

Technosocial Predictive Analytics Initiative

Summer 2010

<http://predictiveanalytics.pnl.gov/>



QUARTERLY NEWSLETTER



Antonio's Notes

As we approach the completion of our third year of operations, I would like to recognize all of you who have continued to follow the activities of our Technosocial Predictive Analytics Initiative (TPAI), as well as those who have recently joined the TPAI interest group. Your input, feedback and support have been crucial in allowing us to make faster progress and be successful in the pursuit of the Initiative goals. A special acknowledgment goes to past and

current members of our internal and external Advisory Committee whose guidance has been so generous and invaluable. A very heartfelt thank you to you all: we could not be where we are today without your help and counsel.

Taking stock of major achievements, we are grateful for the many opportunities we have had, and continue to enjoy bringing our vision to the PNNL client base and the international scientific community. Here are some highlights.

- » Conducted three major conference events with strong participation by members of the PNNL client base and the international scientific community
 - 3-day symposium on Technosocial Predictive Analytics sponsored by the Association for the Advancement of Artificial Intelligence, Stanford University, California, March 2009
 - Workshop on Social Computing and Applied Gaming, under the auspices of the IEEE International Conference on Social Computing, Vancouver, British Columbia, August 2009
 - Workshop on Model Interoperability and Evaluation at the IEEE Intelligence and Security Informatics Conference, Vancouver, British Columbia, May 2010
- » Published nearly 50 papers in refereed international conference proceedings, journals and book collections, and (co)edited 3 conference proceedings
- » Delivered and scheduled talks and keynote speeches on TPAI or TPAI-related work at variety of high-visibility events, including
 - Invited talk at the NATO Advanced Research Workshop on Threats to Food and Water Chain Infrastructure, Vienna, Austria, December 2008
 - Invited talk at the Global Futures Forum, Proliferation COI, Crete, Greece, May 2009
 - Invited talk at the Global Futures Forum, Illicit Trafficking COI, London, United Kingdom, May 2009
 - Invited talk at the Center for Language and Speech Processing Summer Seminar Series, Johns Hopkins University, Baltimore, Maryland, July 2009
 - Invited talk at the NRC/NGA Workshop on new research directions for the National Geospatial-Intelligence Agency, Washington D.C., May 2010 (**continued**)

PROJECT FOCUS

Knowledge Encapsulation Framework (KEF)

This project enables subject-matter experts to discover, gather, and arrange evidence and other material in support of modeling and simulation projects, as well as other domains that require collaborative workspaces for knowledge-work.

Serious Gaming Technology

This project develops techniques and a systematic framework to enable the creation of games that provide a means for modelers, developers, and users to create, improve, and explore technosocial predictive models. The Analytical Gaming Framework provides a flexible environment to combine the computational power of models with the creativity of human players, facilitating a more robust decision-making process.

Illicit Nuclear Trafficking

This project includes mathematics and a computational collaborative methodology to forecast organization behavior using models, empirical data, and experts' opinions. Our technical approach to integrate predictive information has three unique and significant aspects: rigorous model validation, formal modeling of experts' assessments, and automatic support for model integration.

Energy Efficiency/Conservation and Grid Vulnerability

The purpose of this project is to better define the characteristics of energy feedback to achieve optimal effectiveness in reducing energy consumption and improving efficiency, and assessing the ensuing impact on grid security and infrastructure integrity in combination with climate change factors.

Leadership Team

Antonio Sanfilippo, Initiative Lead
Scott Butner, Initiative Co-Lead
Jim Thomas, Initiative Co-Lead

Operational Team

Carrie Almquist, Operations
Keri Schneirla, Communications
Wendy Andres, Administrator
Fran Stanley, Finance



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Antonio's Notes (continued from p. 1)

- Invited keynote speech at the Annual Conference of the Prognostics and Health Management Society, Portland, Oregon, October 10th–14th, 2010
- Panel on Implications of Social Computing in Health Informatics, 1st ACM International Health Informatics Symposium, Nov 2010, Arlington, Virginia
- Symposium on Using Quantitative Content Analysis to Assess the Likelihood of Terrorist Violence, 2011 AAAS Annual Meeting in Washington, D.C., February 17–21 (in collaboration with DHS).

