Human-agent Collaboration Ontology (HACON)™:
Implications for Designing Naturalistic C² Decision Systems

Azad M. Madni, Ph.D.
Weiwen Lin, Ph.D.

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**Human-agent Collaboration Ontology (HACON)™: Implications for Designing Naturalistic C2 Decision Systems**

**Intelligent Systems Technology, Inc, 2800 28th Street, Suite 306, Santa Monica, CA, 90405**


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Presentation Overview

- Human-agent Collaboration
- Human-agent Collaboration in C²
- Understanding Agents
- Human-agent Collaboration Ontology
- Ontology Applications
- Naturalistic Decision-making Example
- Metrics
- Research Program
Human-agent Collaboration

- Is not one human – one agent
- Is more than human-agent communication language
- Goes well beyond human-agent interaction
- Is especially significant in complex decision-making applications

Emphasis is on capitalizing on the respective strengths of humans and agents during collaborative decision-making
Human-agent Collaboration in C²

- Military decision-making applications (e.g., C²) impose certain unique requirements on human-agent collaboration
  - adaptive human-agent collaboration architectures
  - dynamic function reassignment
  - decision-making under time-stress, uncertainty, risk

*Emphasis is on optimally leveraging the human role in the face of ongoing changes*
Understanding Agents

- Agent Roles
- Agent Classification
- Human-agent Collaboration Regimes
Agent Roles

- **Peers**
  - develop shared understanding of task, their interdependencies, and contingencies
  - achieve seamless handoffs with shared understanding of context
  - deviate from “best practice” shared role when human is overloaded and/or fatigued, or unavailable

- **Associate/Colleague**
  - cooperates with human but performs different tasks than humans do
  - different from peer because this agent cannot be used to replace the human

- **Assistant/Staff**
  - agent performs tasks on behalf of the user
  - agent(s) has a clear notion of a goal and knowledge of the task domain to achieve it
  - shared vocabulary and task domain concepts enables terse, high-level human commands

- **Teacher**
  - pedagogical agent with domain as well as instructional knowledge
  - goal is transfer of knowledge/skills from domain KB/agent to learner
  - learning consists of getting to know and apply concepts, skills

- **Learner**
  - agent “learns” to perform tasks on behalf of the user; the information-seeking policy of the user
Agent Classification

- **User agents**
  - collect relevant information from user to initiate a task
  - interpret user commands/decompose user commands
  - assign work to task agents

- **Task agents**
  - have knowledge of the task domain as well as other task agents or information agents
  - coordinate with other task agents and information agents
  - form plans to achieve goals
  - executes plans

- **Information agents**
  - provide intelligence access to collection assets
  - are initiated either top down (by user or task agent) or bottom up by occurrence of particular information patterns
  - notify other interested agents when a particular condition of interest occurs
  - actively monitor information sources
Human-agent Collaboration Ontology (HACON™)

- Human Representation Schema
- Software Agent Representation Schema
- Human-agent Collaboration Schema
Human Representation Schema
Software Agent Representation Schema
Human-agent Collaboration Schema
Ontology Applications

- Decision-making
- Planning
- Decision support
- Design

For example, HACON can be extended for naturalistic decision-making
Naturalistic Decision-making

- Simply described as “the way people use their experience to make decisions in field settings”
- Emerged from the study of how real people make real decisions in real situations
- Well-suited to describing how decisions are made under time-stress, uncertainty, and risk

NDM has yet to be exploited within Decision Support Systems!
NDM Schema...

... is the first step to operationalizing naturalistic decision-making within DSS
Case-based Reasoning...

- Exploits heuristics and knowledge of previous cases to find a solution to a current problem
- Solution typically takes the form of an adaptation of a solution to a previous case

... is the second key component for operationalizing NDM within DSS
# NDM Implementation in DSS

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<th>NDM Concepts</th>
<th>Implementation</th>
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<td>Familiar Situations</td>
<td>– Similar cases (based on ontology)</td>
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<td>Situation Familiarity Assessment</td>
<td>– Based on reachback for relevant cases using case-based reasoning</td>
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<td>Activation of Information from Memory</td>
<td>– Agent tasking (user agent)</td>
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<td>– Context-driven search of historical cases (information agent)</td>
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<td>Evaluation of Suitability of Contemplated Action</td>
<td>– Case-based reasoning; similarity metrics</td>
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<td>Implementation of Action</td>
<td>– Execution of plan/workflow associated with “best-fit” case (task agent)</td>
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Sample Metrics

- Human cognitive load
- Agent utilization statistics
- Task completion times for various human-agent function assignments
- Execution delay due to function reassignment
- Execution delay due to resource unavailability
- Multi-agent synchronization delay due to function reassignment
Research Program

- Create “cognitively-inspired” software testbed based on HACON to investigate performance impacts of:
  - adaptive human-agent collaboration architecture
  - dynamic function reassignment options
  - context switching between human and agents
  - agent learning

*We need to understand these issues before we can effectively exploit the human role in shared human-agent C² decision-making systems.*