(Web Service to Geolocate Places Mentioned in Microblogs and News Text)

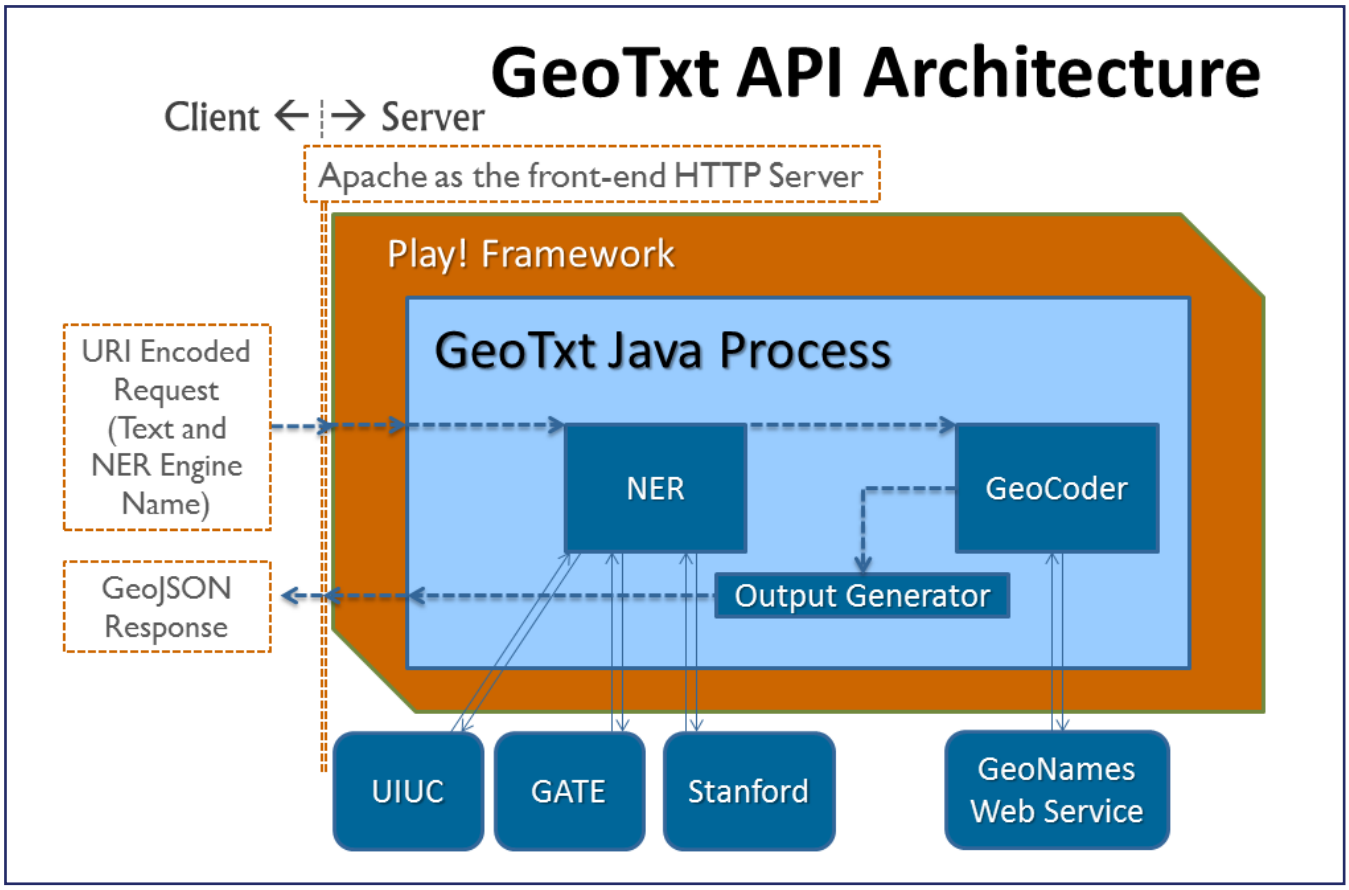
PRODUCT

The Research

Place is critical to homeland security; crisis events happen in place, resources need to be moved from place to place, vulnerable people and infrastructure are at particular places. Place references found in text documents (ranging from news stories and intelligence reports to social media feeds) provide an important complement to formal place-based data already encoded in geospatial databases — if those place references can be recognized, extracted and turned into geospatial data. That capability is what the GeoTxt web service provides, with a specific emphasis on informal text in social media.

What GeoTxt Does

GeoTxt uses techniques from a wide array of research areas — applied linguistics, natural language processing, search engine optimization and geographic information science — to parse out places, people and events explicitly or implicitly mentioned in text (e.g. tweets), and then analyze and contextualize in order to locate them in geographic space.



The architecture of GeoTxt's application programming interface.

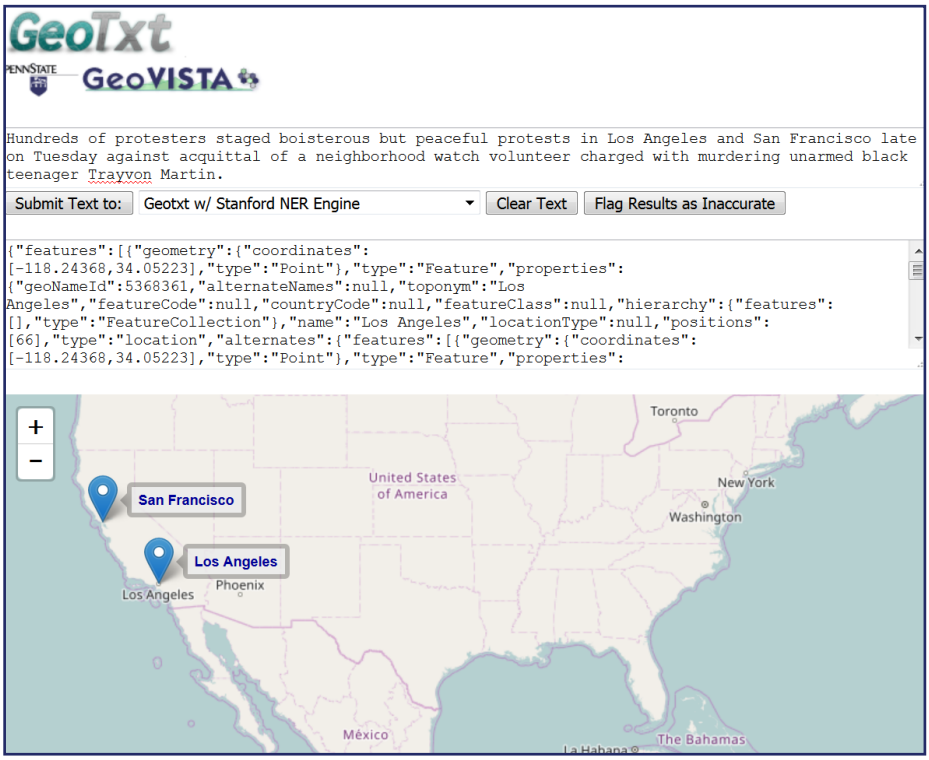
continued . . .

Why it is Useful

GeoTxt detects locations, people and organizations mentioned in text and assigns geographic coordinates to those locations. This enables references to geographic locations that appear in public posts on social networks, newspapers and other text sources to be harnessed for a variety of analytical tasks.

Accurate geoparsing must address a range of challenges, particularly with Twitter, because users often abbreviate, use nonstandard syntax (e.g. don't capitalize proper nouns) or simply make grammatical mistakes. Additionally, most place names can refer to more than one location (the mean for place names globally is over 100 different locations/names); thus determining the intended location is a challenge.

GeoTxt is specialized to cope with challenges like these. For instance, a tweet that reads "Finally landing in London. I love Canada!" would be geolocated to London, Ontario, instead of London, UK, based on the two locations mentioned in the text — not based upon location population or ranking in GeoNames.



GeoTxt web user interface.

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PRODUCT

Jigsaw — A Visual Analytics System that Puts the Pieces Together

What Jigsaw Does

Jigsaw helps investigative analysts explore, analyze and make sense of unstructured and structured document collections, from articles and reports to spreadsheets, XML documents and blogs. By identifying and highlighting connections between entities — such as people, organizations and places — within the large set of data, Jigsaw provides a visual index to help guide the analyst toward relevant reports.

The process takes four steps:

1. Import document
2. Identify entities
3. Analyze computational text
4. Explore visualizations

Jigsaw has an easy-to-use, human-centered approach that puts the analyst in charge of the analysis instead of relying on algorithmic, automated techniques. Through visual representations of the information within textual documents, Jigsaw helps analysts better search, review and understand the reports.

With its rich interactive user interface, Jigsaw offers computational text analysis that includes document summarization, sentiment, similarity and clustering. It also supports the discovery of hidden and embedded relationships across the documents.

Why it is Useful

While reading reports, analysts inherently form mental models of the people, places and events discussed in the information. But as these reports grow, it is increasingly more challenging to cipher through the relevant information, follow the connections between data and interpret the information. This is where Jigsaw comes in.

This system helps analysts reach more timely and accurate understandings of the larger stories and important concepts embedded throughout textual reports. Jigsaw is valuable for a variety of uses and fields, including:

- Law enforcement and intelligence community
- Fraud (finance, accounting, banking)
- Academic research
- Journalism and reporting
- Consumer research

History/Background

The Jigsaw project began at Georgia Institute of Technology's School of Interactive Computing in 2005. In the summer of 2008, Jigsaw was made available via private URL and provided upon request with easy-to-track downloads. It was put online in August 2012 as a Java application for anyone to download.

Since its inception, Jigsaw has been downloaded 5,000 times. Organizations recently downloading the system include CDC, NSF, Deloitte, Netherlands Defence Academy, Washington, D.C., Public Schools, Oracle and Chick-fil-A. A team of researchers from Georgia Tech used the Jigsaw system to win the 2007 VAST (Visual Analytics Science and Technology) Contest.

"Without the use of Jigsaw, examining reports would have been tedious and time consuming, and connections between entities may not have been seen. The local police department was very impressed with Jigsaw and stated that the program will become very useful in tracking criminal activity. Jigsaw is also used to analyze incidents relating to the security of the Washington State Ferry System, providing a searchable database and quick analytical tool for tracking potential threats to the largest ferry transportation system in the U.S."

— Chad R. Melton, Criminal Intelligence Analyst,
Washington Joint Analytical Center WAJAC/FBI-FIG

"I think Jigsaw's strength is its visual and investigative support. Analyzing our reports would have been impossible without that support. When I showed the results and connections to my colleagues, it was easy for them to understand how a certain person is connected to others."

— Damien Williams, Criminal Intelligence Analyst,
Rock Hill, South Carolina, Police Department

Georgia Institute of Technology

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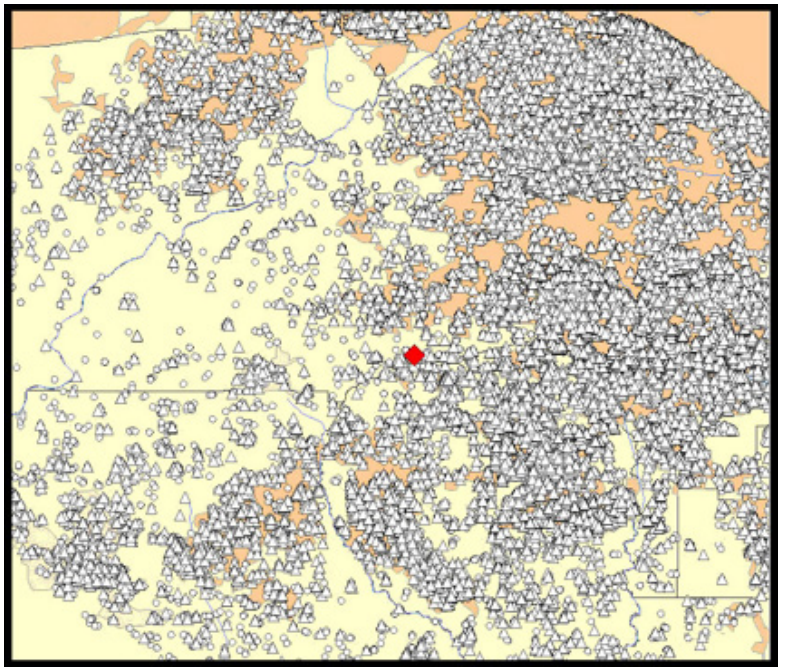
LAHVA (Linked Animal-Human Health Visual Analysis) PRODUCT

What LAHVA Does

LAHVA, which stands for Linked Animal-Human Health Visual Analysis, is a software application that visually shows the correlation between animal and human disease and provides a framework for public health officials to uncover potential threats and respond quickly to health crises. Also, it visually links data collected at human emergency rooms and veterinary hospitals according to geographic region, tracks changes and abnormalities, and provides advanced statistical analysis of those links.

Why it is Useful

LAHVA's additional monitoring of animal symptoms can provide an early alert system, saves time required for manual analysis and enables a quick response time. Also, since many current systems for mining human disease and location data are limited by privacy concerns, LAHVA's ability to extract more precise details in animal cases significantly increases accuracy of event detection and decreases false alarms.

