CAOE | Center for Accelerating Operational Efficiency

A DEPARTMENT OF HOMELAND SECURITY CENTER OF EXCELLENCE

Improving Homeland Security Operations

Annual Report
2019

CAOE Leadership

Ross Maciejewski, *CAOE Center Director*

Pitu Mirchandani, *CAOE Chief Scientist*

Beth Jones, *CAOE Managing Director*

Dan McCarville, *CAOE Associate Director of Education*

Dawn Janssen, *CAOE Communications Manager*

Amy Bennett, *CAOE Project Manager*

Letter from the Director

Currently, data is king, and organizations across the globe are scrambling to leverage their data into product insights and operational efficiencies. Established in 2017 and housed at Arizona State University, **Center for Accelerating Operational Efficiency (CAOE) – A Department of Homeland Security Center of Excellence** – is designed to enable the evolution of data-enabled analysis and decision-making practices within the Homeland Security Enterprise. 2019 was our third year of operation, and CAOE has developed a strong portfolio of research and education that has advanced the current state-of-the-art in data analytics, operations research, economic analysis and risk science, while training the next generation of the Homeland Security Enterprise (HSE).

By serving as the data analytics center, CAOE is in a unique position to serve across the numerous agencies in DHS, and our current portfolio reflects the need for studies and tools that support analysts working on disparate challenges. For example, our researchers have helped the Transportation Security Administration (TSA) develop models to more efficiently deploy Transportation Security Officers, explored how to improve interdiction of smuggling with Customs and Border Protection, and surveyed areas that could be improved in contract procurement with the DHS Procurement Innovation Lab.

Along with our strong research focus, CAOE has developed a unique education and training program. Partnering with Minority Serving Institutions and the TSA, we were able to create a unique experience where undergraduate students collected operational data at McCarran International Airport – Las Vegas, Nevada, and received training to model and analyze the data. This summer program is just one of our many educational opportunities offered to train the next generation of data scientists.

This annual report serves to provide an overview of CAOE's current portfolio, highlighting some of our recent research, education and outreach activities over the past 12 months. I am proud of the work being done by CAOE and look forward to advancing DHS's research and education agenda as part of our continued partnership.

Ross Maciejewski
Director

Center for Accelerating Operational Efficiency (CAOE)

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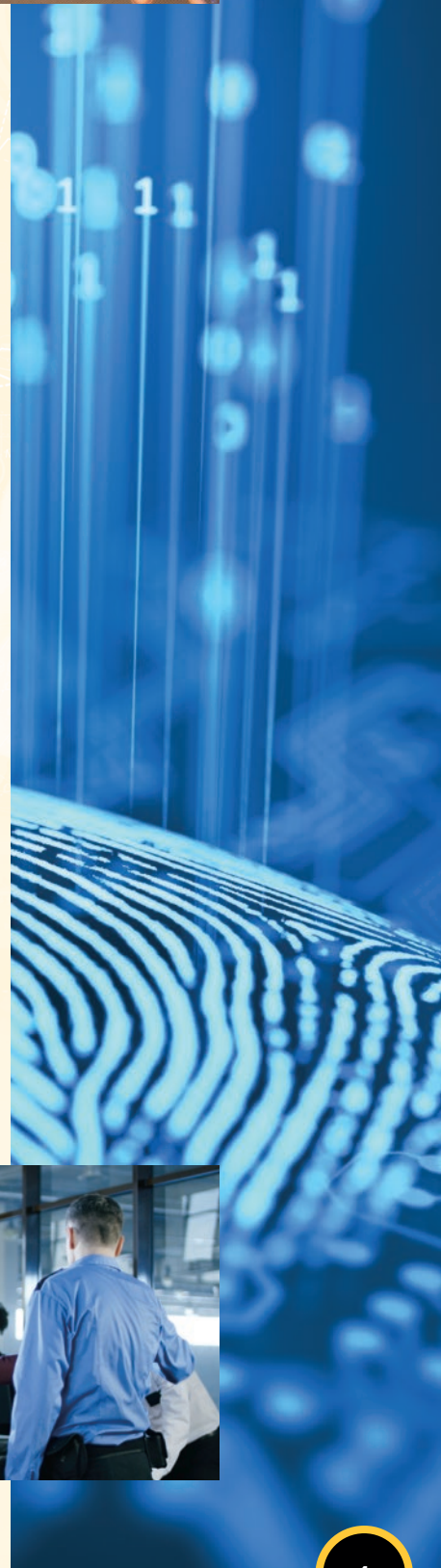# Our Mission & Strategic Initiatives

Center for Accelerating Operational Efficiency (CAOE) is developing innovative approaches to enhancing and streamlining homeland security operations. The research, systems and technology created at CAOE provide the U.S. Department of Homeland Security with dynamic information and predictive tools to help resource and response planning, risk analysis and real-time decision-making.

Based on the strategic vision and core research strengths, CAOE has identified three key strategic initiatives for the center that focus on the goals of developing crosscutting solutions that are transdisciplinary and accelerate efficiency across the HSE.

Improving Predictions to Enhance Preparation and Response

Developing new predictive analytics methods that can link historical data collections and large-scale real-time streaming data to better predict threats and proactively mitigate impacts.

The projects in this initiative include:

Detecting, Characterizing, Tracking and Forecasting Rare Events on Multi-Sourced Networks

University of Illinois, Urbana – Champaign
Lead PI: Jingrui He

Real-Time Decision Support Systems for Proactive Response under Uncertain Cascading Emergencies

Arizona State University
Lead PI: Pitu Mirchandani

Development of a General Testing Methodology for Evaluating the Performance of Commercial Artificial Intelligence Technologies

Arizona State University
Lead PI: Michelle Mancenido

Value-focused Robust Optimization for Disaster Response

Arizona State University
Lead PI: Pitu Mirchandani

Optimizing Screening and Border Operations for Threat Detection

Building tools and processes to better anticipate possible threats, optimize screening efficiency and allow for better response when threats occur.

