Flight Deck Cognitive Assistance

Friends and Partners in Aviation Weather (FPAW)

November 2023

MITRE | SOLVING PROBLEMS FOR A SAFER WORLD®

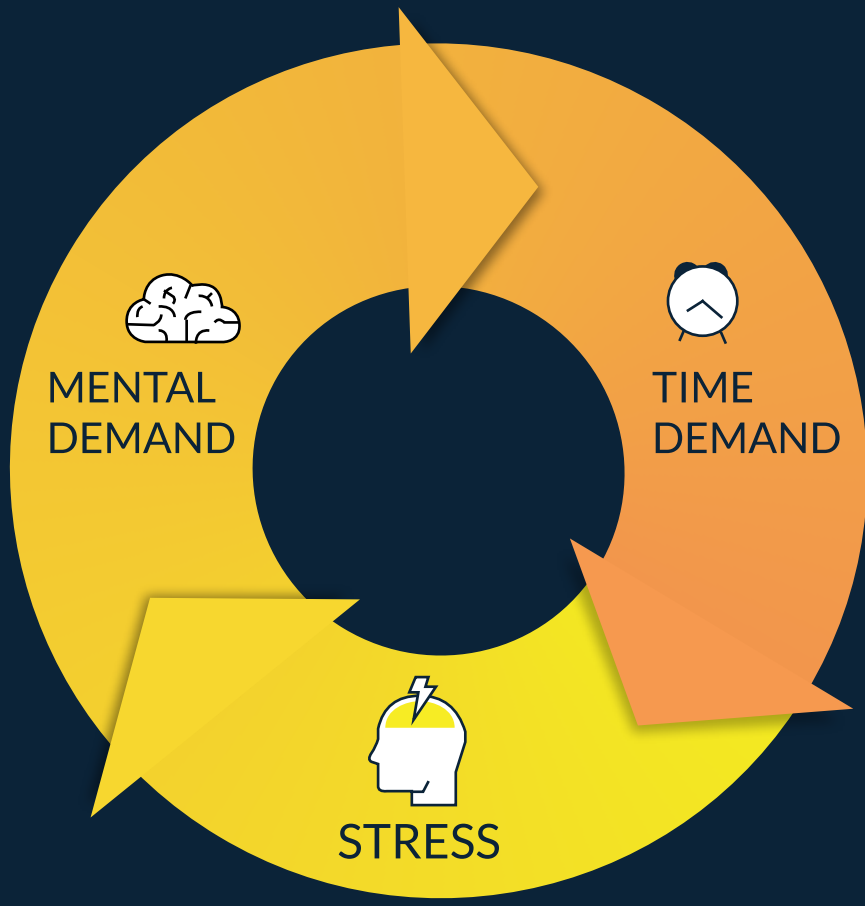
© 2022 THE MITRE CORPORATION. ALL RIGHTS RESERVED. APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED. PUBLIC RELEASE CASE NUMBER 22-2811

MITRE

© 2022 THE MITRE CORPORATION. ALL RIGHTS RESERVED. APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED. PUBLIC RELEASE CASE NUMBER 22-2811

MITRE

© 2022 THE MITRE CORPORATION. ALL RIGHTS RESERVED. APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED. PUBLIC RELEASE CASE NUMBER 22-2811



Workload Loop

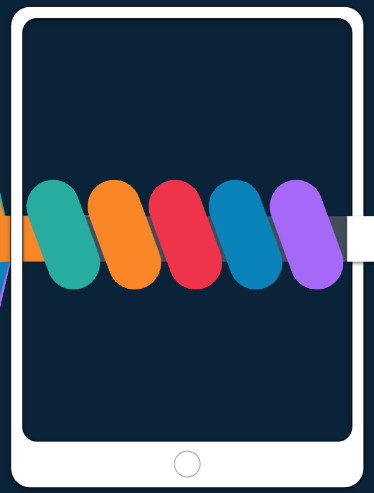
MITRE

© 2022 THE MITRE CORPORATION. ALL RIGHTS RESERVED. APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED. PUBLIC RELEASE CASE NUMBER 22-2811