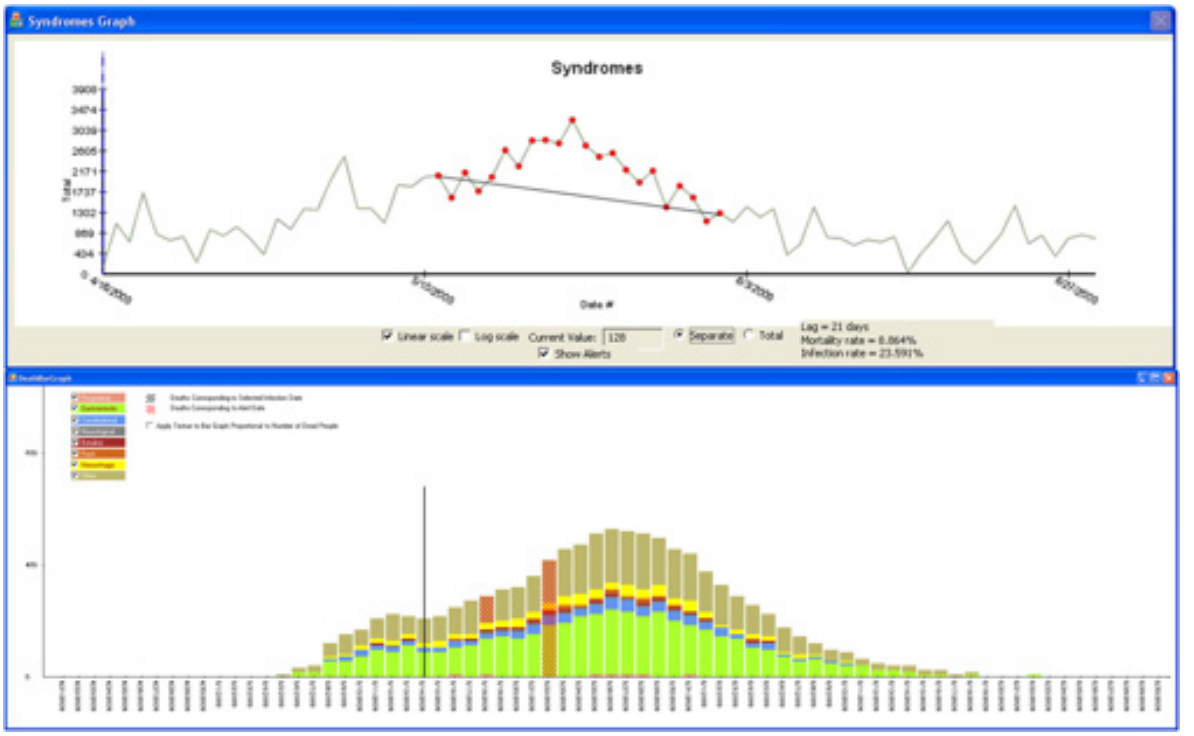


Red point as location of chemical spill, representation of veterinary visits in the surrounding area.

Not Just for Outbreaks
Animal companions often reflect environmental events. Above is LAHVA's representation of veterinary visits in the surrounding area of a chemical spill during the same week.

The LAHVA Technology Difference
LAHVA uses data entered into national databases in real time — by the Banfield Pet Hospital and Indiana Network for Patient Care (INPC) — enabling public health officials to respond quickly to events.

- Components
- Filtering for exploration of potential causes and spread patterns
- Map view for spatial data visualization
- Stacked graph view analyzing links between patient visits and deaths
- Statistical summary window with details on illnesses by age, gender and chief complaint
- Interactive time slider for animation, exploration and analysis
- Tape measure tool for use on the line graph view to measure parameters of pandemic



Tape measure tool and stacked graph view of patient visits and deaths.

Support for Future Detection Award
VAST 2010 Mini Challenge 2

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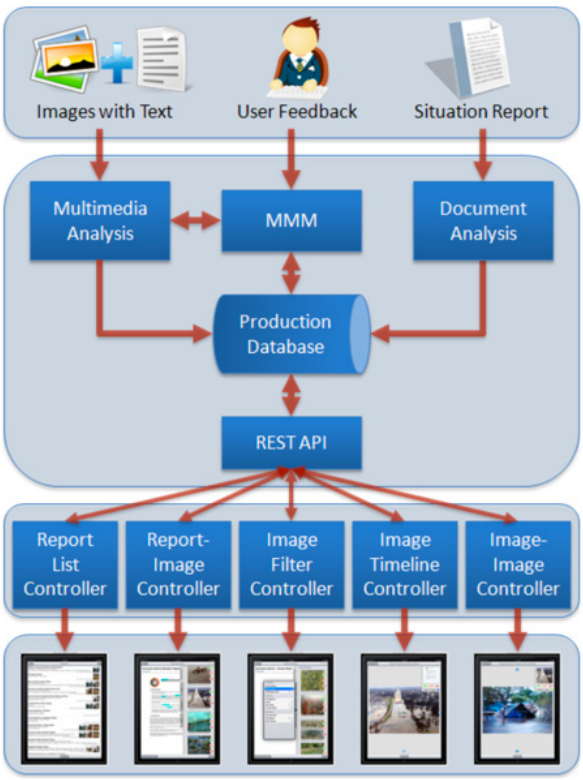
MADIS (Multimedia-Aided Disaster information Integration System) PRODUCT

What MADIS Does

MADIS, which stands for Multimedia-Aided Disaster Information Integration System, is an information integration framework designed and developed on an iOS platform for enhancing situation reports with photos and video and enabling quick emergency response.

Through a preprocessing component, the tool can catalog disaster-related images and identify relevant subject text in posted situation reports, training modules that establish the systems cataloging and text-analysis capabilities, and a web-based database system with a RESTful application program interface (API) that provides support for web or mobile-device client applications. MADIS has been developed for primary use on an iPad by responders in need of an interactive solution for efficient disaster situation assessment.



Model of the MADIS overview.

Direct Search Engine (DSE)

DSE is an extended function of MADIS that integrates multiple publicly sourced disaster information, providing versatile search functions such as keyword-based search and vertical search with mapping.

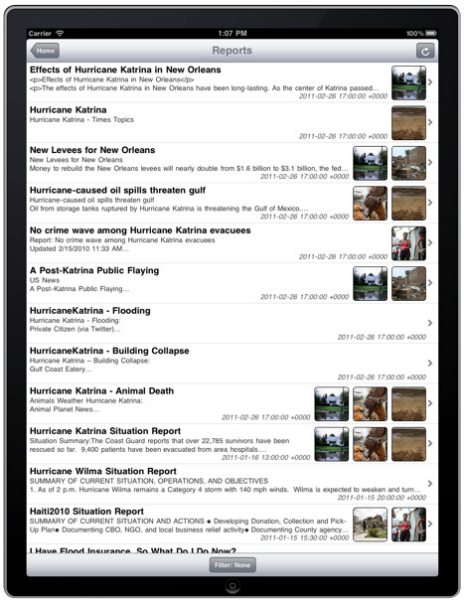
Through DSE, the user is able to quickly explore three different data sources: general web pages, latest news, and blogs and tweets. To access the data for users, one method relies on a keyword search while another method is based on data integration, with the results presented on maps.

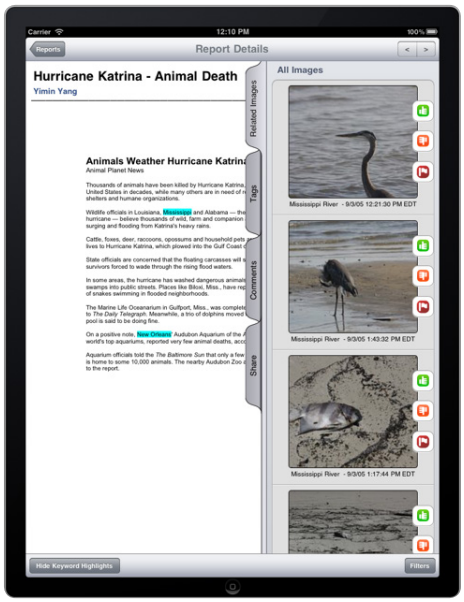
Screen shot of DSE's map-based search results.

continued . . .

Why it is Useful

Currently, responders are relying on solely textual reports to assess disaster damage. Enhancing these reports with photos and video provides more detail and allows for a more effective response.





Screen shots of 1) main report list with thumbnail-sized images and 2) an open situation report with highlighted keywords and related images identified by the system.

Additionally, the need for portability has made mobile devices a must-have in disaster response. MADIS provides emergency personnel with free, fast interaction in communicating between both the command centers and actual disaster sites.

An improved response time improves survival rates, but it also benefits businesses in the long term. Studies have shown that when a business is closed because of a disaster, even for a short time, it becomes highly likely that the business will fail. A quicker recovery improves the likelihood of higher survival rates of people and businesses success — a quicker recovery that MADIS enables.

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SMART (Social Media Analytics and Reporting Toolkit) PRODUCT

What SMART Does

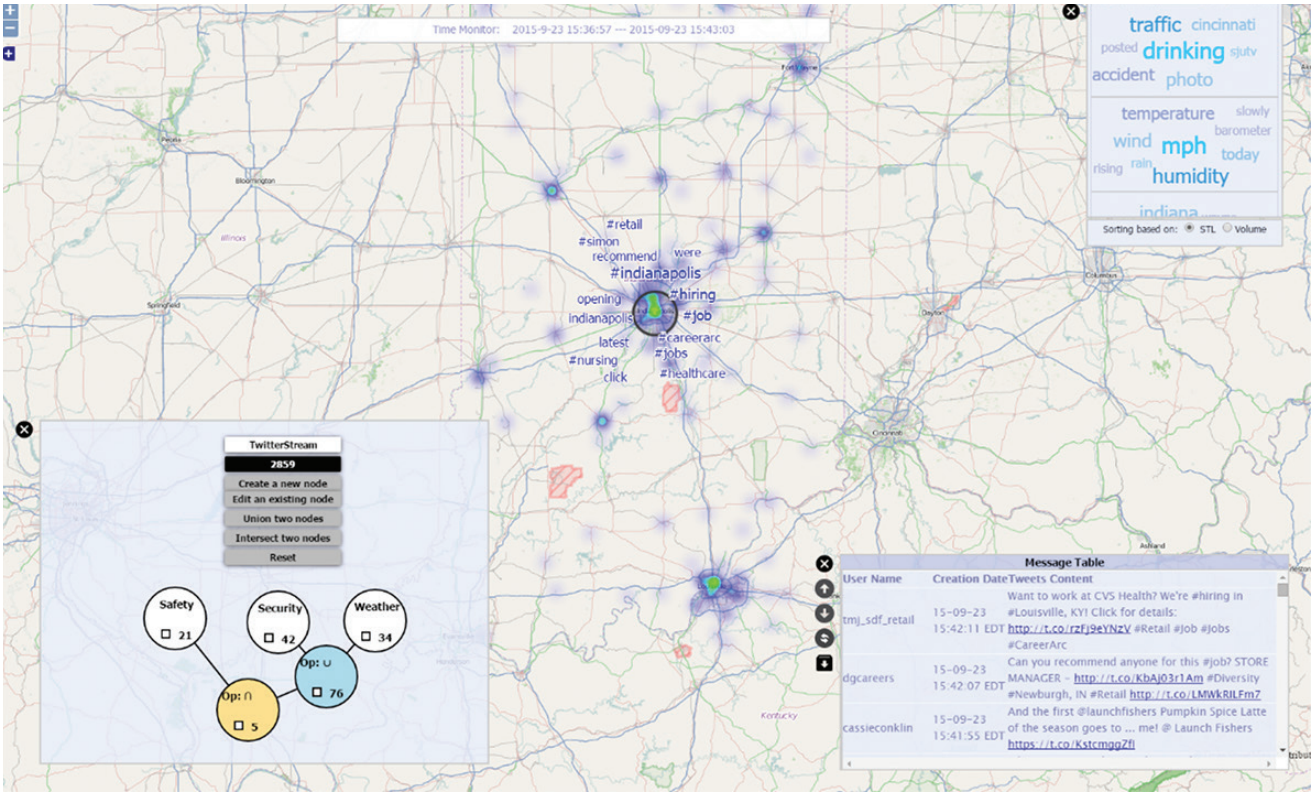
SMART software organizes large, unwieldy, uncoordinated social media datasets and displays them in ways that make them useful in decision making. SMART users can map, explore and navigate data from social media sites such as Facebook, Twitter, YouTube and others. Users also can customize the software's message/keyword filters and modes of display based on their needs. And as social media data changes and users' information needs evolve, SMART customizations also evolve.

Why it is Useful

SMART enables data-driven decision making. It turns disorganized social media data — essentially noise — into useful information. With SMART software tools, information about topics in social media and trends in human behavior on social media become discernible and understandable, and can become the basis for sound decision making.

