Contingency Management with Human Autonomy Teaming

HAT Lab Presentation to the

Emergent Aircraft Systems and the Dispatcher Workshop

March 14, 2018

Contingency Management

- Operations in the NAS are becoming increasingly automated
  - *Flight planning software for dispatch*
  - *Flight management systems, and autoland for pilots*
  - *Conflict detection, spacing tools for ATC*
  - *Proposals for UTM and UAM are highly automated*
- However, for the foreseeable future, none of these jobs can be fully automated
  - *"No matter how powerful it [the AI] is, we always find a case where the car will be stuck." – Carlos Ghosn, Chairman and (then) CEO of Nissan*
  - *Humans need to oversee critical decisions*
  - *Human needs to be brought into the loop when automation comes close to its boundaries*
- $\Rightarrow$ Contingency Management
  - *Operator steps in to handle contingencies*

Who Monitors the Automation?

Problem 1: If people are monitoring, it will take a lot of them

Problem 2: People are very bad at monitoring for rare events (vigilance)

Solution: Automation can detect slightly elevated risks

Frequency

Perceived/Calculated Risk

Nominal

Off-Nominal
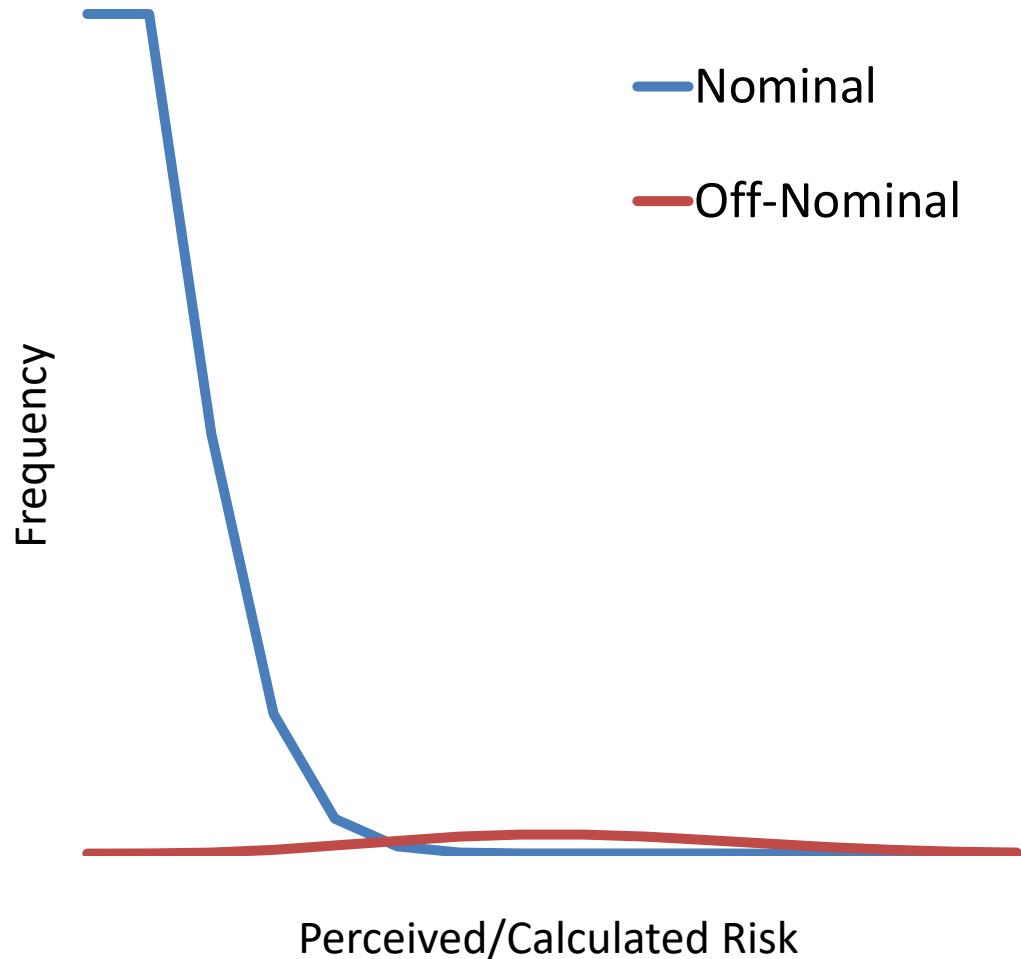
Human Autonomy Teaming (HAT)