COGNITIVE ASSISTANCE

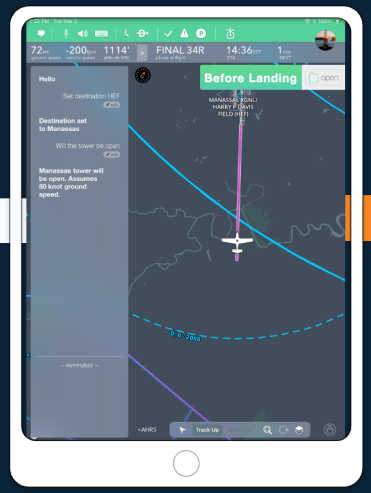
& MITRE's Platform for Pilot Assistance

User Intent Inference
Reasoning Algorithms
Speech Recognition
Context Awareness
Workload Offload



Cognitive Assistance

A tool that aids the user rather than replacing them. Provides context aware notifications and responds to user questions.



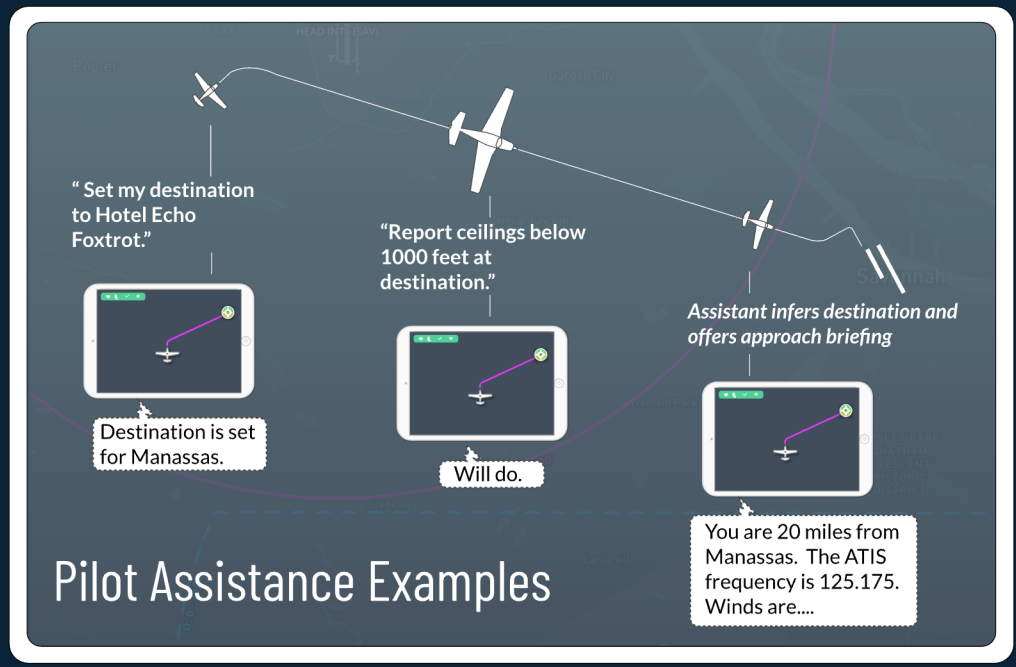
Maneuver Intent Inference
Phase of Flight Reasoning
Pilot Tuned Speech Rec
Location Context Awareness
Pilot Workload Offload

Pilot assistant

A cognitive assistant developed by MITRE to improve aircraft pilot safety

MITRE's pilot assistant

A few examples taken from the dozens of cognitive assistance features built into MITRE's pilot assistant



MITRE

© 2022 THE MITRE CORPORATION. ALL RIGHTS RESERVED. APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED. PUBLIC RELEASE CASE NUMBER 22-2811

VISUAL NOTIFICATIONS

AURAL NOTIFICATIONS

DATA OUT
pireps

PILOT INPUT

Speech Recognition

~ or ~

Adaptive Keyboard

ON-BOARD DATA

airport info
runway info
position

COGNITIVE ASSISTANCE PROCESSOR

AHRS
Attitude
G Forces

ADS-B DATA

FIS-B
TIS-B

INFERENCE PROCESSOR

inferred pattern leg
inferred phase of flight
inferred destination
manuever intent