How it is Used

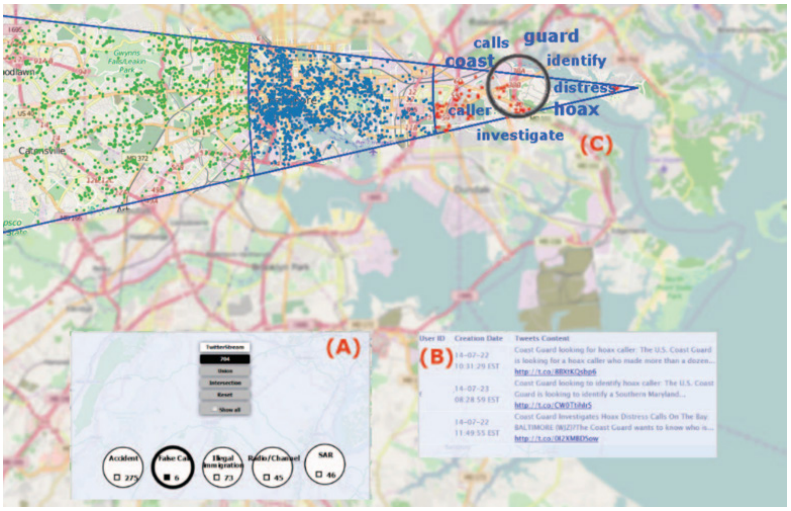
SMART enables users to look at data that's presented in a map or viewable by topic. It also allows a "filter" view that shows things such as traffic, weather and safety information — or other classifiers that the user can create and modify.



The SMART map includes a variety of view options that users can choose from. The "classifier" view loads traffic, severe weather and safety classifiers, and allows users to make their own classifiers or change those being used. When clicking a classifier, other corresponding data is refreshed and automatically appears. The map also shows prominent keywords taken from tweets that are relevant to a user's classifiers.

SMART gets smarter to uncover deception

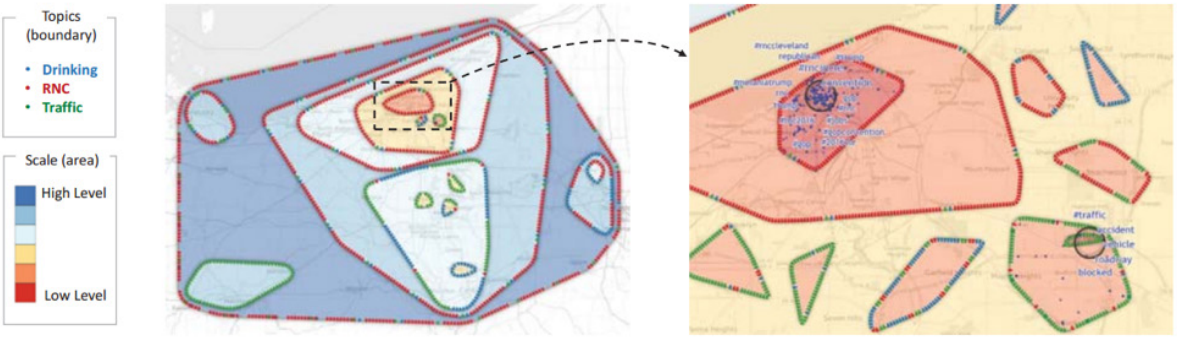
SMART has been enhanced to help investigate possible hoaxes. It provides a set of deception-related keyword collections through automatic expansion and human verification. It also resolves the lack of social media data by using user networks. This framework enables investigators to identify suspicious Twitter users and provides a visual-analytics environment that's designed to examine geo-tagged tweets and Instagram messages in the context of hoax distress calls.



SMART has been extended to support the investigation for hoax distress calls. SMART provides a set of hoax-related keyword collections through automatic expansion and human verification, and resolves the lack of social media data by utilizing user networks. The framework allows investigators to identify suspicious Twitter users and provides a visual analytics environment designed to examine geo-tagged tweets and Instagram messages in the context of hoax distress calls.

More SMART info = more SMART power

SMART's extension, called TopoGroups, provides visualizations of multiple levels of spatial aggregation of social media posts in a specific area. It also supports comparison, correlation and analysis of multiscale aggregates by showing them in the same display. This helps users understand the spatial distribution and identify trends and anomalies at different granularity levels.



An extension of SMART, named TopoGroups, visualizes multiple levels of spatial aggregation of social media posts at a specific region. TopoGroups supports effective comparison, correlation and analysis of multiscale aggregates by combining them into the same display, thereby helping users to understand the spatial distribution as well as identify trends and anomalies at different granularity levels.

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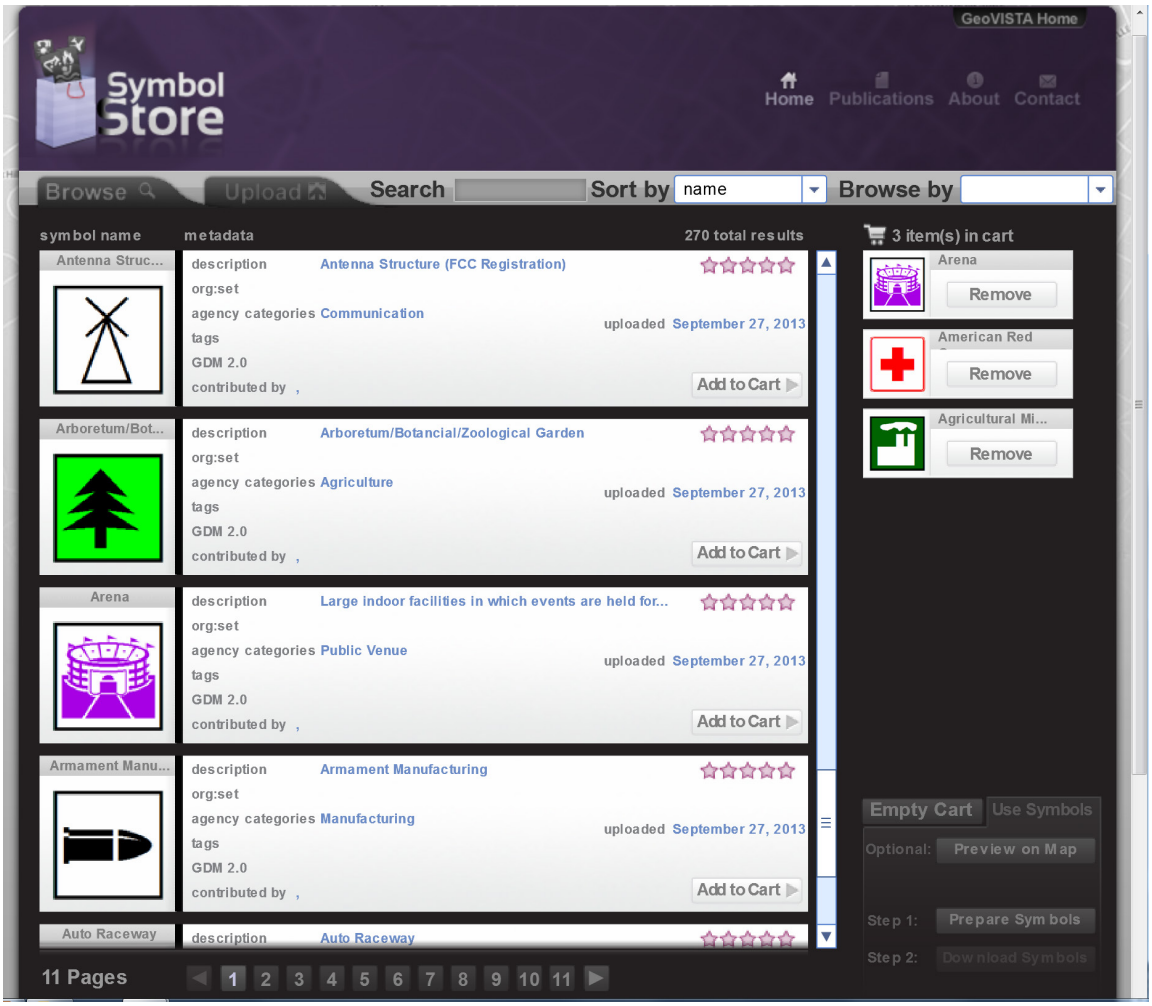
Symbol Store (Searchable Store for Map Symbols) PRODUCT

The Research

The focus of Symbol Store research is to share point symbols for maps, particularly those used commonly in emergency management tasks. These tasks can include disaster mitigation and response planning activities as well as direct response and situational assessment mapping in the immediate aftermath of a disaster. Additionally, they can include remediation mapping efforts as communities engage in recovery efforts.

What Symbol Store Does

Symbol Store is a web-based prototype tool that holds map symbols collected from U.S. government and public domain symbol sets designed by independent cartographers. Users can use keyword-based searches on www.symbolstore.org, and they also can search using time (most recent uploads), contributor and symbol categories. As Symbol Store's user base grows, the popularity of certain symbols also can be a search criteria.



Symbol Store's initial prototype interface with symbols contributed from Infrastructure Information Collection Division.

continued . . .

Why it is Useful

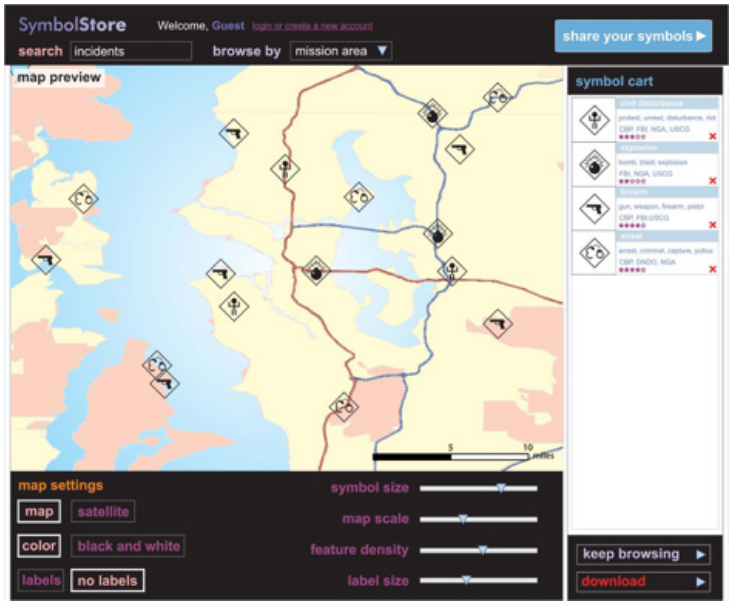
Several agencies within the U.S. Department of Homeland Security use maps as part of their daily operations, and those agencies need consistency to communicate and cooperate with one another. One clear need is that since emergencies are time-sensitive in terms of response, the rate at which responders and officials can read and interpret a map can make the difference between life and death and property saved or lost.

The need for Symbol Store was based on a comprehensive analysis of map symbol use by DHS and collaborating emergency management organizations at the state and local level. This analysis identified a substantial mismatch between some prior efforts to develop map symbol standards and the wide range of application cases for which DHS has primary responsibility. This mismatch resulted in duplication of map symbol sets and sometimes conflicting map symbols that could lead to confusion on the part of map users in a rapidly evolving crisis. Further systematic work with emergency map producers and users guided the development of Symbol Store and map symbol choices.

So far, a great deal of effort has gone into developing new symbol standards to support map interoperability in defense, crisis management and humanitarian mapping domains, however much less progress has been made toward making symbols easy to discover and share.

Symbol Store has over 2,400 map symbols that can be previewed on various map designs before downloading, including mobile symbols. This can improve the capacity for cartographers to design easily legible maps, and for users to read maps easily and respond quickly. Qualified users also can share their own images for others to search.

Symbol Store's upload interface.



The map preview function.

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VALET (Visual Analytics Law Enforcement Toolkit)

PRODUCT

What VALET Does

The Visual Analytics Law Enforcement Toolkit, or VALET, developed at Purdue's Homeland Security Center of Excellence, assists law enforcement officers and first responders in reducing crime and ensuring public safety. By providing real-time data, law enforcement officials can be more strategic in how they allocate resources in their communities.

As a computer software program, VALET analyzes high-volume criminal, traffic and civil incident data as well as related emergency management and disaster preparedness events.

The technology creates a picture of what is happening at any given time and what could happen in an hour or a day or a week, enabling law enforcement agencies to interactively visualize and analyze their datasets in linked geospatial or mapping and temporal views of time graphs, calendars and clock views. It can layer in weather information, zoning tracks, census and demographic data — even the moon phase.

VALET can be used on most computers, and its companion software, called iVALET, has been designed specifically for the iPhone and iPad.

> "One of my sayings is, 'We need to work smarter, not harder,' and the VALET toolkit allows us to pull data so we are in a better position to put officers in the right place at the right time when a situation arises. Providing this type of situational awareness gives us the higher level of assessment so we can better cover high-crime areas or give officers context of what is happening so they know what they are walking into when on patrol or responding to a call."
>
> *— John K. Cox, Purdue University Police Chief*

Why it is Useful

Law enforcement relies on data for analyzing high-volume criminal, traffic and civil (CTC) incidents for assistance in preventing crimes and judiciously allocate resources for the law enforcement community. Datasets, however, are increasing in size and complexity. And as budgets shrink and departments scale back, local law enforcement agencies are strained to effectively analyze the helpful data being collected.