The projects in this initiative include:

Simulation, Analytics and Modeling for Border Apprehension and Security

University at Albany
State University of New York
Lead PI: Brandon Behlendorf

Optimization of Resources at Screening Facilities for Increased Threat Detection

Arizona State University
Lead PI: Jorge Sefair

Identifying Sociotechnical System Predictors of TSO Performance and Retention

Arizona State University
Lead PI: Erin Chiou

A Novel Data-Driven Model for Quantitatively Evaluating the Effectiveness of Border Security Investment

University at Buffalo
The State University of New York
Lead PI: Jun Zhuang

Research Areas

Data analytics

Operations research and systems analysis

Economic analysis

Homeland security risk sciences

Informing Prevention Policy Through Risk and Cost Analysis

Minimizing risk while optimizing investments in resources that will have the most impact on improving homeland security.

The projects in this initiative include:

Enhancing Aviation Security Through the Use of Signal Detection Theory

University of California, Irvine
Lead PI: Nicholas Scurich

Motivations and Perspectives of Northern Triangle Migration to the United States: Narrative Analysis of Central American Media

Oklahoma State University
Lead PI: Skye Cooley

Acquisition and Operations Efficiencies Working with the Procurement Innovation Lab

Arizona State University
Lead PI: Thomas Kull

Scalable Near-Real-Time Identification and Characterization of Malware Behaviors Using Darknet Data

Penn State University
Lead PI: John Yen

Validating Adaptive Behavior Models of Adversaries for Risk Assessment (VABMARA)

University at Albany -
State University of New York
Lead PI: Gary Ackerman

Deferring Decisions: Effects on Human-AI Team Performance

Arizona State University
Lead PI: Michelle Mancenido

Examining Ideologically-Motivated Cyberattacks to Better Secure Cyber Critical Infrastructure from Compromise

Michigan State University
Lead PI: Thomas Holt

Recommendations for Technical Exploitation for Organizational Analysis

University of Nebraska Omaha
Lead PI: Gina Ligon

Detecting and Tracking Isolated Malicious Activities

Some of the greatest common challenges of the U.S. Department of Homeland Security are the threats posed by Isolated Malicious Activities (IMAs). Also known as "lone wolf attacks," threats from individual homegrown extremists are diverse and difficult to detect. One reason is that unlike terrorist cells, IMAs seem to be completely isolated from each other, without outside direction or communication. To assist homeland security efforts, CAOE is studying IMAs in hopes of developing new ways to predict attacks by identifying suspicious individuals and tracking their activities.

Working directly with DHS, TSA, Office of Intelligence & Analysis (I&A) and CBP, CAOE researchers, led by Principal Investigator Jingrui He from the University of Illinois, Urbana-Champaign are collecting relevant data and developing theories and algorithms with the following goals:

- Identify IMAs with common traits and characteristics
- Reveal relevant IMA networks, attributes and active time steps
- Track and predict IMAs over time

CAOE's project team started by gathering critical information from multiple sources of coded, dynamic and heterogenous information. This search included known networks used for money laundering, email exchanges, human trafficking, smuggling, traditional mail, terrorism, and online black markets to provide valuable information to the intelligence community.

From there, one of the frameworks that the project team created is called Self-Paced Network Representation for Few-Show Rare Category Characterization (SPARC). The use of SPARC will facilitate more reliable propagation to the large number of unlabeled examples to identify more potential IMAs.

The impact of this research has been immediate and noteworthy. For the CBP, extracting geo-coded information from drug-related news articles may no longer need to be performed manually in a process that can be slow and error-prone. Using automated techniques developed from this project, the CBP is able to capture this information more quickly and accurately than ever before.

The TSA has also benefited from this project. The Insider Threat Unit (ITU) manually receives, reviews and tags a large amount of reported information. The project team is in the process of transferring the software prototypes to the ITU to assist with updating and automating the information tagging process along with providing useful insights on recent insider threats.

A key to the ongoing success of this project depends on the application of rapid data analysis to predict outcomes, even as monitored situations change. In response to this need, CAOE experts have developed new methods of high-performance data analysis that provide accurate results without having to wait for additional forensic study. As a result, the speed of the predictive metrics is increased and the time needed to respond with the appropriate resources is greatly reduced. As a deployable technology, this project gives law enforcement the ability to determine rare signals that indicate and identify activities from IMAs such as violent extremists and insider threats at airports.

The project has shown so much potential, that early findings have led to the creation of a new joint project, teaming CAOE with other DHS Centers of Excellence (COEs); National Consortium for the Study of Terrorism and Responses to Terrorism (START) and Critical Infrastructure Resilience Institute (CIRI). These organizations will work together to develop a multi-pronged approach for the triangulation of open source information on transnational criminal organizations (TCOs) making it easier for agencies to share intelligence.

The effort includes the exploitation of foreign government documents, automatic geocoded information extraction from news articles, and scraping of social media. The resulting information is then linked to a geographical index and compiled by deep learning algorithms to identify subtle trends a human analyst might miss using traditional methods. The overall goal of the project is to provide new open source tools to the U.S. Government to share domestic and international information while protecting confidential sources in the detection and tracking of potential malicious activities.

Background

❑ Dynamic Networks

Many complex systems with relational data can be naturally represented as dynamic processes on graphs with the addition/deletion of nodes and edges over time.

