Autonomous Task Management and Decision Support Tools

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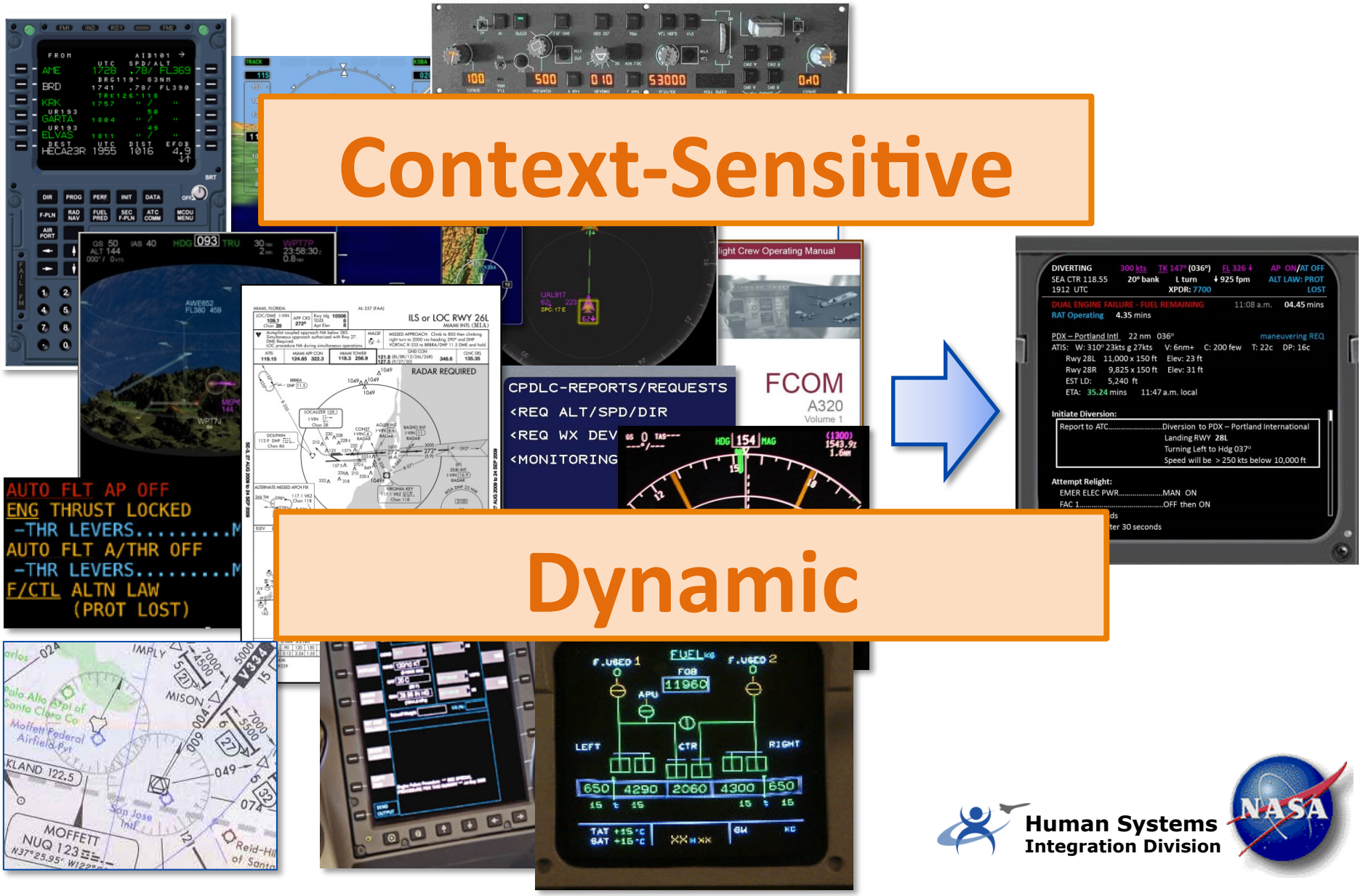
What Are They?



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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)

Mosier, K.L., Fischer, U., Burian, B.K., & Kochan, J.A. (in press).

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

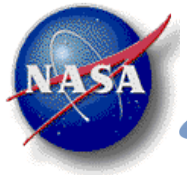
- Level of Certitude (see also, verification and validation)
- Human's responsibility relative to it
  - How autonomous is the autonomous system?

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



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Burian, B.K., Kochan, J. A., Mosier, K.L., & Fischer, U. (in press).
Autonomous, context-sensitive, task management systems and decisions support tools II: Contextual constraints and information sources.
NASA Technical Memorandum.

Structure of Content and Dynamic Drivers

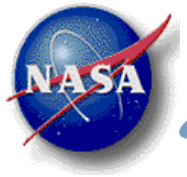
- Contextual Sensitivity
  - What does this mean?
  - What contexts?
  - What thresholds?
- Prioritization and Dynamic Re-prioritization
  - Who decides?
  - Keeping everyone in-the-loop
  - Maintaining shared understanding of current task/goal and overall (mission) goals

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?
      - The human team member?
      - The autonomous system?
      - Developers of the autonomous system?

Verification, Validation, and Certification

- 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?
  - FAA Order 8110.105A: Simple and Complex Electronic Hardware Approval Guidance (April 5, 2017)
  - RTCA/DO-254: Design Assurance Guidance for Airborne Electronic Hardware (April 19, 2000) and related Advisory Circular 20-125 (June 30, 2005)
  - RTCA/DO-178C: Software Considerations in Airborne Systems and Equipment Certification (Dec. 13, 2011)

Thanks!!

Questions? Comments?

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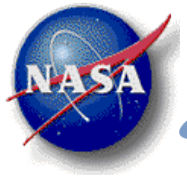
Flight Cognition Laboratory

http://humansystems.arc.nasa.gov/flightcognition/



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