

**13<sup>th</sup> ICCRTS**  
**“C2 for Complex endeavors”**  
**Automated Decision Support in a Complex**  
**Information Space.**

Topic 4: Cognitive and Social Issues

Topic 8: C2 Architectures

Topic 9: Collaborative Technologies for Network-Centric Operations

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## **Automated Decision Support in a Complex Information Space.**

The trend in combat C2 as well as emergency management situations is to increase the flow of data into command centers. These data flows span dimensions of discipline, multi-national and government jurisdictions, with redundant sources, multiple protocol, and of varying levels of temporal importance. One problem facing the decision makers is a failure to transform the data into information and knowledge prior to being integrated into the decision process, adding significant cognitive loads to the decision maker, and overwhelming the process, leading to sub-optimal decisions. What has/is being developed at Sandia is a decision support capability that supports data fusion with Peircean based reasoning and a mathematically grounded knowledge representation technology. The current version is a “flat” reasoning system with an integrated inductive learning engine, and an abductive hypothesis generation engine coupled to a formal concept analysis knowledge representation system. The integrated system has been demonstrated in an intel analysis scenario and is being augmented to support a forensic analysis function. The architecture of the system will support extensions into hierarchical reasoning enabling the system to cross information blocks to do analogical reasoning as well as draw inferences that reflect a greater global awareness of developing situations.

# **Proposed Outline**

## **1. Introduction**

Philosophical heuristics vs Cognitive “physics”  
Decision Making Paradigm

## **2. Knowledge Representation**

Formal Concept Analysis definitions and limitations  
Ordered Set theoretic basics  
Extensions of the theory to support decision making  
Predicates to enable sub-domain reasoning  
Fuzzy set integration for real valued attributes

## **3. Peircean “Method of Scientific Inquiry”**

## **4. Inductive Learning**

Definitions  
Inductive reasoning and Finn’s Method  
Inductive Learning and the ability to discover patterns in data

## **5. Abductive Reasoning**

Definitions as defined by C.S. Peirce  
Mathematical basis for abduction in a FCA architecture  
Construction of the “Belief state”, the mathematical basis of situational awareness

## **6. Intel Analysis Results**

Application of the Peircean Decision Aid (PDA) on a terrorism scenario.  
Incident, communications, transaction, and suspects databases.  
Short discussion of the forensics application.

## **7. Reasoning Extensions**

Current temporal reasoning and extension  
Hierarchical reasoning extension  
Scalability potential  
Deductive-Inductive “Severe Testing” extension

## **8. Observations and Conclusions to date**