Web Graph   Social Network   Transaction Network

❑ Network Representation

Network embedding provides an essential class of tools for leveraging the node proximity to learn a low-dimensional representation before using the off-the-shelf machine learning models.

Recommendation   Community Tracking   Money Laundering Detection

❑ Interpretability

Many real systems with highly regulated processes (e.g., finance, health care) often require the learning models to be interpretable and the output results to meet compliance.

Web Graph — Social Network — Transaction Network → Explainable Representation of Time-Evolving Graphs → Recommendation — Community Tracking — Money Laundering Detection

New CAOE Technology Used to Anticipate Changing Border Dynamics

Securing the U.S. border between Ports Of Entry (POEs) requires the coordination of considerable infrastructure, technology and personnel. To maximize security, current resources must be used more efficiently to discover pathways used by smugglers, human traffickers and unauthorized migrants.

Success in this effort is difficult to measure. The area of responsibility for Customs and Border Protection (CBP) along the U.S.-Mexico border is over 150,000 square miles. At the moment, there is no effective way of measuring those crossing the border undetected. Looking solely at those apprehended only tells part of the story. To further complicate matters, smugglers have learned how to spot sensor locations and move their activities to avoid detection. Leaving researchers to answer the challenging questions of: what pathways are being used between ports of entry and where might new pathways emerge in response to changes in infrastructure?

Through the Simulation, Analysis, and Modeling for Border Apprehension and Security (SAMBAS) project, CAOE, under the guidance of Principal Investigator Brandon Behlendorf of the University at Albany (State University of New York), helped the CBP leverage existing data to anticipate pathways of unauthorized migration between POEs. Through the examination of key metrics, researchers hope to offer ways to optimize the positioning of border resources for maximum effectiveness.

Project challenges include working with existing field technologies that are often static, difficult to scale and require advanced training to operate. They were also not designed to monitor changes in pathway activity in ways that help CBP Sector and Station Commanders reposition resources accordingly.

CAOE researchers set out to create a toolkit to help station and sector personnel conduct rapid analysis of their operations and tactics. Requiring scalable and flexible capabilities in limited computing environments, SAMBAS used commercial off-the-shelf (COTS) software to model, analyze and forecast probable routes of individuals between POEs. Validated against existing apprehension data from CBP/OBP, the toolkit can conduct a variety of analyses for intelligence personnel, including:

- Projecting probable pathways drawn of recent apprehensions;
- Identifying potential shifts in pathways due to changing field dynamics;
- Assessing the impact of fixed and tactical infrastructure on probable pathways;
- Supplementing return-on-investment (ROI) analyses for specific deployments; and
- Anticipating potential route changes to inform future enforcement options.

Leveraging existing administrative data in new ways, the SAMBAS toolkit is able to integrate advanced geosimulation methods to generate new insights for Intelligence operations and tactical planning along the border.

This project also supports operational planning by reducing the uncertainty of potential smuggling pathways taken to avoid infrastructure along the border. As a result, CBP should increase the number of data-informed deployment decisions and the frequency of apprehensions near infrastructure.

By enlisting the help of CAOE experts, the CBP is developing new ways to leverage data to anticipate shifting migration dynamics in the battle to keep our country's border safe and secure.

Evolving Procurement: CAOE Collaborates with DHS Procurement Innovation Lab (PIL) to Improve Performance

Over the years, the operations of U.S. Department of Homeland Security (DHS) have continued to evolve. However, policies and procedures related to DHS procurement process have remained mostly unchanged. This is due to the culture surrounding the procurement process that tends to rely on more conservative, proven and defendable methodologies. The downside of these outdated policies and procedures make it challenging to promote greater speed, competition and cost-efficiency that DHS demands.

Researchers from CAOE, led by Principal Investigator Thomas Kull from Arizona State University, are working with the DHS Procurement Innovation Lab (PIL) in an initiative designed to increase efficiency and implement best practices across the procurement process. The PIL provides the DHS acquisition community with an innovative procurement platform and lower-entry barriers to encourage new, non-traditional contractors to compete.

CAOE researchers studied the culture of procurement through analytical data, interviews and a review of policies and procedures. As strictly observers, coaches and advisors, researchers offered suggestions and facilitated discussions to further support innovation, overcome internal resistance and improve performance within the procurement culture.

As a result, this project makes great strides in accelerating the speed and agility of the DHS procurement process. Polly Hall, DHS Acquisition Innovation Advocate, explained the value of the CAOE relationship: "Through CAOE, Dr. Thomas Kull embedded directly with the DHS PIL team. Dr. Kull's work has helped us draw out underlying motivations and beliefs that can either inspire or resist innovation in the procurement process. This engagement helps our PIL team coach better!"

Beyond Borders: How CAOE is Making Airport Security Checkpoints More Effective and Efficient

The U.S. Department of Homeland Security (DHS) faces a wide range of complex threats and hazards in the country's airports. To better anticipate and respond to these challenges, the researchers at CAOE are teaming with TSA regional offices and headquarters to increase the efficiency of screening and decrease average passenger wait times at checkpoints

Increasing Airport Security Checkpoint Efficiency

U.S. airports currently handle over 900 million air passengers per year. The CAOE is working with the TSA to make security checkpoints more efficient and effective.