- Traditionally automation is handed a set of tasks to do on its own

- With HAT, the automation and operator work together on tasks

- Example:
  - *Currently a dispatcher will get a flight plan from the automation and modify it, with no feedback from automation about why it did what it did*
  - *With HAT operator and human interact. E.g., the automation might point out inefficiencies in the modified flight plan; the operator might request fewer waypoints*
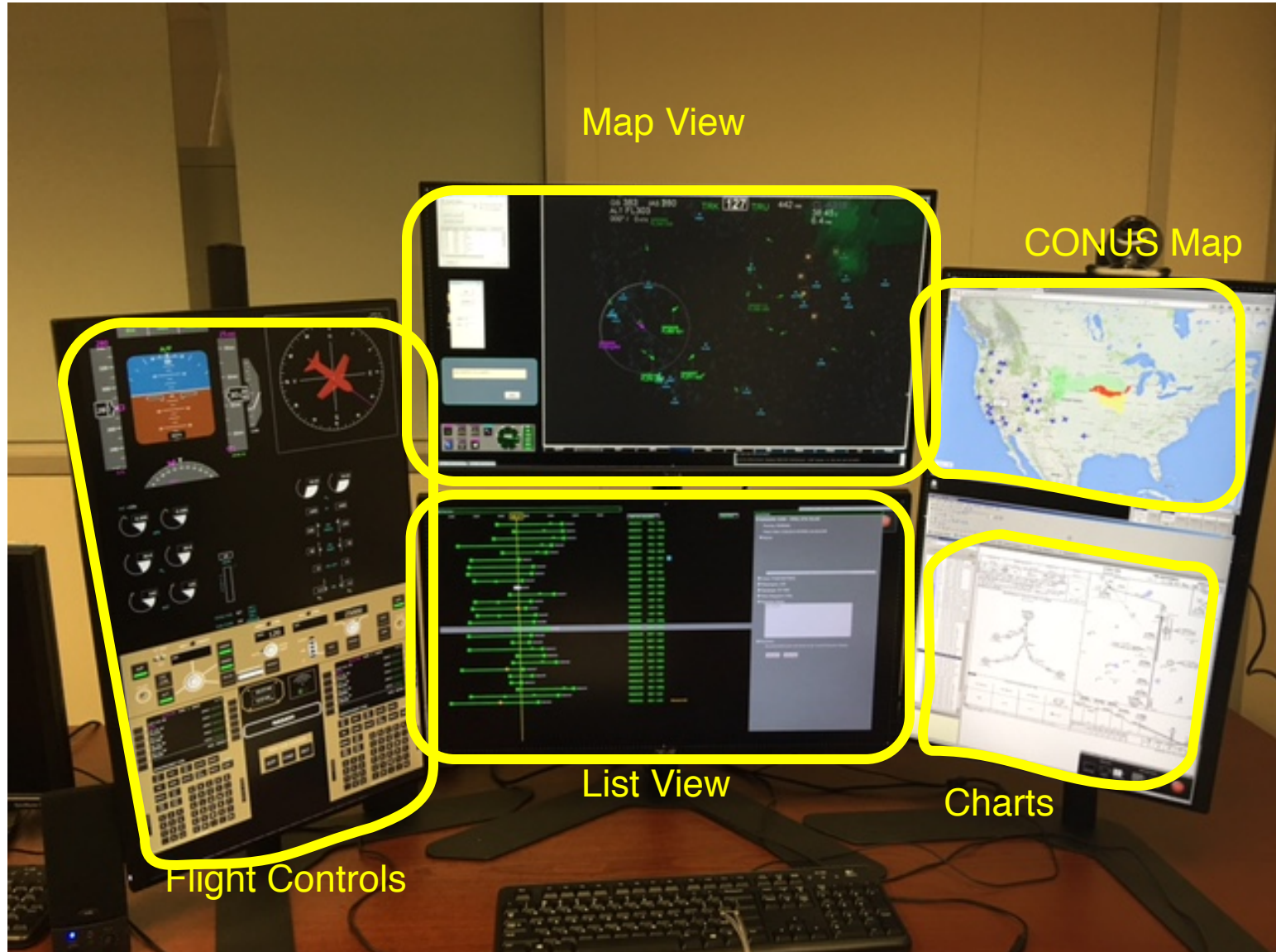
Key HAT Concepts

- Bi-directional Communications
  - *Procedures and interfaces for gathering and integrating information*
  - *Crew Resource Management (CRM) for automation*
- Working Agreements/Plays
  - *Procedures and roles and responsibilities for specific situations*
  - *Standard Operating Procedures (SOPs)*
  - *Roles and responsibilities can shift based on factors such as workload*

# HAT and Contingency Management in a Flight Following Context

- Ground support of pilots under reduced crew operations
  - *Looking primarily at flight following/re-routing*
  - *ConOps: automation does more flight planning; dispatchers aided by automation and real time information do more tactical decision-making*
- Alerted pilots when
  - *They go off path or fail to comply with clearances*
  - *Significant weather events affect their trajectory*
  - *They fail to act on EICAS alerts*
- Rerouted aircraft when:
  - *Weather impacts their route*
  - *System failures or medical events force diversions*

Ground Station Layout

Map View

CONUS Map

Flight Controls

List View

Charts

Bi-directional Communication

A recommender system shows divert reasoning and factor weights.