The capabilities developed within the Initiative have had a strong early market impact with programmatic sales of about \$5 million, including projects on

- » Weapons of Mass Destruction-Terrorism, with DoD CWMD-T and RRTO Support Programs
- » Nonproliferation, with NNSA NA-22

- » Social Network Analysis, with the Naval Postgraduate School
- » Energy efficiency, reliability and related topics, with DOE/BTP, DOE/ARRA, DOE/FEMP and the DOE offices of Electricity Delivery & Energy Reliability, Energy Efficiency and Renewable Energy
- » Pollution prevention, with EPA
- » Social intelligence and crowd-sourcing, with DARPA
- » Science and Innovation Policy, with NSF
- » Bio-surveillance, with DHS Threat Characterization Program.

As the Initiative lead, I am very proud of my team for the excellent work everyone has been doing on all aspects of the initiative, including scientific research, software development as well as administrative, communication, and operational activities. This year, it has been a pleasure to see such a large group of talented professionals working together toward the completion of the Illicit Trafficking Demonstration, which we will present this month at PNNL

in the Richland campus and at our Battelle office in Crystal City, Virginia. This effort combines components from our three focus areas—modeling, knowledge encapsulation and gaming—into an engaging workflow for analysis and decision making. I invite you all to check our feature story below where details about the outcomes of this activity are provided.

I would like to conclude with a special acknowledgement to my dear friend and mentor Jim Thomas for his huge contribution to TPAI. Jim unexpectedly passed away in August, but he continues to be the heart and soul of our work. It was Jim who back in 2006 led a team of over 30 scientists at PNNL who identified Predictive Analytics as the top research priority in support of the Laboratory Mission Outcome on *Preventing and Countering Acts of Terrorism and the Proliferation of Weapons of Mass Destruction*. Since the Initiative took shape in late 2007 as the result of these consultations, Jim's advice, mentorship, and enthusiasm have been and continue to be a unique driving force for all of us. This newsletter is dedicated to him.

ILLICIT TRAFFICKING DEMO

As a capstone to the TPAI, the individual pieces of the TPAI research agenda—knowledge management tools, technosocial models, and analytical gaming—are being brought together into an integrated technology demonstration (ITD). The TPAI team has worked together to assemble an integrated demonstration that illustrates how the TPAI components work together to address the sort of analytical challenges faced by our clients. This demonstration will be presented twice during the month of September: at PNNL for an internal audience on September 16, and in Crystal City, Virginia for TPAI external advisors and stakeholders on September 24.

Focusing on the issue of illicit trafficking of nuclear materials and technologies, the ITD follows a team of analysts as they use the TPAI tools to shed light on a hypothetical scenario of suspected nuclear smuggling. In the first half of the demo, the analysts work together via the collaborative environment of KEF to define and build a model that describes the likelihood of a nation to seek nuclear weapons. The Bayesian network model is calibrated using conjoint analysis before being loaded into KEF once again. This time however, KEF is used as an evidence-marshalling tool to

document the model parameters that make up each case study, and to automatically identify candidate evidence, which drives the model.

Having used these tools to focus attention on a specific state actor, the second half of the demo follows the team of analysts as they use analytical gaming to explore strategies and scenarios for how nuclear materials and expertise might be brought to the target country. Using both “table top” (board-style) games and their computerized counterparts, the analyst team can identify different strategies that emerge from the game play, and evaluate how each of them might be countered.

The next version of this demo will include an agent-based model (ABM) of exchange strategies between state and non-state actors within an illicit nuclear trafficking context. The ABM will be calibrated using the behavioral data generated through role-playing in the analytical gaming exercise described above and will provide insights about possible futures that may ensue from such behavioral presuppositions. The ABM will then be integrated with the gaming environment so that players may interact among each other to rank the order of the

various, possible future scenarios generated by the ABM via role-playing.

The integrated demonstration of TPAI capabilities responds to an often-articulated desire by TPAI stakeholders to see how the pieces of the Initiative work together. By bringing together technology and social/behavioral modeling, analytical gaming, and the collaborative knowledge management framework of KEF, the demo illustrates how these tools can help analysts identify and evaluate a broad range of plausible scenarios quickly, efficiently, and with reduced bias.



Analytical Gaming task lead, Rick Riensche, leads a design meeting as part of the analytical gaming process.