A team of CAOE researchers, led by Principal Investigator Jorge Sefair of Arizona State University and co-principal Investigators, Kelvin Cheu of the University of Texas, El Paso and Ronald Askin of Arizona State University, was assembled to study these issues. The team began by closely examining airport screening processes at high volume airports with dynamic passenger demands. The results of these activities led to the development of customized tools that gather data on ongoing TSA checkpoint operations to allow the simulation and optimization of their processes. These research tools include:

- **Passenger Arrivals Estimator (PAE)**
  Collects, analyzes and validates data to identify airport traveler flow patterns.
- **Dynamic Queue Analyzer (DQA)**
  Observes, predicts, and analyzes multi-lane, multi-server, passenger security lines.
- **Transportation Security Officer Scheduler (TSOS)**
  Analyzes data and predicts peak traveler flows and proper allocation of resources.

Using data gathered from multiple sources, CAOE researchers were able to develop mathematical models and run simulations to validate potential impacts on security and traveler flow. The results were validated with TSA regional partners. Current efforts focus on the transition of these tools to operation. Having actionable information assists TSOs in the ability to forecast passenger arrivals and appropriate resources to improvement of carry-on screening times and reduced queue lengths without any reduction in security. These models also reduced stress among travelers and TSOs, improving satisfaction among both groups.
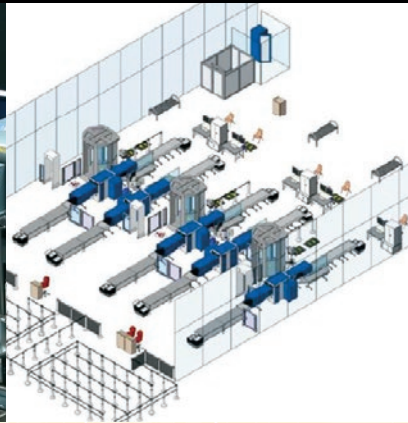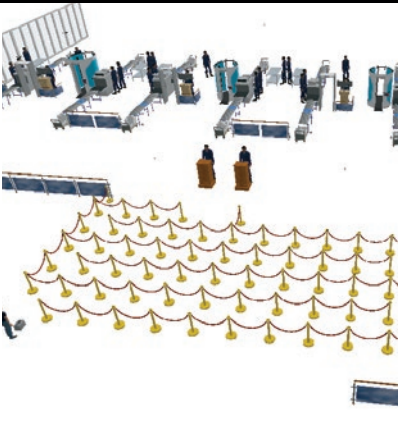
As a direct result of this project, formal recommendations will be made to TSA leadership on positive changes that will impact the agency's ability to provide airport security in ways that promote an improved airport traveler experience.

ASU Professor of industrial engineering Ronald Askin defines the potential this research offers both travelers and TSA personnel. "Right now, sometimes wait times are long, sometimes wait times are short. If we can do a better job of predicting when and where passengers will be arriving for their flights, we can do a better job of allocating security officers to those checkpoints." The results will make the process of going through airport security as pleasant as possible for everyone involved.

Strategic Multilayer Assessment (SMA) Academic Consortium

CAOE has been actively involved in supporting the Strategic Multilayer Assessment (SMA) of the Department of Defense. CAOE's work in the SMA is a follow-on effort to an existing research portfolio to examine the emerging Foreign and Domestic threats to homeland security.

The projects in the SMA include:

Contested Space Operations, Reach Back Support to Operations in Afghanistan and Pakistan, and Strategic Outcomes in the Korean Peninsula — PI: Skye Cooley (Oklahoma State University), Co-PI: Robert Hinck (Monmouth College)

Emerging Foreign and Domestic Threats to Homeland Security — PI: Gina Ligon (University of Nebraska Omaha), Co-PI: Douglas C. Derrick (University of Nebraska Omaha)

Strategic Outcomes in the Korean Peninsula Psychology and Neuroscience — PI: Nicholas Wright (Intelligent Biology)

Moscow's 'Trojan Horses?' Elite Risk-taking, Disruption, and Russian Strategic Interests in German-speaking and East Central Europe — PI: David Dorondo (Western Carolina University)

Chinese Cooperation and Competition with the United States: Cognitive and Motivational Analysis — PI: Peter Suedfeld (University of British Columbia)

A Flexible Framework to Achieve Strategic Objectives in US-China Policy — PI: Maorong Jiang (Creighton University)

Brandon Behlendorf

Brandon Behlendorf has a long history of working on homeland security projects through the U.S Department of Homeland Security Centers of Excellence (COE) program, starting first as a researcher with the National Consortium for the Study of Terrorist and Responses to Terrorism (START), then leading projects for START and CAOE while working closely with U.S. Customs and Border Patrol (CBP). His primary research centers on social analytics that inform decision-making within security communities. Behlendorf enjoys helping others make informed decisions and believes that the process requires data, a strong grasp of the data generation process and a thorough understanding of the context in which the data is collected.

Behlendorf is passionate about helping translate social scientific theories and advanced data analytics into operational applications, often bridging gaps between researchers and practitioners in the process. He is skilled at translating theories and data into real-world scenarios and his engagements with field-level CBP practitioners has turned scientific advances into helpful tools for front-line personnel working along the border.

Lauren Davis

Associate Professor Lauren Davis focuses on decision-making under uncertainty, primarily using stochastic optimization techniques (Markov decision processes, stochastic programming) and simulation. Her work has been applied to solve optimal stocking, transportation scheduling and distribution decisions in for-profit and non-profit supply chains.

For CAOE, Davis serves as co-PI on the "Development of a Real-Time Decision Support System for Proactive Response" team. Davis has worked with both DHS component agencies and private enterprise to examine the diesel fuel supply chain. As a result, her research team led by Pitu Mirchandani, Chief Scientist for CAOE, was able to create a real-time decision system (RTDS) that will provide proactive recommendations for repair and recovery of transportation, electrical and diesel-fuel supply chains in the event of natural disasters and national emergencies.