VALET explores and analyzes multivariate, spatial and temporal law enforcement data to enable advanced data exploration and analysis of CTC incidence reports. VALET includes temporal prediction algorithms to forecast future criminal, traffic and civil incident levels within a 95% confidence interval. That means estimates of the collected data could be reliably repeated and used to predict future behaviors or actions.

Examples:

- At police department headquarters, officials can plan regular routes based on crime rates and the times of the day or week crimes are most likely to occur.
- Factoring in weather forecasts or scheduled major events that could clog vehicular traffic on main roads.
- Statistical analysis of historical data and temporal prediction algorithms can forecast future criminal, traffic and civil incident levels with 95% confidence.
- Available to officers in patrol cars, who can access it via their onboard laptops. The mobile version, iVALET, works with iPhones and iPads for officers who are on foot.

Data Layers:

- Criminal, Traffic, Civil
- Calendar Events
- Weather
- Census & Demographic
- Geographic Information Systems
- Moon Phase

"We are doing more than providing law enforcement officers with specific data covering their areas, because we've developed a portal for potential other issues such as prominent calendar dates, zoning tracts and even weather reports to help officers in their daily routines to protect the public."

— Abish Malik, research scientist

What's Next

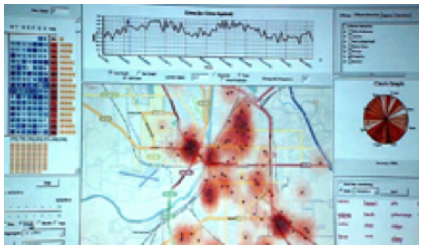
IMPACT

Analyzing high-volume criminal, traffic and civil (CTC) incident data is a crucial component for building and maintaining situation awareness of these incidents to ensure effective policing for maintaining public safety. Additionally, systems that are portable are desired because law enforcement officers are often on the road for duty. Police departments from South Carolina and Virginia to Indiana and Ohio have been tapping into predictive analytics as a crime-solving and -prevention tool — with success and positive results.

By developing a mobile visual analytics toolkit, Purdue-led researchers are able to assist law enforcement in the exploration and analysis of the multivariate spatiotemporal CTC data in detecting unusual criminal occurrences. Other work includes integration with the GARI technology to show gang tags, chemical plume modeling based on current weather conditions, and risk profiling based on the user's current time and location.

COLLABORATORS

- Illinois State Police Department
- Lafayette (Ind.) Police Department
- New York State Police Department
- Ohio State Highway Patrol
- Purdue University Police Department
- Tippecanoe County (Ind.) Sheriff's Department
- West Lafayette (Ind.) Police Department



This image developed through the VALET tool highlights a map of a selected location surrounded by a line graph, calendar view, clock view and crime history, with a time slider that ties the data together so crime reports, for example, can be viewed over a selected time. The screen also includes a Twitter widget to help detect unusual activity, such as a protest or riot.

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VASA (Visual Analytics for Security Applications) PRODUCT

What VASA Does

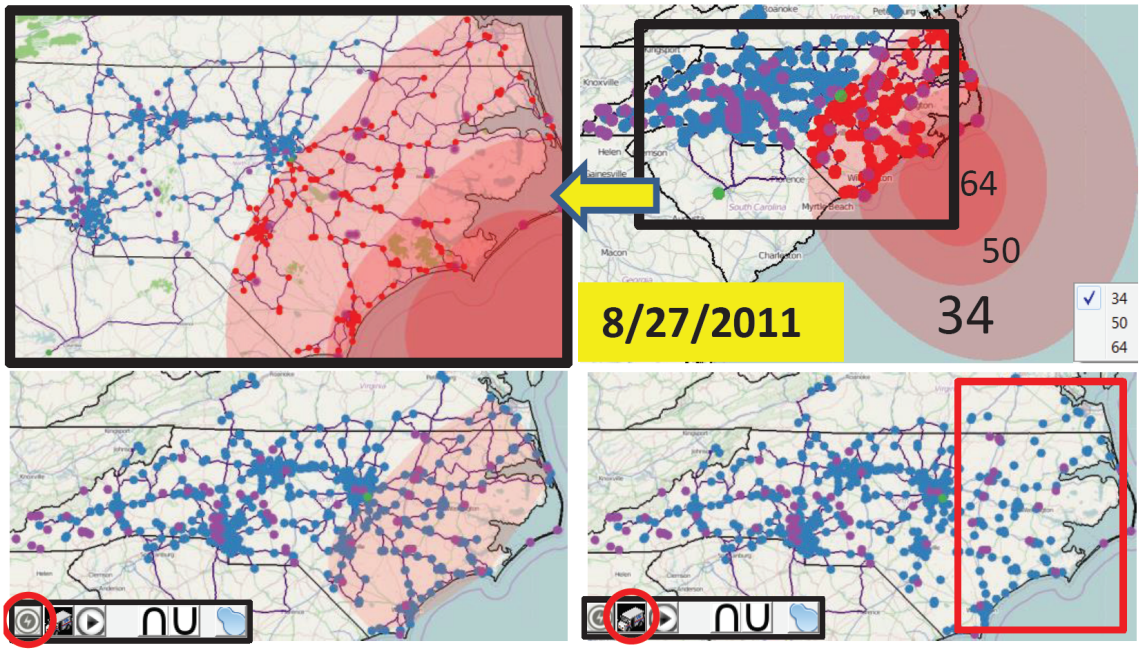
VASA, which stands for Visual Analytics for Security Applications, is a visual analytics platform for simulating the impact of societal threats such as weather, food contamination and traffic on critical infrastructure. It consists of a desktop application, a component model and a suite of distributed simulation components.

Why it is Useful

Both civic and business analysts often struggle to estimate the impact of an event, forecast damage and discover optimal solutions, because they lack complete sets of data, reliable simulation models and existing environments for decision-making.

VASA is a visual analytics system currently in development that provides this environment for analysts and decision-makers, and it provides a model for investigating a disaster-stressed, regional smart grid infrastructure. VASA also can investigate weak points and cascading effects due to failures in an overall infrastructure including electrical, water, transportation, food distribution and others.

Additionally, it provides a web service for onsite managers to access the results of simulations. This offers the unique capability to determine what will happen, when and where, and who and what infrastructures will be affected. Immediate, appropriate action can be taken, and analysts can evaluate the risk vs. return of different alternatives.



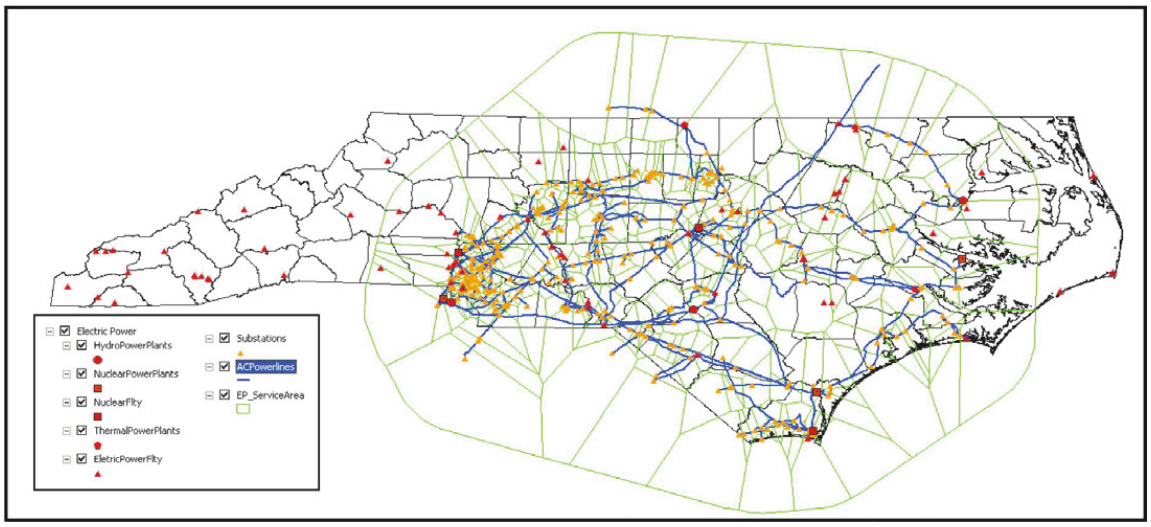
Visualization of stores in North Carolina damaged by Hurricane Irene (August 2011).

continued . . .

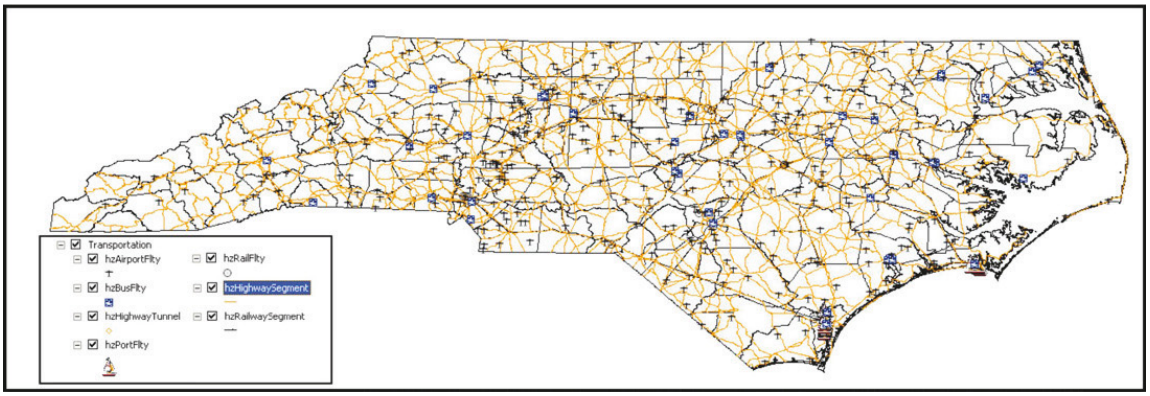
Layers of Data

VASA juxtaposes various data to provide an accurate evaluation and context of the scenario. The layers are:

- Infrastructure geolocations
- Distribution routes
- Economic and business models
- Weather event data



Power transmission grid for simulation.



Transportation network for simulation.

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vBOLO (Video Be on the Lookout)

PRODUCT

What vBOLO Does

vBOLO, which stands for Video Be on the Lookout, is a video detection technology that enhances current video surveillance by identifying features of a person committing a crime. The tool then uses those features to create a lineup of subjects matching those identifying features. Ultimately, it can re-identify persons of interest who reappear in the surveillance system, in a lineup of 10, at 90% accuracy.

Screen shot of vBOLO selecting a target, pulling a lineup and matching the subject.

How it Works

The method uses computer vision and image processing techniques to create features of the subject. Humans are continuously detected and monitored to determine when the subject reappears in the video. This is done by extracting features, which include color, texture, face and motion information, from each candidate and matching it to the subject. The result of the matching process is a constantly updated list of likely matches to the subjects.

Why it is Useful

In many cases, a subject will return to the scene of his/her crime days or hours later, at which point there is an opportunity to re-identify the person of interest, sound an alarm and apprehend the individual.

vBOLO provides that opportunity by re-identifying persons of interest, flags that the subject has reappeared and where they are located. Developers hope to improve the accuracy rate to 95% in a lineup of five by adding high-resolution video, motion features, improved body features, facial analysis and subject attributes (items carried or specific type of clothing worn, such as a backpack or a skateboard).

continued . . .

Where it is Being Used

vBOLO was developed for the Greater Cleveland Regional Transit Authority, where it has been tested.

"The results to date have been very impressive and I feel that continuing the development of these techniques will have real impact in how we are able to use our surveillance system. This could be easily extended to other transit systems and law enforcement applications throughout the country."

— John P. Joyce, Chief of Police, Director of Security
Greater Cleveland Regional Transit Authority

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Example Commercialization Plans

Investor Presentation

SMART:

Social Media Analytics and Reporting Toolkit

VACCINE Center, Purdue University

The Team

- **Management Team**
  - Credentials
  - Track record
  - Domain experience
- **Advisors**
  - Mentors and coaches

Problem Statement

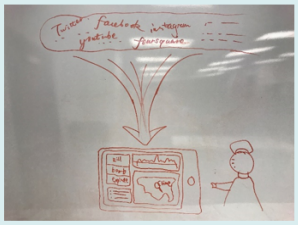
- Scope out the burning business problem
  - –There is a need to utilize real-time social media data for improving public safety and emergency management.

Problem Statement

- How big is this problem? Use 3rd party statistics to validate the metrics
  - The incident and emergency management market is estimated to grow from USD 88.58 Billion in 2016 to USD 114.01 Billion by 2021, at a Compound Annual Growth Rate (CAGR) of 5.2% during the forecast period (http://www.marketsandmarkets.com).
  - The social media management market in 2014 was worth $801m, and projects it to reach nearly $1.1bn in 2015 and $2.5bn by 2019 (https://www.yankeegroup.net).

