Crowdsourcing for C4I: Pitfalls and Promise

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Critical Issues in C4I Symposium
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crowdsourcing noun \ˈkraʊd-,sœr-sir\ : the practice of obtaining needed services, ideas, or content by soliciting contributions from a large group of people and especially from the online community rather than from traditional employees or suppliers

*First known use: 2006*

www.merriam-webster.com/dictionary/crowdsourcing
Why Pay Attention?

• Clear applicability and potential benefits to many C^4I problems and concerns
  ▸ 2-way citizen engagement in operations involving the military
  ▸ Anticipating and monitoring unrest / crisis / revolution
  ▸ Forecasting important trends in geopolitics / science & technology

• There are issues unique to C^4I that must be addressed to make effective use of crowdsourcing
  ▸ Multi-level security
  ▸ Policy challenges
  ▸ Cultural barriers within military / intelligence community and among citizenry
Crowdsourcing and Crisis Response

• Real-time citizen interaction is transforming crisis response
  ‣ Haitian citizens collaborated with volunteers worldwide to map damage during 2010 earthquake
  ‣ Social media figured prominently in US government response to recent hurricanes (Irene, Sandy)
  ‣ In aftermath of Nepal earthquake, crowdsourcing is being used to:
    - Map relief needs
    - Coordinate volunteers
    - Fund relief efforts

• Avenues for two-way communication with citizens
  ‣ Social media (e.g., Facebook, Twitter) allow multi-way interaction
  ‣ SMS is low-tech, reliable communication tool in distressed areas with weak infrastructure
“The Boston Marathon bombings are certainly a tale of terror, but also a tale about the power and perils of social media.” – cbsnews.com
Self-Organizing Communities

- Disaster often sparks emergence of self-organizing communities
  - Broad participation orchestrated by indigenous leaders
- Social media can serve as enabler
Case Study: Community Self-Organization in Atlanta

C2 and Citizen Engagement

• Nationwide Suspicious Activity Reporting (SAR) Initiative (NSI)
  ‣ Oneway portal for posting and compiling anonymous reports of suspicious activity
  ‣ Does not support the kind of real-time interaction that occurred in the Boston Marathon event
  ‣ Does not support emergence of self-organizing communities

• Social media can support real-time collaboration

• Need to adapt command and control systems and processes to exploit technologies for communicating directly with citizens
  ‣ Design and evaluate new systems and processes
  ‣ Achieve benefits while mitigating problems
  ‣ Train responders in new systems and processes
  ‣ Leverage self-organizing community response
Simulation Experiment to Examine Citizen Participation in Crisis Response

• 2012 simulated crisis to examine impact of citizen involvement on tactical/operational decision-making and implementation.
  ‣ Refine and evolve CONOPS and TTPs for citizen participation in tactical/operational planning and implementation
  ‣ Refine and evolve prototype DSS
  ‣ Examine impact of DSS on tactical / operational decision-making & execution.

• Scenario: Defense Support of Civil Authorities
  ‣ Radiological Dispersal Device detonates on Mason campus.
  ‣ Notional NCR military/civilian emergency managers collaborate from Emergency Operations Center (emulated at the NSEL at MITRE McLean)
  ‣ Student volunteers use decision support tools to collaborate in response decision making.

• Provided valuable insights to emergency managers who participated
Citizens’ Emergency Response Portal System (CERPS) Public Interaction

Simulated Sensory Environment (SSE)

Unfolding experiment events (view)

Reported events (view and post)

Citizens (GMU students)

Simulated News Network

News

Discussion of events (view and post)

“Chirps”

Chirp [open-source Twitter clone]

Polling

Citizens’ Emergency Response Portal (CERP)
CERPS SIMEX Operational View

- EDMSIM
  - Simulated Entities
- Simulated News Network
  - News
  - Visual & Sensory Information
- SSE
- CERP
  - Reports
  - Pictures
- Unified EOC
  - Tasking
  - News
  - Chirps, Polls
- VCOP
  - Chirp
- CRDS
- Students
  - Chirps & Poll Responses
  - Student Chirps and Poll Responses
Government Stakeholders

- NORTHCOM
- Joint Staff
- Fairfax County
- Virginia Commonwealth
- DHS/FEMA
- National Guard Bureau
- FBI
- Israeli Home Front Command*
Participant Perceptions

- Operators showed trust in social media
- Influence of simulated “bad actors” was limited and short term
- Trust would have been improved with geospatial information (disabled for privacy reasons)

- Students felt they were kept informed about emergency
- Students found messages from EOC useful
- Students felt their contributions were taken into account
Research Issues

• Effective integration of citizen input into C2 processes
• Integrating public participation into logistics
  ▸ Provide timely assistance where it is most needed
  ▸ Facilitate and leverage self-organizing community efforts
  ▸ Develop CONOPS and TTPs for leveraging citizen involvement
• Human factors – citizens and operators
• Identifying trusted sources / filtering bad information
• Information security
• Providing information to operators while protecting personally identifiable information
• Mining large volumes of social media for actionable information
Policy Challenges

- **Expectations** – Does responding to Twitter establish a public expectation that we will always respond (especially for 911-type tweets)?
- **Liability** – What happens if you ask public to do something (like evacuate using a certain route) and people get hurt as a result?
- **Privacy** – How must personal info, geolocations, etc., be handled?
- **Two way communications with public, following/liking** – Who will be allowed to do this and under what circumstances?
- **Law Enforcement** – Emergency management has fewer constraints on interactions than law enforcement
- **Consent** – Does the public need to consent before we respond using social media?
- **Involvement** – Who is the public? Who can be involved?