Davis is the Principal Investigator for a NSF-funded National Research Traineeship grant that explores food insecurity and hunger relief using computational data science. Additionally, her research examining hunger relief supply chains has been also featured in CNN's "Great Big Story."

Mickey Mancenido

In the age of artificial intelligence, we are faced with algorithms and technologies that require rigorous design, analysis, and testing. Assistant Professor Mickey Mancenido is focused on research in statistical design and analysis that ensures new technologies such as artificial intelligence (AI) and machine learning (ML) are used efficiently and effectively. Mancenido describes herself as an engineering statistician who advocates for the sound and valid use of statistical methods. Mancenido's current project for CAOE, "Deferring Decisions: Effects on Human-AI Team Performance," combines her research interests with a passion to design statistically valid studies that optimize the performance of the AI and machine learning solutions currently deployed by DHS.

Researchers	Expertise	Institution
Principal Investigators		
Ackerman, Gary	Terrorism; Threat Assessment; Chemical,; Innovation; Adversary Behavior Modelling; Red-Teaming; Emerging Technologies; Extremist Ideologies	University at Albany State University of New York
Askin, Ronald	Production Logistics; Manufacturing Systems Analysis; Applied Operations Research; Applied Statistics	Arizona State University
Behlendorf, Brandon	Illicit Trafficking Networks; Violent Victimization across the Life Course; Geospatial Dynamics of Conflicts and their Effects on Individuals; International/Comparative Criminology; Quantitative and Mathematical Modeling of Violence; Policing	University at Albany (State University of New York)
Cheu, Ruey Long (Kelvin)	Applications of Artificial Intelligence in Transportation, and Intelligent Transportation Systems (ITS); Cross Border Transportation; Transportation Security	University of Texas, El Paso*
Chiou, Erin	Human-automation Interaction; Trust in Automation, Human-agent Cooperation in complex systems; Resilience Engineering; Health Systems Engineering, Healthcare Human Factors, and Medical Devices	Arizona State University
Cooley, Skye	Strategic Communications; International Relations and International Studies; Political Communication, Public Relations; Global Media and Digital Democracy	Oklahoma State University
Dorondo, David	European Strategic Analysis; Military and Political History; Modern European History;	Western Carolina University
He, Jingrui	Heterogeneous Machine Learning; Rare Category Analysis; Social Network Analysis; Semiconductor Manufacturing; Traffic Analysis; Medical Informatics	Arizona State University
Holt, Thomas	Criminal Justice; Computer Hacking, Malware; Internet Crime	Michigan State University
Jiang, Maorong	International Relations;, History; Philosophy; Diplomacy; Political Science	Creighton University
Kull, Thomas	Behavioral Supply Chain; Sociocultural Issues; Supply Chain Risk	Arizona State University
Ligon, Gina	Industrial and Organizational Psychology; Quantitative Psychology; Innovation and Leadership; Organizational Structures; Non-normative organizations (e.g., violent ideological)	University of Nebraska Omaha
Maciejewski, Ross	Visual Analytics; Predictive Analytics; Geographical Visualization; Information Visualization; Healthcare Informatics; Data Science	Arizona State University
Mancenido, Michelle (Mickey)	Mathematical and Natural Sciences; Optimal Design of Experiments; Mixture Experiment; Non-linear responses; Quality Control; Machine Learning; User - centric product design; Efficient Industrial Processes	Arizona State University
McCarville, Daniel	Quality engineering; Industrial statistics; Engineering management with a general focus on continuous improvement methodologies	Arizona State University
Mirchandani, Pitu	Optimization; Decision Making under Uncertainty, Real-Time Control and Logistics; Applications in Urban Service Systems; Transportation; Homeland Security	Arizona State University
Sefair, Jorge	Network Optimization; Robust Optimization; Integer Programming; Applications of Optimization in Environment; Public Policy; Urban Planning; Finance	Arizona State University
Scurich, Nicholas	Psychology & Law; Judgment and Decision Making; Violence Risk Assessment	University of California – Irvine*
Wright, Nicholas	Neuroscientific, behavioral and technological insights to understand decision-making in politics and international confrontations	Intelligent Biology (UK)
Suedfeld, Peter	Psychological Processes And Behavior; Restricted Environmental Stimulation Therapy; High-Level Political And Military Decision-Making; Surviving Genocide And Persecution	University of British Columbia
Yen, John	Artificial Intelligence; Machine Learning and Data Analytics; Health Informatics; Cognition and Neuroinformatics; Cybersecurity	Penn State University
Zhuang, Jun	Operations Research: Big Data Analytics; Game Theory, Decision Analysis; Health Care, Transportation, Supply Chain Management	University at Buffalo The State University of New York
Co-Principal Investigators		
Birge, John	Stochastic Programming and Large- Scale Optimization; Methods and Models for Optimal Decision-Making under Uncertainty; Relationships between Operations and Finance	University of Chicago
Burns, William (Bill)	Risk assessment, Rick Perception and Behaviors, Economic Impact, Social Psychology behind Public Resilience and Demotivating Terrorists	California State University San Marcos/ Decision Research
Davis, Lauren	Humanitarian Logistics; Supply Chain Optimization; Emergency Preparedness/Response	North Carolina A&T State University*
Hinck, Robert	Communication Studies; International Communication; International Relations; Global Studies; Geopolitics; Organizational Rhetoric	Monmouth College
John, Richard	Risk Analysis; Terrorism; Public Response to Terrorism; Decision-Making – Human Judgment; Nuclear Power Plant Risks	University of Southern California
Lawson, Catherine	Urban Transportation Data and Information Systems; Freight Planning; Travel Behavior; "Healthy" Infrastructure; Water Transport; Hazmat Transport;; GIS Applications	University at Albany (State University of New York)
Morris, Brendan	Computer Vision, Intelligent Systems, Pattern Recognition, Machine Learning, Intelligent Transportation Systems, Intelligent Vehicles	University of Nevada, Las Vegas*
Morton, David	Stochastic Optimization and its Application to Energy, Security and Health Systems	Northwestern University
Pavlic, Ted	Operations Research Modeling and Simulation; Autonomous Systems	Arizona State University
Tong, Hanghang	Large Scale Data Mining and Machine Learning; Social Networks Analysis; Healthcare; Cybersecurity; e-Commerce	Arizona State University'
Vogiatzis, Chrysafis	Optimization; Modeling; Linear Programming; Mathematical Programing; Combinatorial Optimization; Network Optimization	North Carolina A&T University*