Solution to the Problem

- What is it? What does it do?
  - A software-as-a-service solution: A visual analytics framework that captures the real-time social media data and performs advanced analytics and reports.
- High quality napkin drawing

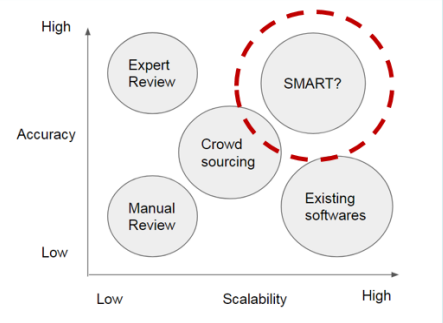


Solution to the Problem

- Include your concrete language
- Analogies and metaphors
- Status of the technology
  - In the intermediate stage between prototype and commercial product.

Current Market Landscape

- Provide an overview of the current market
  - Manual review
  - Expert review
  - Crowding-sourcing
  - Automatic software (existing toolkits)
  - SMART? (our opportunity)



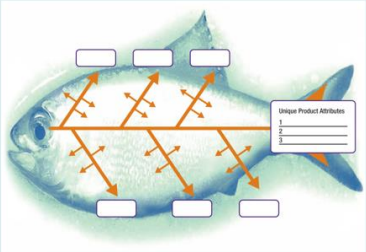
Current Market Landscape

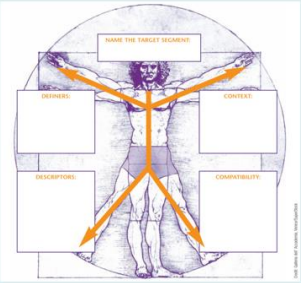
- Discuss the key drivers impacting this market space
  - Accuracy and scalability
- Discuss the alternative categories and their positioning
  - Accessibility/compatibility, price, software maintenance/update, technical support (ordered based on the importance: high to low)
- Highlight your opportunity
  - Highlighted in the last slide

Target Customer Segments

- Information derived from Market Fishbone and Segment Strawman
  - Do not use actual fishbone or strawman diagrams
- Profile what you know about your target segments
  - Who are the decision makers and buyers?
  - What criteria do they use?
  - How long does it take?
- How many customers are there?
- What lead customers will you work with?

- Results are shown in the next slide (table)



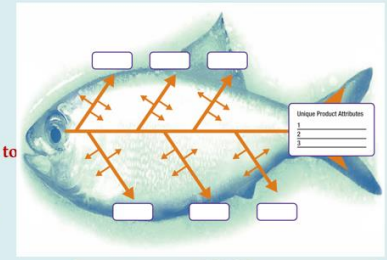


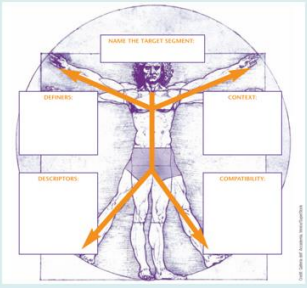
Target Customer Segments

Customer category	Decision maker	Lead customer	Number
Police departments	Chief/sheriff	Chief/sheriff and police officers	~20k law enforcement agencies employing more than 1 million full-time workers in the US
Intelligence institutes (e.g., Fusion Center)	Director of the center	Crime analyst, intelligence analyst	More than 72 fusion centers in the US
USCG	Admiral, vice/rear admiral	Intelligence analyst	36 sectors (operation unit) within USCG.
American Red Cross, FEMA, etc.	President of the organization	Disaster manager/specialist, service/resource provider	--

Target Customer Segments

- What will be your marketing & sales approach?
  - Maintain relationships with the currently active users
  - Advocate in the law enforcement conferences and events.
  - Use various channels (social media, email, mail) to advertise to potential customers (police depts. USCG sectors)
  - Organize regular meetings/workshops to enhance influence and exposure
  - Seek opportunities in a broader scope (business intelligence, education, etc.)





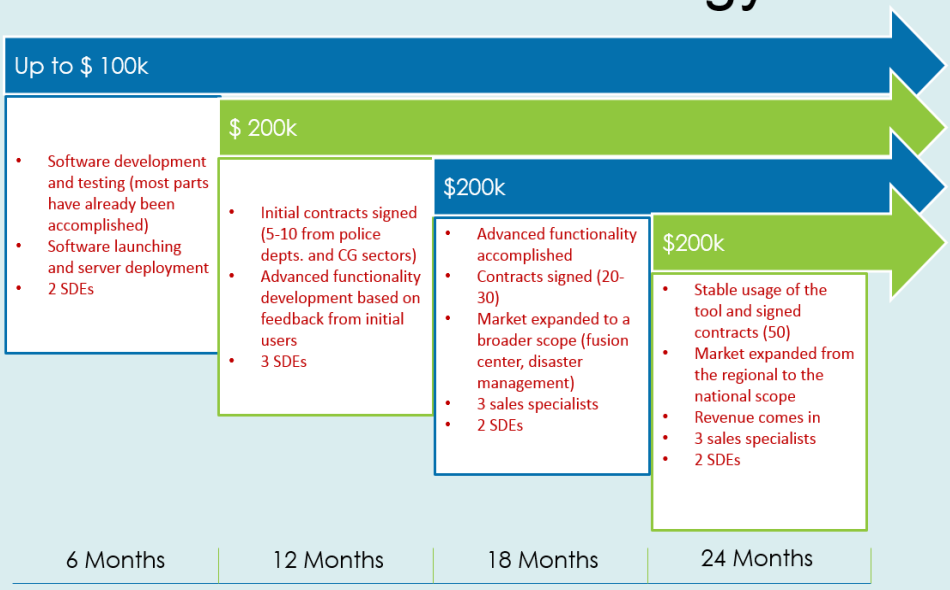
Product

- Whole product for your target customer segments?
  - What is in the box?
    - Real-time analysis, abnormal detection, flexible interactivity, email alerts
  - Include value added elements
    - Technical support via phone or webinar, training sessions, user manual, software update

Product

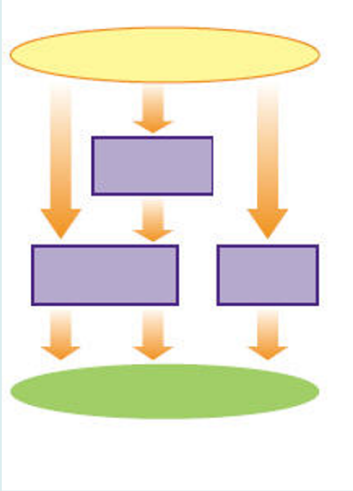
- How far are you from a market ready product?
  - Current stage of development
    - Proof of concept, beta, etc.
      - The intermediate stage between prototype and commercial product. (Major functionality is accomplished. May need to refactor depending on the number of users.)
    - When do you plan to launch your product?
      - In 6 months to 1 year
    - How long before revenue comes in?
      - 1 to 3 years

Go to market strategy



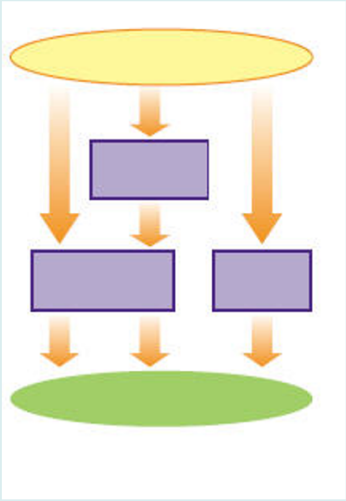
Channels of Distribution

- How will customers get your product?
  - Through web access on computer or mobile devices
- Where is your target customer?
  - Most are Regional and national. May include global customers.



Channels of Distribution

- Map your channels and partnerships to deliver your product to your customer
- Since our product is a web-based software, most of our channels for product delivery will be direct sales via online access and communication.



Competitive Comparison

- What is your competitive differentiator?
- Who are your competitors?
- How do they stack up?
- Why will you win out over these competitors?

- The result is shown in the next slide (table)

Tools	Features					Clients
	Geo-Location Analytics	Anomaly Detection	Topic Classification	Real-Time Monitoring	Text Analytics	
SMART	✓	✓	✓	✓	✓	Public Safety
TwitterFall				✓	✓	Indiana Police Department
SnapTrends	✓			✓	✓	Multiple Law Enforcement
Sproutsocial				✓	✓	Companies
TOPSY(Pro)				✓	✓	Bloomberg
Sysomos	✓			✓	✓	Microsoft
Radian6				✓	✓	L'ORÉAL
Storyful	✓			✓	✓	The New York Times
Lithium				✓	✓	Skype
Mention			✓	✓	✓	Arte
Geofeedia	✓			✓	✓	Law enforcement, risk mgt., journalism, brands

Financial Forecast Example

Item	12 months	18 months	24 months
Operating expenses (sales marketing, development, administration) development, administration)	300k	200k	200k
Revenue (# of user*subscription per user per year) year)	(5-10)*5k	(20-50)*5k	100*5k
EBITDA	negative	negative-50k	300k

Milestones

- What have you accomplished to date?
  - The current product is in the intermediate stage between prototype and commercial product.
  - Customer engagement: around 3-5 initial customers (stable) are engaged.
- What key items do you lack to accomplish your goals?
  - Technical aspect: funding for accessing firehose data and employing developers for maintaining/improving the product.
  - Market: funding for advertisement and exposure to potential customers and employing sales specialists.

Investment and Use of Proceeds

- How much money do you need? 700k
- What will you do with it?
  - Hardware support 50k (hardware and data services)
  - Product development 450k (SDE)
  - Market employees 200k (sales)
- Timeline
  - 6 months to 1 year (initial stable version)
  - 1 year to 2 years (advanced functionality and stable performance)

Investment Highlights

- Remind investors why you are a great investment
  - Leading experts in data visualization
  - A relatively mature product and initial customer groups available
  - Close connections with potential customers (police depts., CG sectors, DHS institutes)
- Reinforce proof points from your presentation
  - Customer engagements
  - Partnerships
  - Experienced team

VALET

VALET
Visual Analytics Law Enforcement Toolkit

Guizhen Wang, Jieqiong Zhao, and Jao Surakitbanharn

May 31, 2017

The Team

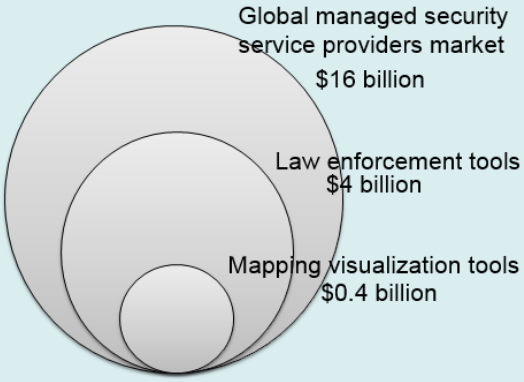
- **Management Team**
  - Credentials
  - Track record
  - Domain experience
  - System development: Purdue faculty and students
- **Advisors**
  - Mentors and coaches

Problem Statement

- Scope out the burning business problem
  - –Public safety needs data analysis to detect incident patterns and prepare for proactive analysis.
  - –Traditional data analysis methods are inefficient.
    - •Data analysis results are complicated to understand.
    - •General tools cannot satisfy interactive data exploration.
      - –Data analysis process is an iterative loop.
      - –Microsoft office, Matlab, R
- How big is this problem?(next slide)
  - Include some shock value
  - Quantify the problem
- Use 3rd party statistics to validate the metrics

Public safety market size

- Global managed security
  - – Law enforcement, insurance
    - Data visualization



http://cds.frost.com/p/71979/#!/nts/c?id=NABA-01-00-00-00
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Solution to the Problem

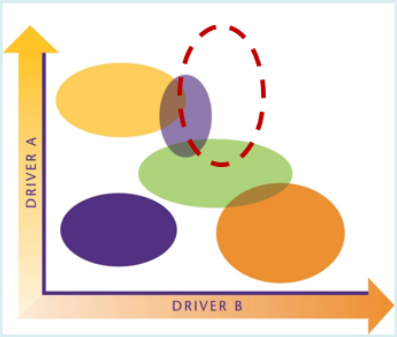
- What is it? What does it do?
  - Data visualization techniques can improve efficiencies of public safety data analysis.
  - Unique product attributes
    1. Customized crime data visualization
    2. Crime pattern and crime prediction
    3. Easy analysis process

- High quality napkin drawing
- Include your concrete language
- Analogies and metaphors

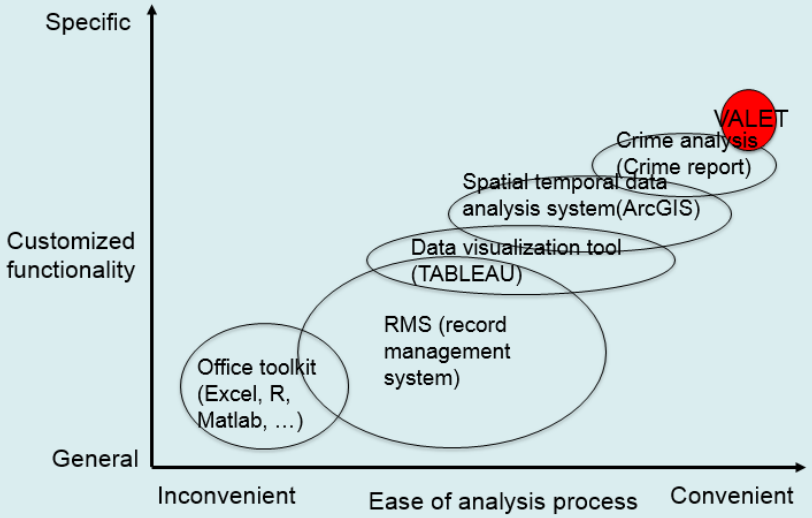
- Status of the technology
  - Patents, proprietary elements?
  - PROACTIVE SPATIOTEMPORAL RESOURCE ALLOCATION AND PREDICTIVE VISUAL ANALYTICS SYSTEM(Publication number: 20170011299)
  - Visual analytics law enforcement tools (Patent number: 8849728)
  - Visual Analytics Law Enforcement Tools (Publication number: 20130057551)

Current Market Landscape

- Provide an overview of the current market
- Discuss the key drivers impacting this market space
- Discuss the alternative categories and their positioning
- Highlight your opportunity

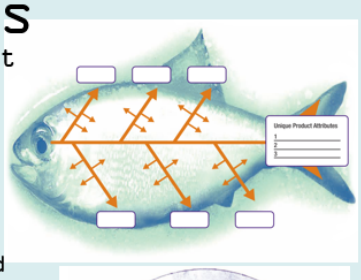


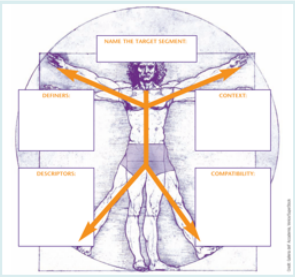
Current Market Landscape



Target Customer Segments

- Information derived from Market Fishbone and Segment Strawman
  - Do not use actual fishbone or strawman diagrams
- Profile what you know about your target segments
  - Who are the decision makers and buyers?
  - What criteria do they use?
  - How long does it take?
- How many customers are there?
- What lead customers will you work with?
- What will be your marketing & sales approach?