Operator can alter weights and request ratings for other airports.
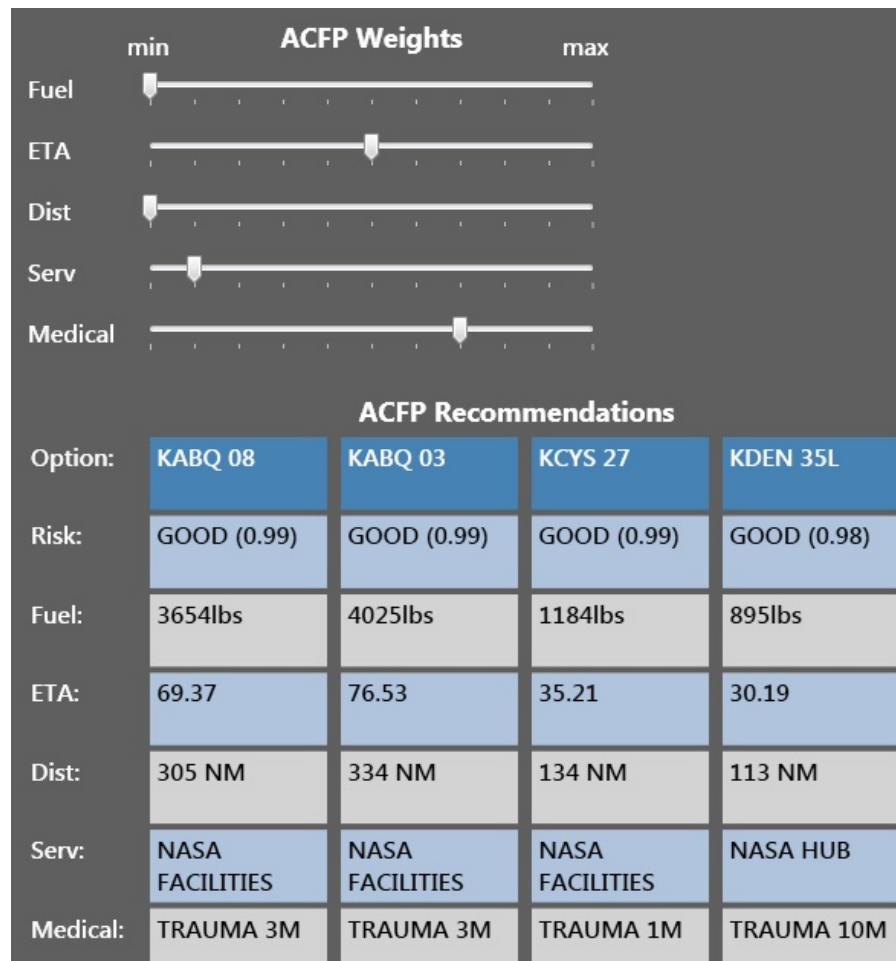
HAT Concept Feedback

- Table
  - *Participants liked having the table (rated 8.33 out of 9).*
  - *They felt the table was helpful in making divert decisions (rated 7.67 out of 9)*
  - *"This [the table] is wonderful…. You would not find a dispatcher who would just be comfortable with making a decision without knowing why."*
- Weights
  - *Participants liked having the weights (rated 8.33 out of 9)*
  - *They felt they were useful in making divert decisions (rated 8.33 out of 9)*
  - *And that they improved the automation's ability to handle unusual situations (rated 7.83 out of 9)*
  - *"The sliders was [sic] awesome, especially because you can customize the route…. I am able to see what the difference was between my decision and [the computer's decision]."*

Plays/Working Agreements

Play Manager
- See all active plays
- View actions requiring operator input
- View actions that have been performed
- Invoke Play Selector to configure and launch new play

Play Node Graph
- Visual representation of a play's structure
- Modify ALTA and override LOAs
- Displays progress of play