*Minority Serving Institution (MSI)

CAOE education program supports the U.S. Department of Homeland Security Enterprise (HSE) in fulfilling its mission through the creation of undergraduate, graduate and workforce development education opportunities. A special focus is placed on providing education in areas including artificial intelligence, machine learning and game theory. These skills will continue to develop the current DHS workforce and engage students to consider future careers within the HSE.

Summer Minority Serving Institution (MSI) Student Workshop Assists TSA at McCarran International Airport

CAOE McCarran Transportation Security Administration (TSA) Summer Workshop was developed as an extension of TSA Sky Harbor Staffing Analysis project with principle investigators, Jorge Sefair and Ronald Askin of ASU, and Kelvin Cheu of UTEP. Sefair led the summer workshop with management support from Brendan Morris and his teaching associates, Cristian Arteaga and Kemil Herath, at the University of Nevada Las Vegas (UNLV). Twelve undergraduate students from UNLV, a Minority Serving Institution, completed the four-week summer workshop in June 2019. The student participants represented majors across the fields of electrical engineering, mechanical engineering, civil engineering, computer science, and business administration.

Each workshop included three hours of classroom education and two hours of data collection at McCarran International Airport Terminal 3. Data collection included analyzing passenger arrival rate sampling at TSA document check and checkpoint positions, respectively. The students processed observations as an external lens with a focus on Terminal 3 TSA checkpoint operations. During the classroom portion of the session, students analyzed the day's collected data and modeled checkpoint processes for future use in TSA simulations and forecasting activities.

The workshop concluded with an informal student presentation of results to TSA representatives Ryan Davis, Assistant Federal Security Director AFSD for Mission Support, TSA Las Vegas and Wes Prochniewski, Safety and Occupational Health Specialist, TSA Phoenix. In turn, TSA representatives discussed how technical challenges, career opportunities and Lean Six Sigma process improvement strategies that TSA utilizes significantly impact operational efficiencies.

The summer workshop program was offered in conjunction with TSA McCarran International Airport Federal Security Director, Karen Burke, and members of her senior leadership team.

Undergraduate Capstone Project with TSA at Sky Harbor International Airport

A key success of CAOE's educational program is the engagement with Transportation Security Administration (TSA) at Phoenix Sky Harbor International Airport (PHX Sky Harbor) on current projects. These opportunities for undergraduate students to work directly on current CAOE projects will make a direct impact on improving operational efficiency. One such project is the "Dynamic Resource Allocation for Predicted Demands at a Network of Screening Facilities." Under the direction of researchers, Jorge Sefair and Ronald Askin of ASU, and Kelvin Cheu of UTEP, a team of eight ASU senior students majoring in industrial engineering and engineering management captured passenger arrival data at TSA checkpoints in PHX Sky Harbor Terminal 4.

The objective of this project was to identify policy recommendations, which TSA could implement with minimal impact to both Transportation Security Officer (TSO) staffing and security checkpoint space configuration. For example, TSA checkpoints in Terminal 4 process approximately 63% of all PHX Sky Harbor departures. However, the uncertainty of passenger arrival times complicates TSA's ability to schedule staff and related technological and financial resources in a dynamic environment. Currently, TSA supervisors configure resources reactively based upon fluctuating passenger arrival rates as they occur. This approach can lead to a less than optimal use of resources and potentially increased wait times for passengers.

The students observed, modeled, and analyzed all TSA operations at Terminal 4 checkpoints. The results provided several recommendations for process improvements to optimize TSO staffing configurations and stabilizing passenger queue lengths. A policy change was also recommended for increasing bag conveyor allocations prior to the deployment of additional Ticket Document Checker (TDC) personnel.

The project produced direct results for improving TSA's operational efficiency at PHX Sky Harbor, as the resulting data was interpolated by the project's principle investigators to adjust and verify the current TSA resource allocation staffing model.

Emiliano Ruiz

Graduate Student, University of Texas at El Paso (UTEP)

The next time you travel through an international airport, you may notice shorter lines at the security checkpoint, thanks in part to Emiliano Ruiz. He is working with CAOE on a project that hopes to make airport security operate more efficiently.

The project is called Dynamic Workforce Management at a Network of Screening Facilities and it aims to provide the Transportation Security Administration (TSA) with tools to improve the agency's day-to-day operations in ways that facilitate positive interaction between Transportation Security Officers (TSOs) and millions of air travelers.

In his role on the project, Ruiz codes models for simulations that forecast how various changes will impact airport security checkpoints. As part of this process, a collaborative team from The University of Texas at El Paso (UTEP) and Arizona State University (ASU) reviews, evaluates and refines the simulated models to generate trusted outcomes and actionable conclusions.

He enjoys and appreciates this opportunity with CAOE, which began when he was an undergraduate student. "What I particularly enjoy about my role is that it has expanded my career interests and allows me to enrich my interpersonal and professional skills."