Target Customer Segments

- Law enforcement agencies
  - Federal governments, like FBI and CIA
  - State government, like local police department
- Enterprise
  - Insurance companies, real estate, retail stores
- Non-profit organizations
  - Red cross, University, Non-profit organization

Target Customer Segments –Law enforcement agencies

Definers
- Local police department in nearby dates IN, IL, OH
- 10 to 20 big cities
- Few hundred to one thousand police officer department

Descriptors
- Government organization needs long term decision process
- Senior officers, chief of police department
- Easy to corporate with their RMS, portable, real-time interactive system
- Improve work efficiency

Context
- Resource allocation for patrol officers
- Prediction of crimes historical pattern of crimes
- Patrol officers, crime analysts
- Improve community safety, reduce crime rate

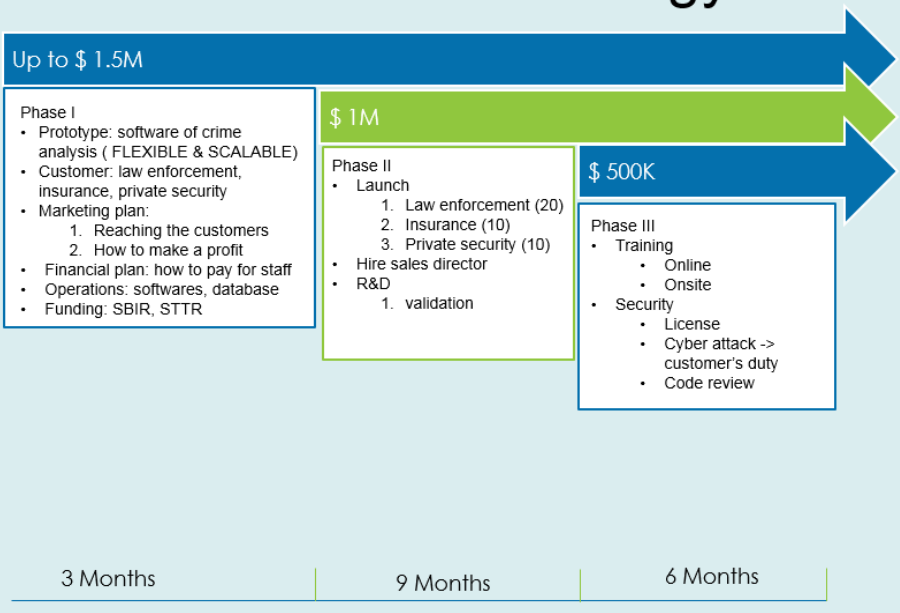
Compatibility
- Connection with current RMS
- Hardware: desktop, tablet
- Security of software

Decision makers: crime analysts, police officers, detectives
Buyers: Public safety business office, Chief of Police

Product

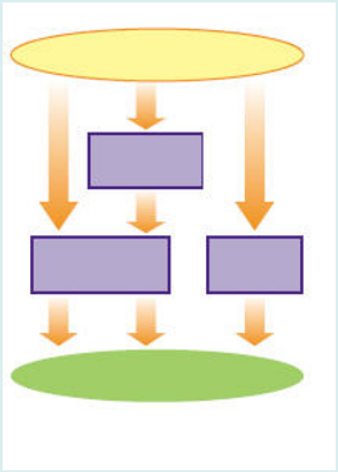
- Whole product for your target customer segments?
  - What is in the box?
  - Include value added elements
- How far are you from a market ready product?
  - Current stage of development
    - Proof of concept, beta, etc.
    - When do you plan to launch your product?
    - How long before revenue comes in?

Go to market strategy



Channels of Distribution

- How will customers get your product?
- Where is your target customer?
  - Regional? Global?
- Map your channels and partnerships to deliver your product to your customer



Channels of Distribution

- How will customers get your product?
  - A: online download or disk
- Where is your target customer?
  - Regional? Global?
  - A: law enforcement agencies, global
- Map your channels and partnerships to deliver your product to your customer

Competitive Comparison

- What is your competitive differentiator?
- Who are your competitors?
- How do they stack up?
- Why will you win out over these competitors?

Company & Product	Unlimited Songs	Multiple Devices	Create Playlists	Radiocast
Spotify				
iTunes				
Pandora				
Rhapsody				

Competitive Comparison

Company& Product	Access of raw date records	Mapping tool	Temporal trend	Simple interactions	prediction
RMS	√				
Tableau	√	√	√		
Crime report	√	√	√	√	
ArcGIS	√	√	√	√	
VALET	√	√	√	√	√

Financial Forecast Example

Three-year financial model			
	(all figures in US dollars '000s)		
Item	**Year 1**	**Year 2**	**Year 3**
Revenue	**6,780**	**14,030**	**20,120**
Cost of Goods Sold	*2,710*	*5,610*	*8,050*
Gross Profit	**4,070**	**8,420**	**12,070**
Sales + Marketing	*1,360*	*2,810*	*4,020*
Product Development	*1,690*	*2,810*	*3,020*
General and Administration	*1,020*	*2,100*	*3,020*
Total Operating Expenses	**4,070**	**7,720**	**10,060**
EBITDA	***0***	***700***	***2,010***

Milestones

- What have you accomplished to date?
  - Prototype
    - Development done
  - Customer engagement
    - Indiana law enforcement agencies, like Lafayette police department and Evansville police department
- What key items do you lack to accomplish your goals?
  - Expertise
  - Finances
  - Partnerships

Investment and Use of Proceeds

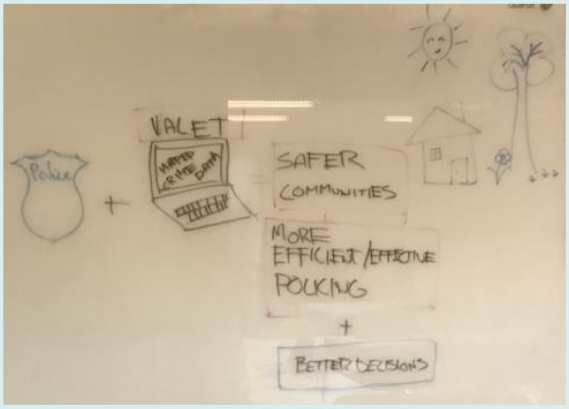
- How much money do you need?
- What will you do with it?
  - Build facilities
  - Complete prototype
  - Hire employees
- Timeline
  - What will you accomplish and when?

Investment Highlights

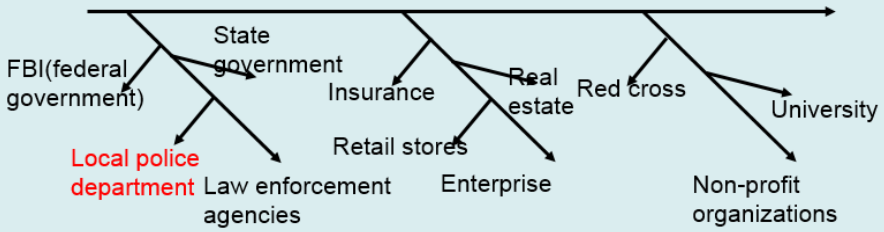
- Remind investors why you are a great investment
  - Public safety is a big market.
  - The value of data analysis
- Reinforce proof points from your presentation
  - Customer engagements
  - Partnerships
  - Experienced team

Backup slides

Napkin Drawing



Target Customer Segments -Fishbone



Unique Product Attributes

1. Customized crime data visualization
2. Crime pattern and crime prediction
3. Easy analysis process

SARVA

Search And Rescue Visual Analytics

The Team

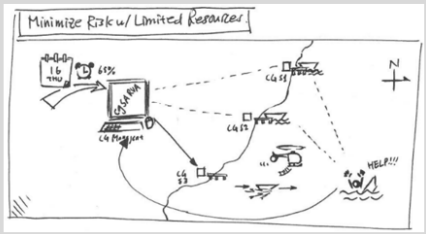
- **Management Team**
  - Domain experience: Coast Guard
  - Engineer: Guizhen Wang
- **Advisors**
  - Mentors and coaches: *Dr. David Ebert*

Problem Statement

- *How do you minimize risks and losses in search and rescue when given limited resources?*
- How big is this problem?
  - *The Office proposed a $1.3 billion cut to the Coast Guard in fiscal 2018, while Coast Guard conduct 48 search and rescue cases on an average day. How should they allocate their resource when that cut happens?*

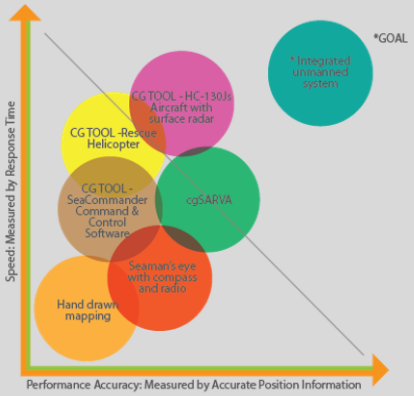
Solution to the Problem

- *cgSARVA is a visual analytics system that analyzes hypothetical station closures on response time, potential lives saved, and property lost and highlights regions that would be exposed to greater risk. The system combines advanced visualization methods showing patterns regarding seasonal search-and-rescue patterns and for specific days of the week, time of the day, and holidays.*



Current Market Landscape

- Effectively direct & deploy resources with self sustaining technology that enables CG to better communicate between land, air and sea.
- Budget and environmental circumstances are the key drivers impacting this market space.
- Coast Guard has several tools and methods for responding to distress calls, however none are all encompassing.
- Difficult to find other resource allocation tools that address the needs of the CG.