Current policies were not designed with social media in mind and need to evolve to integrate social media into crisis management
Forecasting and the Wisdom of the Crowd

• “Prediction is difficult. Especially about the future.”
  - Niels Bohr

• “…predicting the future has a strong role to play in preparing your defenses for probable attacks.”
  - Dan Geer, Black Hat Keynote, 2014

• Crowds do better than individuals
Potential – As reported by WSJ

**Smarter Intelligence**

The U.S. government is inviting people outside the intelligence community to develop new ways to anticipate global events. One project, ForeST, forecasts developments in science and technology by inviting amateur forecasters to predict in real time the probability that certain events will occur.

**QUESTION:** When will the Chinese National Space Administration land a man or woman on the moon?

From the **WSJ Article:** “U.S. Intelligence Community Explores More Rigorous Ways to Forecast Events” Sept 5, 2014

The same systems and methods covered in the article are proposed for use by the IEEE Foundation and Spectrum. Best practice results have exceeded traditional opinion poll results by 70% in prediction accuracy.

**QUESTION:** How many states will report at least one case of a West Nile virus human neuroinvasive disease by August 1?

- **Actual:** 11 states
- **Source:** Charles Twardy, George Mason University

The Wall Street Journal
SciCast is a crowdsourced forecasting platform for science and technology.

SciCast originated as a research project funded by IARPA to test the efficacy of crowdsourced forecasting techniques.

We aggregate the knowledge and expertise of a diverse group of participants from around the world into probability forecasts.
SciCast’s unique combinational prediction market captures dependencies between related forecasts.

Forecasters are rewarded with points for making accurate forecasts.
1. Questions are posed and iterated
2. We draw relationships between questions if applicable*
3. Once the question and its relationships are defined, it is published to Predict where our forecaster pool makes forecasts
4. We output real-time, ongoing probabilistic forecasts until the answer to the forecasting question is known

* i.e. a forecast about the price of a raw material may be directly related to another forecast about a company’s ability to bring a product to market
SciCast is the largest S&T focused crowdsourced forecasting site in the world:

**NUMBER OF FORECASTERS**

10,000+

**NUMBER OF FORECASTS**

- Total
  - 120,000+
- Daily Average
  - 150+

**FORECAST QUESTIONS**

- Posed
  - 1257
- Open
  - 587
- Completed
  - 619

Using Brier scores, a standard proper scoring rule that measures the accuracy of probabilistic forecasts:

- We beat a uniform distribution 84/100 times by an average of 46%
- We beat an average 78/100 times by an average of 26%

*As of March 2015*
SciCast has proven to be effective at forecasting unstructured questions combining technical knowledge, time, contextual information, and data:

Will the Axion Dark Matter Experiment detect axions by July 2014?

a) Forecast never moved above 50% likelihood;

a) Definitive “No” 2 months ahead of answer being known

Will Bitcoin be accepted at online retailer, Amazon, by March 31?

a) From the start, always judged unlikely to happen;

b) Occasional rumors never swayed the probability +/- 10%
• Quantitative forecasting methods are superior\textsuperscript{1}
• Prediction markets have proven prediction accuracy and calibration\textsuperscript{2,3}
• SciCast forecasts are more accurate and better calibrated than simple averages

We are finishing a 4-year research program on crowdsourced prediction

- First 2 years: geopolitical forecasting
- Second 2 years: science and technology forecasting

SciCast is being transitioned to operate inside a DoE laboratory

We continue to pursue transition opportunities for an open public science and technology prediction market

Questions about working directly with SciCast:

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Questions about the SciCast platform or SciCast research:

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Take Aways

• Harnessing the crowd brings new opportunities for the C^4I community
• We are just beginning to understand how to exploit these opportunities
• With the opportunities come challenges
  ‣ Institutional and cultural barriers to new ways of doing things
  ‣ Inexperience with how to make the most of the opportunities
  ‣ Need for training
  ‣ Need for new policies
  ‣ Many research opportunities and challenges
Thank You!

This talk would not have been possible without the contributions of many collaborators and partners:

- MITRE Corporation National Security Experimentation Laboratory
- Participating agencies in CERPS SIMEX
- Student volunteers in CERPS SIMEX
- Researchers and staff of the GMU C4I Center
- SciCast partners: IEEE, AAAS, ACS, ISACA, AMIA, ICE
- Thousands of volunteer forecasters
- IARPA