Ruiz is from El Paso, Texas, and attends UTEP where he is working on a master of civil engineering. After graduation he hopes to work in the private sector for a construction consulting company that could collaborate with U.S. Customs and Border Protection (CBP) on future projects.

Dominiqueca Edwards

Graduate Student, North Carolina Agricultural & Technical State University

In the event of a disaster or emergency, Dominiqueca Edwards wants you to have the fuel you need to get to safety. For CAOE, she is working with other researchers to ensure catastrophic events don't block critical fuel supplies for evacuation.

The project is called Real-Time Decision Support System (RTDS) for Proactive Response including Recourse Planning, under Uncertain Active Cascading Emergencies. The results promise to change the way agencies like the U.S. Coast Guard make decisions on fuel vessel traffic. Her role on the project centers on the gasoline component of port operations and the real-time decisions to prioritize, position and transport fuel, while informing and recommending specific actions to affected populations.

Edwards is enlightened by her work on the project team. "I've learned so much, from a new understanding of mathematical models to practical experience coding and working with specialty software." Working closely with the U.S. Department of Homeland Security (DHS) has also helped her to understand the depth and breadth of the agency's mission and research. "I now have a much greater understanding of the DHS mission, including securing and coordination of port operations. And I'm confident that our work will help the agency to assist emergency responders fine tune their response to disasters and emergencies."

Edwards is from Anderson, South Carolina, and attends North Carolina Agricultural and Technical State University, where she is working toward a master of science in industrial and systems engineering. After graduation, she will be working for The Boeing Company as an industrial engineer.

Emily Gilmore

Graduate Student, Arizona State University (ASU)

Air travel can be stressful, not just for passengers but also for security personnel. As a student researcher with CAOE, Emily Gilmore is using data to help airport security be more efficient and less stressful for travelers and Transportation Security Officers (TSOs) alike.

Gilmore worked on the Operational Analysis of TSA Screening Processes at Sky Harbor International Airport in Phoenix, Arizona, while completing her bachelor's degree in industrial engineering at ASU. The project team sought to help the TSA by using data to identify small changes the TSA could make to staffing and configuration of security checkpoints to improve the airport security experience.

Working with seven other industrial engineering undergraduate students, Gilmore's role focused on creating processes for the collection of accurate data within the security checkpoint space. This project gave her new insight into extracting important data from complex systems. "Observing different checkpoints and analyzing how to count arrivals and processing times of each scanner can apply to all types of systems, like traffic intersections, manufacturing lines and more."

She feels fortunate to work on this project and appreciates the new experiences and friendships that have come about as a result of working on this project team. Through collaboration and teamwork, they have managed to capture data that can be used in other CAOE projects at airports all across the country. As a result, both the team and the TSA hope to make air travel more efficient and less stressful for all involved.

Gilmore is from Gilbert, Arizona, and attends ASU, where she is pursuing a master of industrial engineering degree. After graduation, she plans to work for a medical device company where she will work with data analytics and statistical modeling.

CAOE Students Shine at COE Summit 2019

The annual U.S Department of Homeland Security Center of Excellence (COE) Summit was held at George Mason University July 31- August 1, 2019, and featured opportunities for CAOE students to showcase their innovative research benefiting Homeland Security. CAOE students participated in the Summit Grand Challenge and the student poster showcase. The Grand Challenge, a new event for the Summit, was a student-led, team-based competition. Its purpose was to identify emerging threats to homeland security posted by Unmanned Aerial Systems (UAS) and develop a counter strategy to those scenarios. Six teams competed in this challenge, including CAOE undergraduate student researcher Emiliano Ruiz, from the University of Texas at El Paso (UTEP). Ruiz was a member of the winning team that developed the proposal, "Automated Drone Integrated Systems."

CAOE student researchers who presented posters also exemplified the innovative work being accomplished through the DHS Centers of Excellence. Students from Arizona State University (ASU), North Carolina Agricultural and Technical State University (NCA&T) and University of Central Florida (UCF) presented CAOE posters. Dominqueca Edwards and Sierra Marshall from NCA&T represented the CAOE well, placing second overall in the poster competition.

TSA-CAOE Symposium – Bridging Research and Practice Innovations in Transportation Security – 2019 TSA-CAOE Symposium

Darby LaJoye

Center for Accelerating Operational Efficiency (CAOE) hosted the continuation of the Transportation Security Administration (TSA) Symposium for a fifth year. The two-day symposium, Innovations in Transportation Security, was an invitation-only event held at Arizona State University (ASU). The proceedings featured keynote speakers and distinguished expert panelists representing thought leaders and senior executives from across TSA, academia and industry.

The symposium launched with an opening keynote address by TSA Executive Assistant Administrator of Security Operations **Darby LaJoye** followed by ASU Executive Vice President Knowledge Enterprise **Sethuraman "Panch" Panchanathan's** keynote. These opening keynotes set the tone, framing two days of interactive discussions focused on how TSA, academia and industry can work together to support a culture of innovation to solve challenging homeland security challenges.

Sethuraman "Panch" Panchanathan

Phoenix Sky Harbor International Airport Chief Executive Officer **James Bennett**, discussed the challenges of managing one of the country's busiest airports and reviewed some potential solutions that include a Central Receiving & Distribution Center (CRDC), enhanced video monitoring and vehicle inspections. The second day of the symposium started with a keynote by TSA Chief Innovation Officer **Alexis Long**, who offered insight into the current priorities for innovation at TSA.

James Bennett

As featured speaker for the closing session, Bruce Schneier of the Berkman Center for Internet & Society at Harvard Law, author and internationally-renowned security technologist, provided his unique perspectives on technology, airport security and future national security challenges.