Recommendation Panel
- Lists ac involved in play and status
- Provides recommendation table with transparency information
- Shows selected ac's working agreement with dynamic checklist
- Used to execute recommendations
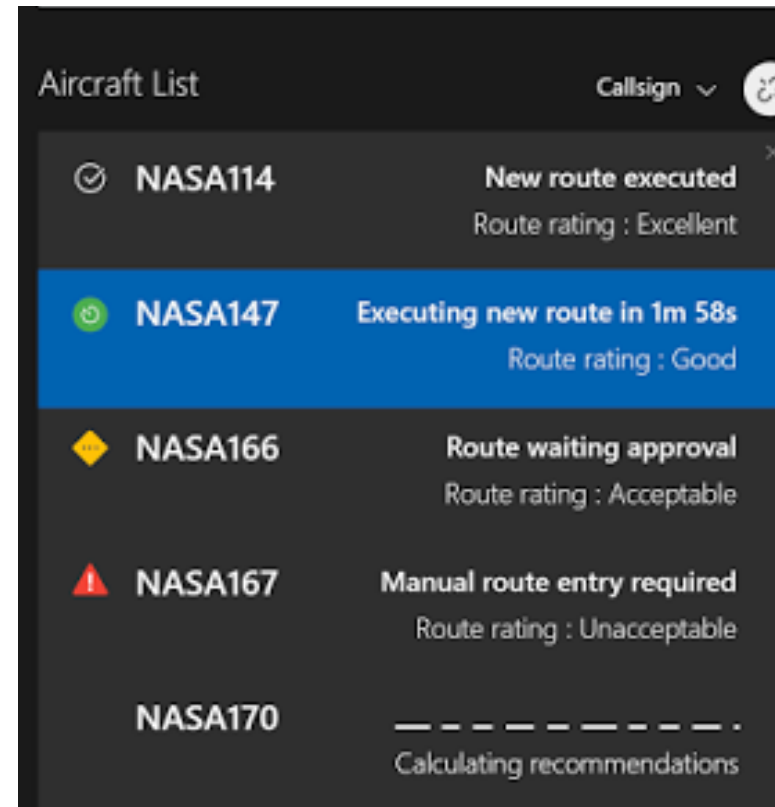- Can be used to constrain LOA determinations

Working Agreements: Automation Level-Based Task Allocation (ALTA)

- A model to achieve contextually aware dynamic LOA determinations
- After a problem has been detected or handed to the agent, the agent will conduct an Evaluation Phase
  - *Agent requests potential solutions from automated recommender*
    - Evaluates on multiple dimensions (e.g., risk, flight delay, fuel)
    - Takes into account user-defined thresholds for each dimension's LOA
    - Sorts solutions by highest LOA first, then user-identified primary criterion

ALTA Action Phase

Working agreements specify, based on predetermined factors, which of the following the automation will do:

- Auto: autonomously executes and informs operator
- Veto: presents solutions one of which will be autonomously executed unless the operator intervenes
- Select: presents multiple options for operator selection
- Manual: task to be performed by operator

Route Recommendations

	Recommended						
	KRNO(16R)	KSJC(12L)	KSMF(16L)	KSMF(16R)	KLAS(25L)	KONT(08L)	KLAS(25R)
Risk 0.950 +	0.990 (Acceptable)	0.990 (Acceptable)	0.990 (Acceptable)	0.990 (Acceptable)	0.990 (Acceptable)	0.980 (Acceptable)	0.990 (Acceptable)
Fuel 12000 lbs+	7944 lbs	7526 lbs	6675 lbs	6660 lbs	5005 lbs	4637 lbs	4492 lbs
Medical Inactive	Trauma 3 M	Trauma 6 M	Trauma 10 M	Trauma 10 M	Trauma 3 M	Hospital 1 M	Trauma 3 M
Dist AC-APT ≤ 300 NM	51 NM	233 NM	163 NM	163 NM	321 NM	397 NM	321 NM
ETTA P ≤ 1h 30m	26m	1h 10m	48m	49m	1h 10m	1h 14m	1h 21m
Path Stretch ≤ 400 NM	-809 NM	-633 NM	-665 NM	-664 NM	-550 NM	-523 NM	-505 NM
Facilities Nasa Hub	Nasa Facilities	Nasa Facilities	Nasa Facilities	Nasa Facilities	Nasa Hub	Nasa Facilities	Nasa Hub

Working Agreements:
A Path to Full Autonomy

- Over time automation improves
  - *Fewer "risky" situations occur*
  - *Therefore situations detected requiring operator intervention*
- Over time reliability of automation better understood
  - *Margin of error can be reduced*
  - *Therefore fewer situations where operators need to step in to verify safety*