Target Customer Segments

- *Resource Allocation sector for emergency responses.*
- *US-based district level organizations with at least 5 years of digitally stored historical data.*
- *User Goal: to reduce response time and loss with more efficient use of resources (less paid waiting)*
- *Use Application: to manage location, schedule, and supplies to minimize risks when resources are lacking*
- *Compatibility:*
  - *Must run on a Windows machine*
  - *Either have secure internet connection or can set up their own database*
  - *May require an initial training for the operational research analysts*

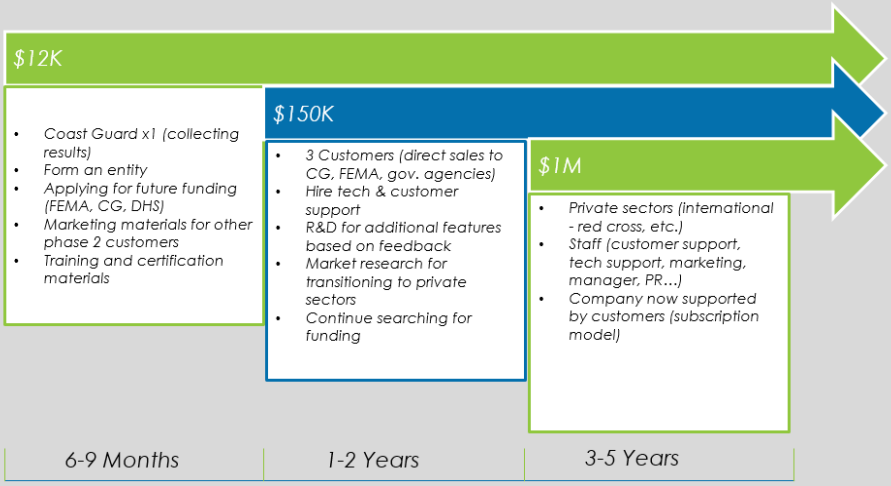
Target Customer Segments

- Profile what you know about your target segments
  - Who are the decision makers and buyers? *Area Commander for Coast Guard*
  - What criteria do they use? *Cost Benefit Analysis*
  - How long does it take? *Proposes in the yearly budget.*
- How many customers are there? *12 Coast Guard Districts*
- What lead customers will you work with? *Coast Guard, then possibly FEMA, Firefighters, etc.*
- What will be your marketing & sales approach? *Direct Sales with the initial customers then subscriptions.*

Product

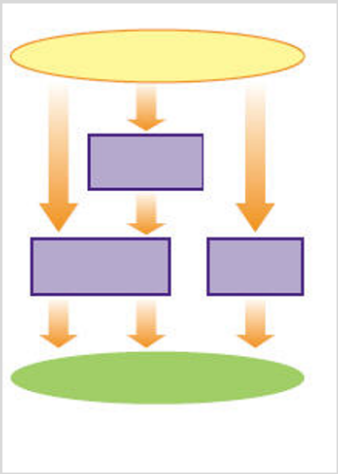
- Whole product for your target customer segments?
  - What is in the box? *Whole system adapted to their data, some tech support.*
- How far are you from a market ready product?
  - Current stage of development
    - *Working version for Coast Guards.*

Go to market strategy



Channels of Distribution

- How will customers get your product? *Directly contact us, we'll set it up for them.*
- Where is your target customer?
  - *Regional (US)*
- Map your channels and partnerships to deliver your product to your customer – *DHS and other Law Enforcement connections.*



Milestones

- What have you accomplished to date?
  - *A Working System*
  - *User Experience and Feedback from Coast Guard*
- What key items do you lack to accomplish your goals?
  - *Finances*
  - *Partnerships*

Investment Highlights

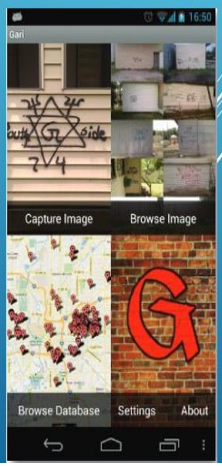
- cgSARVA is a vital component for analyzing and assessing operational efficiencies of different Coast Guard missions across the US.
- The system aids with the risk assessment of potential staffing changes.
- The analyst will be able to understand the distribution of incidents, risk, and benefits involved with the reallocation or reduction of resources.

SARVA

Your Buoy 4 Life

A Gang Tattoo And Graffiti Analysis, Recognition And Interpretation System

Provide Patrol Officers An Alternate, Accurate And Fast Method To ID Gang Members And Their Associates.



Target Market:

Patrolmen, Gang Taskforce Leader/Intel Analyst, Prison Special Threat Group at:

5,000 Prisons/Jails and 15,000 PDs

How we started - Version 1.0

The Business Model Canvas - GARI

Key Partners
- Large initial LE/Govt.Org
- Federal, State, and Local governments
- Law enforcement/ corrections Departments
- Purdue (IP)

Key Activities
- Cultivate a community of LE/CO Users
- Get Large (Fed) LE to host DB
- Get Large (Fed) LE to Fund initial creation
- Maintaining and enhancing service

Key Resources
- Physical – Central Server/DB
- IP – License From Purdue; GARI developed software
- Human – All LE officers that grow the DB; Developers, Trainers; Sales

Value Propositions
- Reduction and prevention of violent crime
- Better prediction of crime trends
- Reduced Training time/costs
- Faster and more accurate intel on Gang members, territories, and activities.

Customer Relationships
- Automated Self Service – End LE/ CO user who needs the data
- Communities – LE/CO who help make the DB better
- Co-Creation – With large LE/CO (Fed)

Channels
- Partner – Will need a large initial Partner (Fed)
- Direct – Will sell directly to LE/Corrections Departments

Customer Segments
- Federal, State, and Local Law Enforcement/ Corrections Departments

Cost Structure
- Value Driven pricing
- Fixed Costs: Servers, IT infrastructure, GARI staff salaries, office space.
- Variable Costs: IP License, Sales staff/commissions, IT costs (bandwidth/server processing/growth).

Revenue Streams
- Subscription to our service paid by LE and corrections Departments

Stepping stones

STEP 1 : POLICE OFFICERS

Interviewed police officers to determine:

- How they currently use graffiti and tattoos in their work
- How a technology for tattoo and graffiti image recognition may help them

Here is what we found….

- Graffiti no longer popular among gangs
- Gangs modify their ROE, use websites/social media
- Small municipalities' expertise is concentrated with a few passionate officers; larger cities: gang TF
- Rely on RMS, personal knowledge, or network
- GARI is a "Nice to have feature"
- Insufficient Budget
- Limited access to major Databases

OUTCOME: Standalone Offering not in demand

Police Officers → Small RMS Providers → Large RMS Providers → Metro PDs

Stepping stones

STEP 2 : SMALL RMS PROVIDERS

Interviewed Record Management System Software providers

- How they currently integrate tattoo images in their RMS
- How a technology for tattoo image recognition can add value to existing RMS software

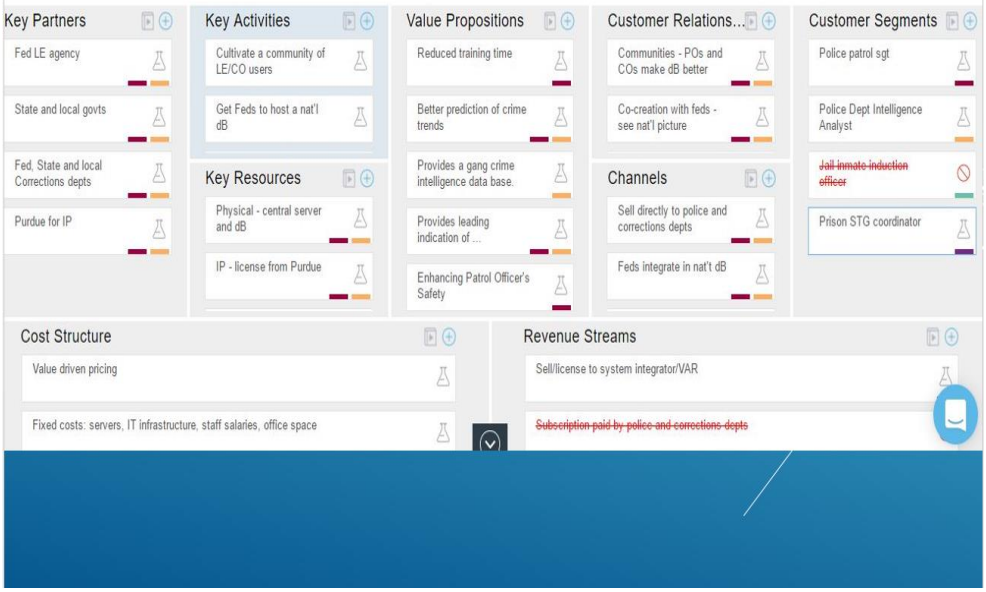
Here is what we found….

- Highly fragmented market
- Low willingness to pay to adopt new features
- Would not include unless demanded by customers
- Challenges:
  - Would spend time and money with each sale.
  - Revenue can cover only operating costs.
  - Separate programming language conversion

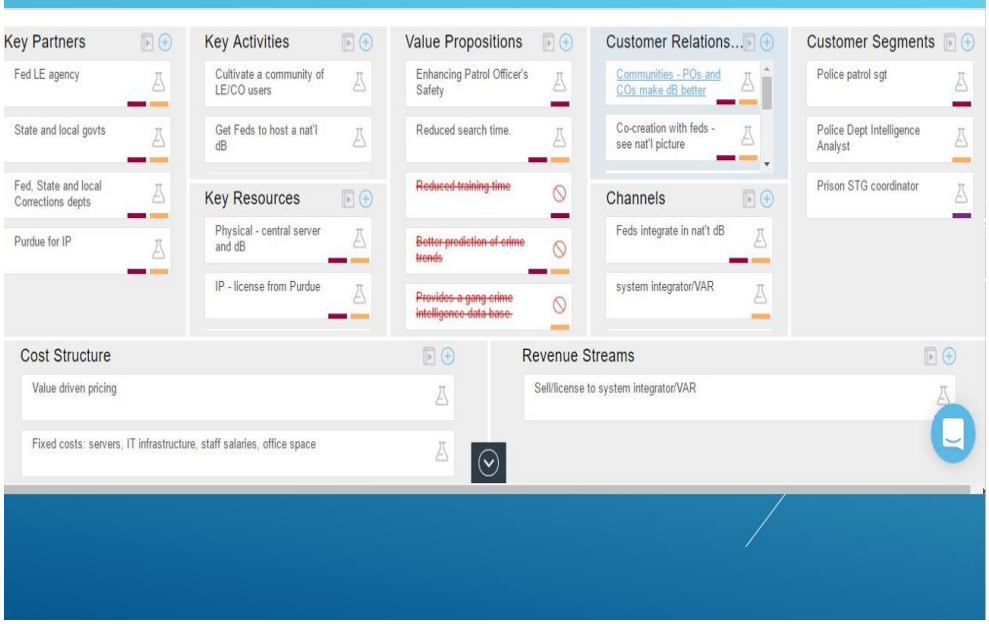
OUTCOME: Difficulty to find RMS partners and low revenue

Police Officers → **Small RMS Providers** → Large RMS Providers → Metro PDs

Business Model Canvas – Week 7



Business Model Canvas – Week 10



Stepping stones

STEP 3 : LARGE RMS PROVIDERS

Interviewed nation-wide Record Management System Software providers

- How they currently integrate tattoo images in their RMS
- How a technology for tattoo image recognition can add value to existing RMS software

Here is what we found….

- Focus on standard features and economies of scale
- Would require an API or compatible code/plugin
- Have not received interest/demand from customers
- Some interest as an added feature to RMS
- Challenges:
  - Tattoo DB concerns; location, content, sharing
  - Not willing to pay very much for feature
  - Extensive development to create API/plugin

OUTCOME: "Nice to have" feature, willingness to pay is low

Police Officers → Small RMS Providers → **Large RMS Providers** → Metro PDs

Stepping stones

STEP 4 : Metro PDs

Interviewed FBI officer

- An image search capability on a national dB

Interviewed experienced public safety software developer

- More profit and maintenance revenue at metro PD

Here is what we found….

- Demand exists but following steps are necessary:
  - software update
  - convert to C++ with grant funds
  - compete in NIST evaluation
- Benefit: Not much money, but much national exposure. Could lead to metro PD sales.
- Status: Principal Investigator does not have a grad student to apply to this task.

OUTCOME: Great exposure and better performance on a national DB

Police Officers → Small RMS Providers → Large RMS Providers → **Metro PDs**

Parallel Route

TATTOO ARTISTS

Interviewed tattoo artist to determine:

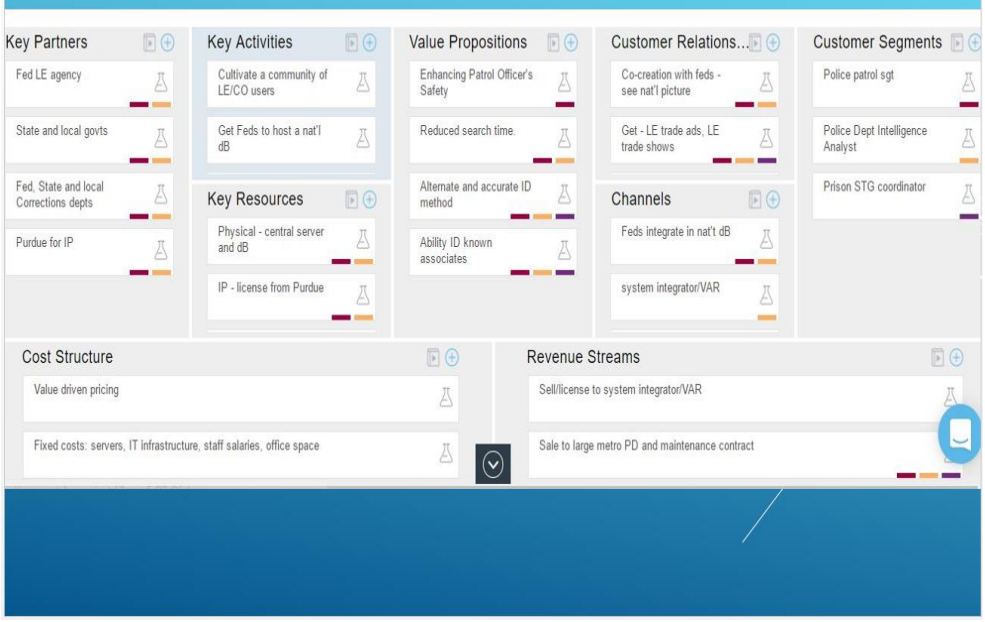
- How they acquire customers
- How customers present tattoo ideas to the artist
- How a tattoo app may benefit their business

Here is what we found….