Informative panel discussions offered diverse expert information and generated robust discussion on the current landscape and projected future of transportation security. Topics ranged from covert operations, red team testing and unmanned aircraft systems (UAS) to threat deterrence, innovations in transportation security and future challenges facing airports.

Alexis Long

Jerry Booker

Jerry Booker, Director, Enterprise Performance & Risk, Strategy, Policy Coordination and Innovation, served as the symposium's presiding TSA official and reflected on the success of the event by stating, "TSA greatly values our partnership regarding the CAOE during the recent academic symposium. This engagement has provided TSA with access to world-class academic resources to better manage risk, improve the security of the Transportation Sector, and to proactively address operational challenges."
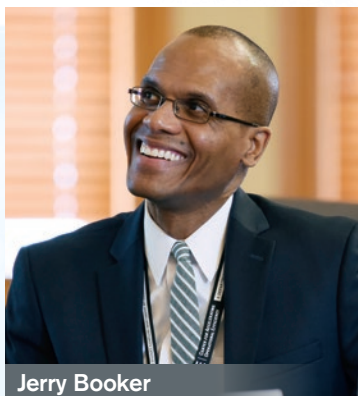
The fifth annual TSA-CAOE symposium represents a tradition initiated in 2015 by CREATE, (now a DHS Center of Excellence Emeritus), at University of Southern California (USC). Hosting locations of subsequent symposiums will alternate between Tempe, Arizona, and Washington, D.C.

DHS Procurement Innovation Lab Engages with Students at CAOE

CAOE researcher Thomas Kull has been working on a project with the DHS Procurement Innovation Lab (PIL). The PIL is a DHS initiative designed for experimenting with innovative techniques to increase efficiency and implementing best practices in the DHS procurement process.

In April 2019, a team from the PIL, including Polly Hall, Acquisition Innovation Advocate/Procurement Innovation Lab Lead, Trevor Wagner, Procurement Innovation Lab Testing & Re-Engineering Lead and John Inman, Senior Procurement Innovation Coach, came to ASU to meet with students, faculty and administration. The discussion exchanged ways to engage with students interested in internships and career opportunities at DHS.

The team was invited to lecture and answer questions in four, 300- and 400-level supply chain classes at the W.P. Carey School of Business. They also discussed research projects with both W.P. Carey and Ira A. Fulton Schools of Engineering students and faculty. Hall stated, "We [the PIL team] were very impressed with the energy of the ASU campus, particularly when students approached us after class to talk more about opportunities at DHS." During the visit, the PIL team openly discussed new project ideas with the CAOE researchers, including the idea of developing more learning simulations for teaching procurement innovations.

"We enjoyed lecturing in Stanley Vitikas (SCM 455) and Robert Wiedmer's (SCM 355) courses, and found the students to be inquisitive and informed. We found several great potential areas for further research collaboration, including some ideas we have for student capstone projects," Hall added.

COE Data Requirements Workshop

Identification of data requirements for evaluating project viability and impact, and the potential lack of access to actionable data, remains challenging for DHS COEs. Most of COE research is funded through cooperative agreements bringing unique conditions regarding the data access, collection and usage. These challenges revealed that data needs impact all COEs at multiple levels. The workshop successfully addressed two key data needs that COEs currently face; acquiring and collecting data to support individual project needs and using data efficiency to help center management make informed decisions.

CAOE hosted a COE-wide Data Requirements Workshop at the Arizona State University (ASU) Washington, D.C. campus. The event was chaired by Executive Director, Ross Maciejewski and attended by COE directors, staff and U.S Department of Homeland Security Science and Technology Directorate (S&T). Detlof von Winterfeldt, Professor and Director of CREATE Center (Emeritus) at University of Southern California, provided the keynote address.

The agenda included speakers, panelists, case studies and working group sessions where attendees shared lessons learned and best practices from across the organization. The goal was to identify and prioritize data requirements as baseline performance metrics for assessing the impact of COE research on processes and associated activities.
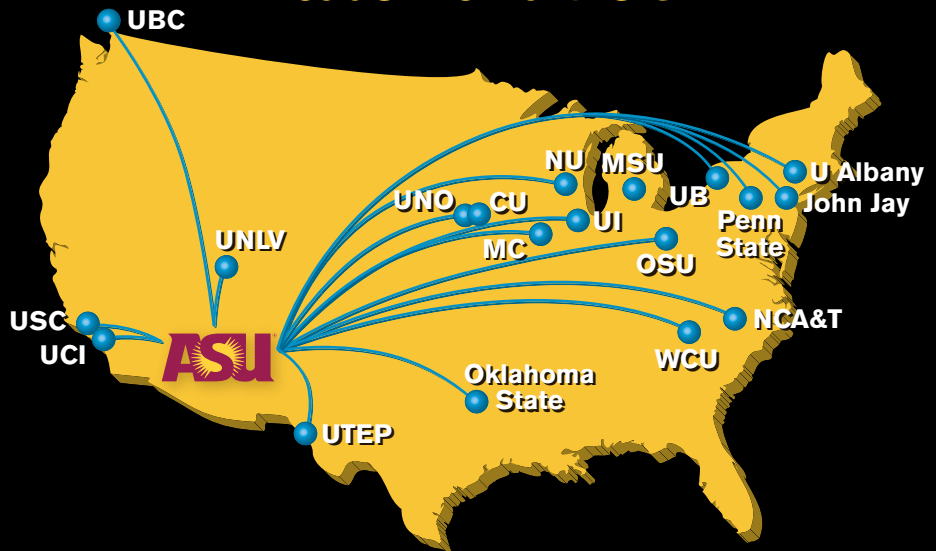
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