HAT Tricks: Understanding Human Autonomy Teaming through Applications

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What is a “Hat Trick”?

Achieving a positive feat three times in a game

Effective Human-Autonomy Teaming in three critical functions:

- MONITOR
- ASSESS
- DECIDE
Safe and Efficient Crew-Autonomy Teaming/Technologies (SECAT) Sub-project

Goal:

Develop and demonstrate the feasibility of using autonomous systems concepts, technologies, and procedures to improve aviation safety and efficiency during nominal and off-nominal operations.

Benefits:

• Provide autonomy-based technologies that collaborate with the human crew to monitor and mitigate risk in flight.

• Develop crew-autonomy teaming strategies and techniques that will enhance trust in autonomy in the cockpit.
Addressing Autonomous Systems Research Needs

• SECAT addresses the research themes identified by the **ARMD Strategic Thrust 6 Roadmap**, primarily:
  – Human-Autonomy Teaming in Complex Aviation Systems
  – Technologies and Methods for Design of Complex Autonomous Systems

• SECAT addresses the emerging White House AI policy
  – Identifying benefits and risks of Artificial Intelligence (AI)

• SECAT addresses USAF Autonomous Systems Research Needs
  – Goal: “the best benefits of autonomous software working synergistically with the innovation of empowered airmen”
Increasingly Autonomous Systems

Performance and safety of combined system is greater than either component alone.
## Levels of Automation (SAE International)

<table>
<thead>
<tr>
<th>Levels</th>
<th>Human Driver Monitors Environment</th>
<th>System Monitors Environment</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>No Automation</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>The absence of any assistive features such as adaptive cruise control.</td>
<td>Conditional Automation</td>
</tr>
<tr>
<td>1</td>
<td>Driver Assistance</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Systems that help drivers maintain speed or stay in lane but leave the driver in control.</td>
<td>High Automation</td>
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<tr>
<td>2</td>
<td>Partial Automation</td>
<td>5</td>
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<td>The combination of automatic speed and steering control—for example, cruise control and lane keeping.</td>
<td>Full Automation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

### Who steers, accelerates and decelerates
- **0**: Human driver
- **1**: Human driver and system
- **2**: System
- **3**: System
- **4**: System
- **5**: System

### Who monitors the driving environment
- **0**: Human driver
- **1**: Human driver
- **2**: Human driver
- **3**: System
- **4**: System
- **5**: System

### Who takes control when something goes wrong
- **0**: Human driver
- **1**: Human driver
- **2**: Human driver
- **3**: Human driver
- **4**: System
- **5**: System

### How much driving, overall, is assisted or automated
- **0**: None
- **1**: Some driving modes
- **2**: Some driving modes
- **3**: Some driving modes
- **4**: Some driving modes
- **5**: All driving modes

Credit: Scientific American, June 2016
Current Flight Safety Challenges with Automation

  – Pilots frequently mitigate safety and operational risks – the aviation system is designed to rely on that mitigation
  – Insufficient depth of system knowledge or understanding of aircraft

• “Enhanced FAA Oversight Could Reduce Hazards Associated With Increased Use of Flight Deck Automation,” DOT OIG Report, 2016:
  – Relying too heavily on automation systems may hinder a pilot’s ability to manually fly the aircraft during unexpected events

  – Stakeholder/Public/Flight Crew perception - autonomy “trust” and “social issues”
Technical Approach

Increasingly Autonomous System

Monitor

Execute

Assess

Human Autonomy Teaming

Decide

Human/Machine Interface

Aircraft

Commands

Automation

Aircraft State

System Faults

Weather & Traffic

ATC Clearances

Human

Autonomy

Teaming

Assess

Monitor

Decide

Execute

Increasingly Autonomous System
SECAT Technical Objectives

Cockpit Hierarchical Activity Planning and Execution

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