- Customers usually have a design in mind and commonly bring in designs from Pinterest
- Rely on word of mouth and social media
- Paid advertising is traditional and locally focused using fliers, business cards etc.
- Concerns about tattoo designs being copied
- There is not currently a popular app devoted to tattoo identification

OUTCOME: Possible Pivot, investigate further

Business Model Canvas – Week 14



Where We Ended Up – Lessons Learned

- Discovery prior to product launch
  - MERGE -> Purdue Police Chief comment -> product launch
- End-User engagement throughout development
  - E2E transition process
  - Deliver what the customer wants
- Software development and integration
  - Starts with source code development
- No LE has this capability
  - All still rely on short text descriptions

Journey Ahead – Miles to go !!!

- Do you have a product or a company?
  - GARI is a product that could be the beginning of a suite of tools
- Pursue this idea?
  - Only enough profit for a owner-developer.

VACCINE

Visual Analytics for Command, Control, and Interoperability Environments

A U.S. Department of Homeland Security Center of Excellence

Co-operative Agreement Close-out Report Overview

David S. Ebert

Overview

- History
- Executive Summary
- Key Successes
  - Research
  - Tools
  - Education
- Recommendations and Lessons Learned
- Summary

CVADA-VACCINE History

Mission Statement: Explore and implement new science and technology to identify, analyze, and understand massive amounts of complex and dynamic information; disseminate, share, and secure such information in support of real-time decision-making by the homeland security enterprise

History:

- Established 2009
- Incorporates prior work under RVACS and IDS-UACs

Co-Leads:

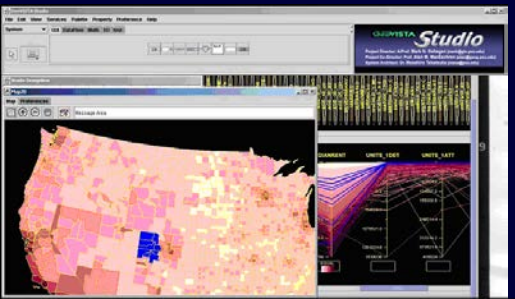
- Purdue University – Visual Analytics for Command, Control and Interoperability Environments (VACCINE)
- Rutgers University – Command, Control and Interoperability Center for Advanced Data Analysis (CCICADA)

Why was CVADA-VACCINE Established? - Importance to Homeland Security

Problem: To solve today's and tomorrow's homeland security problems requires exploring, analyzing, and reasoning with massive, multi-source, multi-scale, heterogeneous, streaming data –**BIG DATA**

- Cuts across entire spectrum of DHS needs

We provide tools to enable end users to get the relevant information they need during any situation and in the time to make a decision or take action

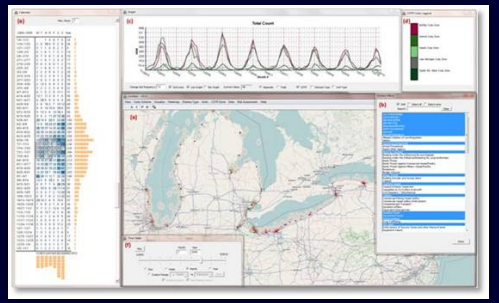


Overview Video

Executive Summary – Impact of VACCINE

- **Developed 33 tools; some used at significant national events.**
- **2nd place in national competition - GARI**
- **Funded > 350 students**
- **Produced > 1000 papers**
- **14 Patents awarded**
- **Grant value > $25,000,000**
- **More than 4000 students trained in VA**
- **Start-up company launched**
- **Only COE with a USCG accredited tool**

DAVISTA TECHNOLOGIES



Key Successes: Research

Link to SuccessVis

- **Provided Intellectual Leadership for VA field**
  - **300 peer reviewed journal articles, 325 conference publications and presentations, 40+ graduate theses, 34+ research projects**

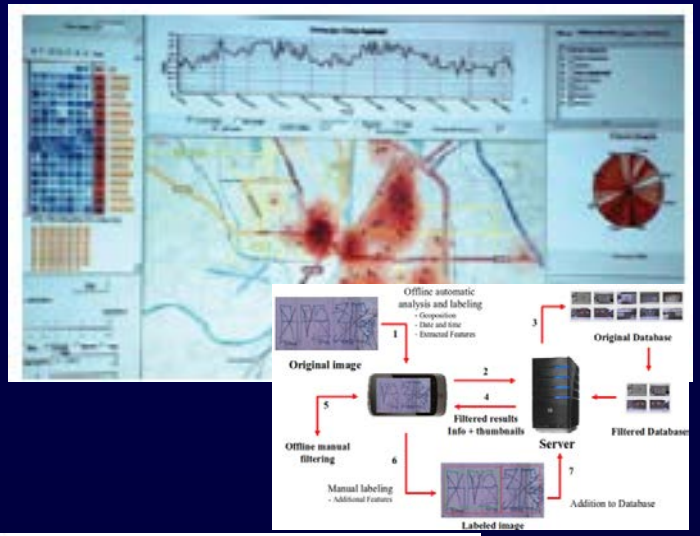
- **Led Efforts to Expand Inclusiveness**
  - **MSIs/HBCUs**
- **Expanded International Partnerships**
  - **Created tools and conducted research**

VACCINE

Public Safety Video

Key Successes: Tools

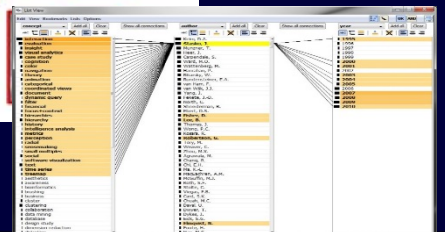
- **VALET**
  - **Licensed to DAVISTA**
  - **Deployed to several law enforcement agencies**



- **GARI**
  - **Finished 2nd in the NIST/FBI TATT-C Challenge**
  - **Used by multiple law enforcement agencies**

- **vBOLO**
  - **Piloted successfully at the Cleveland Rapid Transit Authority**

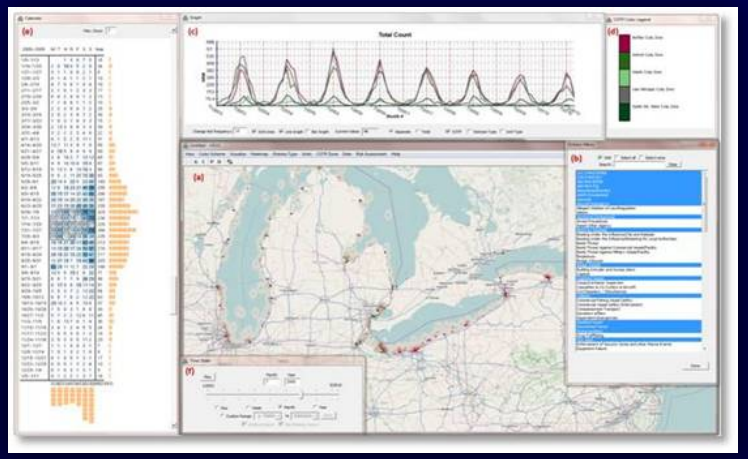
- **JIGSAW**
  - **Approximately 7,000 downloads**



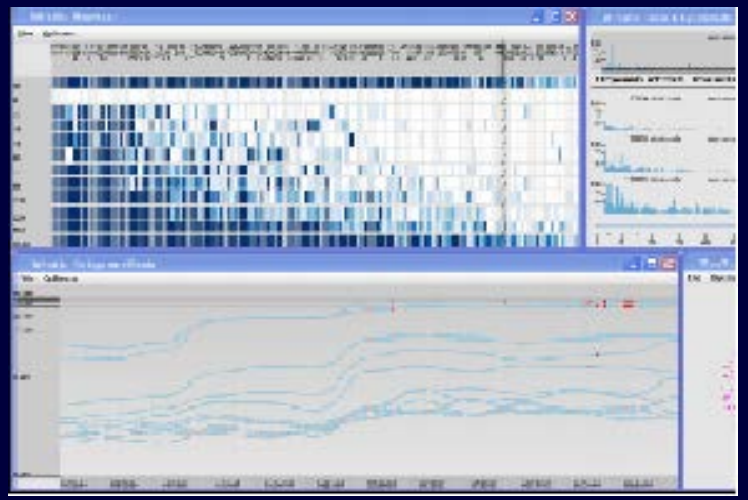
Response Planning Video

Key Successes: Tools

- **cgSARVA**
  - **Rescource allocation tools for USCG saved millions**
  - **Only DHS COE tool accredited for use by USCG**
- **MADIS**
  - **Tested and used by Miami-Dade Department of Emergency Management**

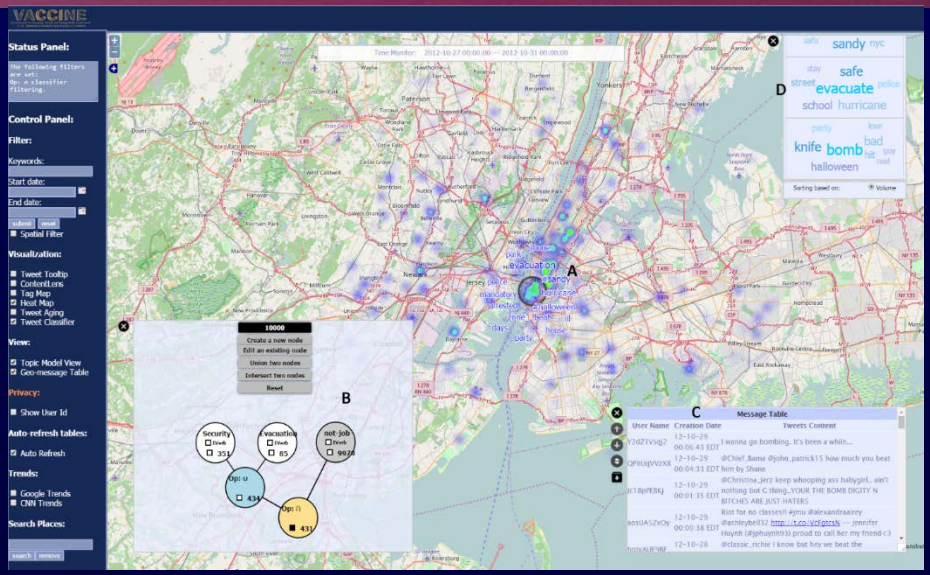


- **LAHVA**
  - **Advanced detection capabilities for adverse chemical and biological occurrences in the general populace**
- **FAVA**
  - **Designed to explore financial datasets and identify potential anomalies**



Key Successes: Tools

- **SMART**
  - **Licensed to DAVISTA**
  - **Used at Republican National Convention**
  - **Deployed at Presidential Inauguration 2017**

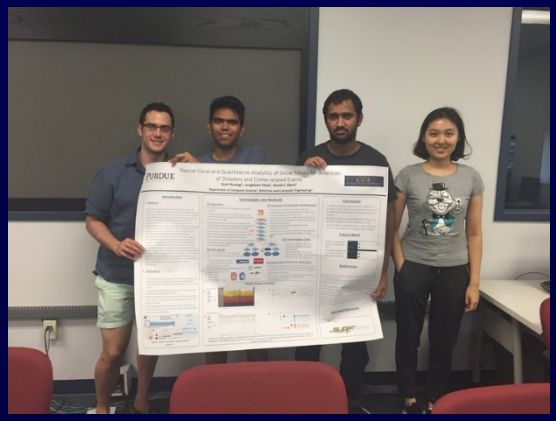


An example screenshot of the SMART software suite displaying social media feeds during Hurricane Sandy.

Key Successes: Education
> 4000 students impacted

Education Video

- Enabled student research
  - 40+ SURF VACCINE students since 2007
  - 250+ VACCINE student research assistants
- Funded education in HSE disciplines
  - 22 total HS-STEM recipients
  - 30+ MSI Undergrad participants since 2011
- Enhanced VA knowledge of university faculty
  - 90+ MSI faculty VA workshop participants since 2013
  - 31+ related curriculum developed by VACCINE universities
- Developed pathways to reach working professionals
  - With VACCINE partner, AMU, 500+ participants participated in webinar series since 2015
- Outreach to next generation of VA students
  - 200+ students from Lafayette Jefferson HS were participants in K-12 outreach program



2016 SURF Students

Key Lessons Learned and Recommendations

- **The uncertainty of funding leads to project delays and retention issues**
- **COE leadership meetings result in greater collaboration**
- **Combining projects from disparate proposals reduces cohesion**
- **Continue project competitions**
- **Encourage the use of Public Safety forums**
- **Use of webinars is an effective tool to reach a broad range of HSE personnel**
- **User centered approach was successful**
- **Low profit margins present a challenge to commercialization.**

2016 Annual Meeting

Hands-on training in the VACCINE lab

Summary

- Take some notes from the Impact Report
- VACCINE was a pioneer in VA for eight (8) years.
- More than 75 faculty partners from 38 institutions
- Hundreds of peer reviewed journal articles
- Created tools that made an impact on end-users effectiveness
- New role as an Emeritus COE
  - Funded projects through task orders
  - CINA - video analytics