Autonomous Task Management and Decision Support Tools

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SAE/NASA Autonomy and Next Generation Flight Deck Symposium
What Are They?

Context-Sensitive

Dynamic
A Sampling of Tools

- Pilot’s Associate  (Banks & Lizza, 1991)
- Rotorcraft Pilot’s Associate  (Miller & Hannen, 1999)
  - Supervisory Control - The Playbook Approach
  - Information Management, Intent Estimator, Adaptive Aiding
- Copilote Electronique  (Champigneux, 1995)
  - Evaluates consequences of selected action prior to implementation
- Onboard Context-Sensitive Information System  (Tan & Boy, 2015)
- Small Aircraft Pilot Assistant  (SAPA; Abbott, et al., 2004)
- Digital Copilot  (MITRE – Estes, et al., 2016)
Human-Autonomy Teaming: Best Practices

- Development of Human Trust in the Autonomous System
  - Transparency
  - Predictability
  - Consistency
  - Provide Feedback

- Development of Autonomous System “Trust” in the Human
  - Predictability
  - Consistency
  - Timely Response

- Development of a Shared “Mental” Model
  - About the situation and tasks to be performed
  - About one’s own role and responsibilities
  - About the other’s role and responsibilities

- Demonstration and Maintenance of a “Team” Orientation

- Ability to Mutually Monitor One’s and the Other’s Performance

- Provide Back-Up Behavior to the Other

- Both Engage in “Polite” but Appropriate and Timely Interventions When Necessary

- Clear, Timely, and Advance Notice of Transfer of Responsibilities from One to the Other

- Demonstration of Team Adaptability When Needed (i.e., not “brittle” or overly constrained)


Autonomous, context-sensitive, task management systems and decisions support tools I: Human-autonomy teaming fundamentals and state of the art.

NASA Technical Memorandum.
Challenges

- Data and Information
- Structure of Content and Dynamic Drivers
- Overall Behavior and Functionality
- Verification, Validation, & Certification
Data and Information

- What are data and what is information?
- Which is needed and for what purpose(s)?
  - Ensure mutual agreement on goals & tasks
  - Maintenance of team orientation
  - Situation awareness / tracking
  - Task manager / informer
  - Option generator / decision support
  - Consequence evaluator
- Sensed vs. Un-sensed
  - Sources
    - Static, never updated
    - Static, is updated/revised
    - Dynamic
Data and Information, continued

- Direct vs. Interpreted
  - Straight from the source - - - logical algorithms, AI

- “Dumb” vs. “Learned”
  - As is - - - machine learning

- How and when presented?
  - How packaged, integrated, organized?
  - Which displays, where on the displays?
  - Pushed vs. Pulled
    - Pushed: always displayed, displayed only when relevant?
  - Time criticality

- Pilot distraction or incapacitation
Data and Information, continued

- Level of Certitude (see also, verification and validation)
- Human’s responsibility relative to it
  - How autonomous is the autonomous system?
Structure of Content and Dynamic Drivers

• Contextual Sensitivity
  • What does this mean?
  • What contexts?
Constraints and Conditions in Flight Operations

- Time
- Risk (Safety, Economic, Productivity)
- Pilot/Operator Characteristics, Workload, and Psychophysiological State
- Autonomous System Characteristics, Functionality, and Limitations
- Aircraft System and Component Status
- Phase of Flight
- Regulations, Procedures, Company Procedures and Policies
- Flight Parameters (e.g., altitude, heading, etc.)
- Equipage and Maintenance Status
- Environmental and External Conditions
- Critical Events
- Aircraft Habitability

Structure of Content and Dynamic Drivers

• Contextual Sensitivity
  • What does this mean?
  • What contexts?
  • What thresholds?

• Prioritization and Dynamic Re-prioritization
  • Who decides?
  • Keeping everyone in-the-loop
  • Maintaining shared understanding of current task/goal and overall (mission) goals
Overall Behavior and Functionality

- Automate the easy and give humans the rest. (NOT!)
  - Should be a shared partnership – joint responsibility for managing that which is hard, novel, unanticipated
    - But roles and responsibilities should be clear
  - Agile vs. brittle – limits to the system’s capabilities are understood and transparent but it still has a role

- “I don’t know – let’s give it to the pilot….Surprise!” (NOT!)
  - Graceful and timely partnering and role sharing/swapping (as opposed to graceful degradation or degradation with no grace at all)
    - But roles and responsibilities should be clear

- “I’ve got a secret and I’m not telling you.” (NOT!)
  - Transparent and provides feedback
Overall Behavior and Functionality, continued

- Who is in charge or responsible,
  - For what?
  - Does it vary depending upon when/circumstances?
    - In other words, roles and responsibilities should be clear!
- Truly context-sensitive
  - Anticipate changes to goals and tasks accurately
  - Anticipate information needs accurately (and in a timely manner!)
- Supports mutual monitoring (and takes the feedback well)
- Provide back-up behavior – human to automated system, automated system to human
  - How is this accomplished and when?
Overall Behavior and Functionality, continued

- How much anthropomorphism should an autonomous system (AS) have?
  - Give it a name? A face? An avatar?
  - Should the AS apologize for “mistakes”?

- Adhere to principles of human social and ethical behavior?
  - Respect for autonomy and human dignity
    - Does the human have primacy? If not, under what conditions does the AS have primacy and does the human know this?
    - AS is transparent, reliable, predictable
  - Beneficence
    - Sharing information to work cooperatively to achieve shared goals
    - Take into account the limitations and constraints of the other
Overall Behavior and Functionality, continued

- Adhere to principles of human social and ethical behavior? (continued)
  - Non-maleficence
    - Limitations and failures causes as little harm to the team as possible
    - Minimize likelihood that action based on faulty or suspect information will be taken (at least not without adequate safeguards)
  - Justice
    - Equitable treatment and fairness. Who has responsibility for errors?
      o The human team member?
      o The autonomous system?
      o Developers of the autonomous system?
How do we verify that the data are and information is correct and current?

How do we validate the functioning of an automated system, especially one that incorporates machine learning and artificial intelligence?

How do we go about certifying such systems?

- Is specifying behavior that the system can NEVER perform adequate?
- RTCA/DO-178C: Software Considerations in Airborne Systems and Equipment Certification (Dec. 13, 2011)
Thanks!!

Questions? Comments?

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