MITRE

© 2022 THE MITRE CORPORATION. ALL RIGHTS RESERVED. APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED. PUBLIC RELEASE CASE NUMBER 22-2811

On-Demand Information

Speech rec requests

Contextual Notifications

Right information at the right time

Contextual On-Demand

Request for contextual information in the future

MITRE

© 2022 THE MITRE CORPORATION. ALL RIGHTS RESERVED. APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED. PUBLIC RELEASE CASE NUMBER 22-2811

Features

MITRE

© 2022 THE MITRE CORPORATION. ALL RIGHTS RESERVED. APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED. PUBLIC RELEASE CASE NUMBER 22-2811

Feature List

Base Algorithms

- Inferred destination
- Phase of Flight (fixed & rotor wing)
- Traffic Pattern Leg
- Rotorcraft Phase of Flight for off-airport landings
- Maneuver Intent
- Active Runway
- Traffic/Wx based Inferred Landing Runway

Progressive Taxi/Approach/Missed Approach/Departure

- Taxi route drawn on map and next turn notifications
- Approach drawn on map and next fix/altitude restriction notifications
- Missed approach drawn on map and next fix/turn/altitude restriction notifications
- Departure drawn on map and next fix/turn/altitude restriction notifications

Conformance Notifications

- Taxi deviation
- Altitude deviation
- Approach/Departure altitude restriction deviation
- Lateral flight path deviation

NOTAM

- Auto-filtered NOTAM list based on flight plan
- NOTAM updated notifications (e.g., if CTAF is NOTAM'd change, CTAF notification will include that information)
- NOTAM update flight planning (e.g., if runway is NOTAM'd closed, indicated in flight planning interface)
- Safety alerts (collision warnings for temporary obstacles, on approach to closed runway)
- Notify pilot when entering a NOTAM'd UAS operating area and draw area on map

MITRE

© 2022 THE MITRE CORPORATION. ALL RIGHTS RESERVED. APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED. PUBLIC RELEASE CASE NUMBER 22-2811

Feature List (continued)

Loss of Control

- Approach Energy (Low/High) warnings
- Sink
- V/Speed decreasing on departure leg
- Unperceived roll detection
- Downwind too fast for turn to final
- Drifting on downwind
- Pass through final
- Runway remaining
- Pre-stall warning if KIAS below threshold on climb out
- Skid in pattern

Navigation Error Detection

- Approach not to declared destination
- Approach/Departure not to/from declared runway
- Approach/Departure not to/from a runway
- Approach to a closed runway
- Class B Excursion

Terrain

- Terrain warning with v/speed necessary to outclimb
- Descent into terrain/not to an airport notification

Speech Rec Flight Planning

- Set destination, origin, add/remove fixes via speech rec
- Direct to via speech rec
- Set altitude via speech rec
- Set runway, pattern turn direction via speech rec
- Modify pattern legs via speech rec (e.g., set two mile base)
- Enter taxi path via speech rec

Reminders

- Request to be reminded to do some event by time, distance, distance from point, at an altitude
- Request report some time/distance from destination/fix
- Request report pattern leg (e.g., report two mile left base runway one eight)
- Request report visibility/ceilings below pilot set threshold at location

MITRE

© 2022 THE MITRE CORPORATION. ALL RIGHTS RESERVED. APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED. PUBLIC RELEASE CASE NUMBER 22-2811

Feature List (continued)

General Info Requests

Request time/distance/bearing to fix/airport via speech rec

Request runways at airport via speech rec

Request traffic pattern altitude or turn directions at airport via speech rec

Request ATIS/Tower/CTAF frequency at airport via speech rec

Request tower hours via speech rec (will include information on whether tower will be open at ETA)

Request destination summary

Request current airspace (say airspace)

Checklists

Request open checklist via speech rec

Request read checklist via speech rec

VFR Approach/Departure

Draws traffic pattern to declared runway

Draws traffic pattern from departure runway

Hold

- Set up unpublished hold via speech rec
- Automated leg timers (distance or time)

Contextual Notifications

- ATIS/Tower/CTAF frequencies
- Weather below VFR at destination
- 5 miles from destination
- Time to complete checklist
- Approach Parachute Jump Area

Practice Areas

- Draw ad hoc practice area
- Notifies of excursion

RTA

- Set up required time of arrival for fix via speech rec
- Speed guidance to meet fix

© 2022 THE MITRE CORPORATION. ALL RIGHTS RESERVED. APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED. PUBLIC RELEASE CASE NUMBER 22-2811

Feature List (continued)

Instrument Approaches

- Notification if destination is cold weather airport and temp is below instrument approach temp
- Notification if destination viz/ceiling is below minimums for selected instrument approach procedure

PIREPs

- Ability to submit PIREP in Oto (LEIDOS/AWC) (speech rec & GUI)
- Ability to submit a request for a PIREP at specified location
- Notification suggesting PIREP submission when turbulence detected
- Notification suggesting PIREP submission when near a PIREP request location

Rotorcraft

- Helo route altitude warnings

© 2022 THE MITRE CORPORATION. ALL RIGHTS RESERVED. APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED. PUBLIC RELEASE CASE NUMBER 22-2811

PROGRESSIVE APPROACH
MITRE

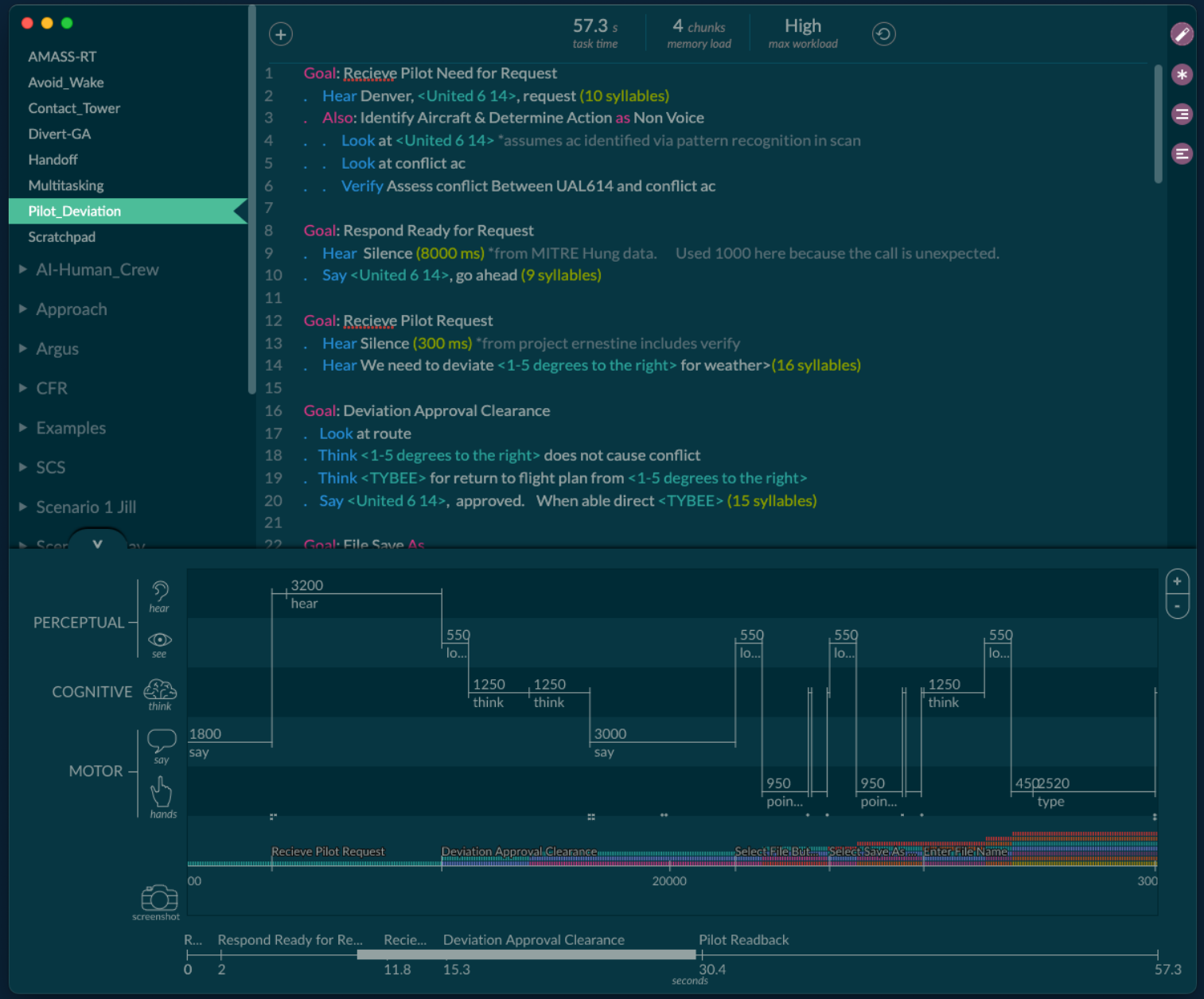
REPORT TRAFFIC LEG
MITRE

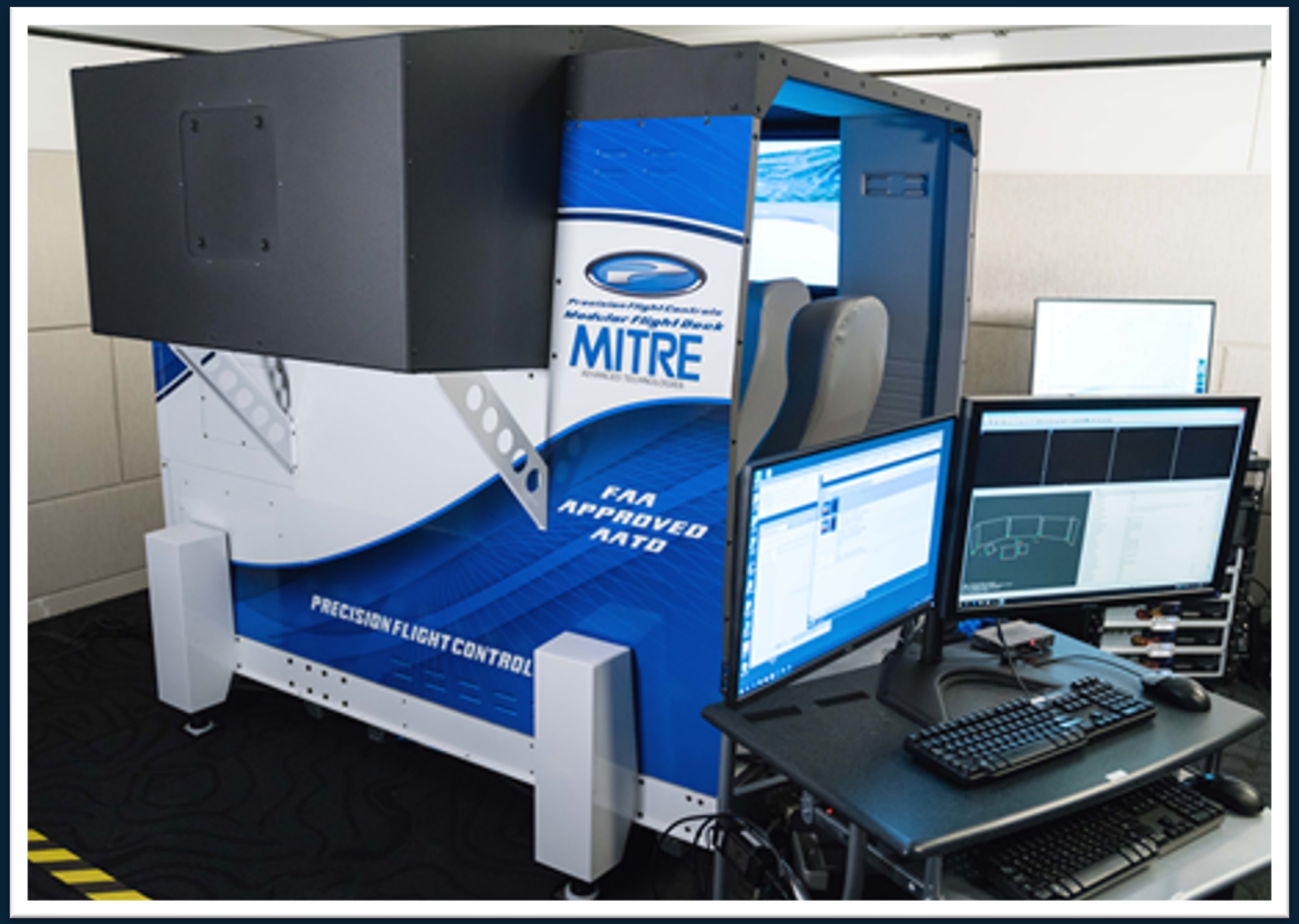
CLOSED RUNWAY
MITRE

MITRE

© 2022 THE MITRE CORPORATION. ALL RIGHTS RESERVED. APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED. PUBLIC RELEASE CASE NUMBER 22-2811

Cognitive Modeling



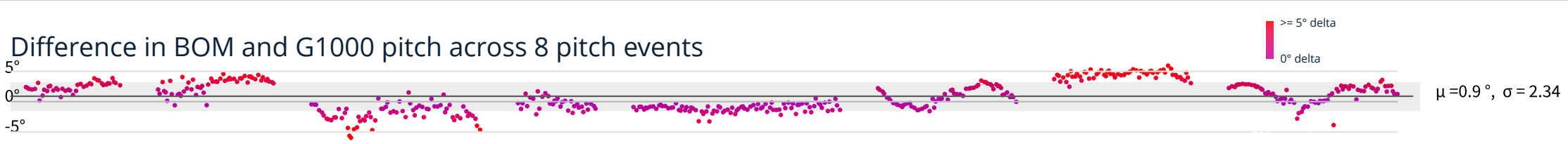


6 HITLS

Usability
Pilot Response
Alert Design
Algorithm Design

Flight Tests

~20 hours Flight Testing



Sources of Benefit

© 2022 THE MITRE CORPORATION. ALL RIGHTS RESERVED. APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED. PUBLIC RELEASE CASE NUMBER 22-2811

Cognitive Offloading

Reducing the workload associated with some task

Subtask Reallocation

Reallocating a subtask to the cognitive assistant

Attentional Capture

Drawing the pilot's attention to critical information

MITRE

© 2022 THE MITRE CORPORATION. ALL RIGHTS RESERVED. APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED. PUBLIC RELEASE CASE NUMBER 22-2811

Questions?

MITRE | SOLVING PROBLEMS FOR A SAFER WORLD®

© 2022 THE MITRE CORPORATION. ALL RIGHTS RESERVED. APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED. PUBLIC RELEASE CASE NUMBER 22-2811

sestes@mitre.org

jhelleberg@mitre.org

mpollack@mitre.org

@MITREcorp

linkedin.com/company/mitre/

MITRE

© 2022 THE MITRE CORPORATION. ALL RIGHTS RESERVED. APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED. PUBLIC RELEASE CASE NUMBER 22-2811

NOTICE

This work was produced for the U.S. Government under Contract 693KA8-22-C-00001 and is subject to Federal Aviation Administration Acquisition Management System Clause 3.5-13, Rights In Data-General, Alt. III and Alt. IV (Oct. 1996).

The contents of this document reflect the views of the author and The MITRE Corporation and do not necessarily reflect the views of the Federal Aviation Administration (FAA) or the Department of Transportation (DOT). Neither the FAA nor the DOT makes any warranty or guarantee, expressed or implied, concerning the content or accuracy of these views.

For further information, please contact The MITRE Corporation, Contracts Management Office, 7515 Colshire Drive, McLean, VA 22102-7539, (703) 983-6000.

© 2022 The MITRE Corporation. All Rights Reserved.

© 2022 THE MITRE CORPORATION. ALL RIGHTS RESERVED. APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED. PUBLIC RELEASE CASE NUMBER 22-2811