

National Aeronautics and Space Administration



Examining the Relationship Between Workload and Resilient Performance in Airline Flight Crews

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Introduction

What we wanted to know

Are there strategies that can guard one's cognitive resources while flying?

Can the TLX be used as a way to differentiate between low and high workload crews?

Why we did this

Understand how resilient performance can impact crew workload

Consider how training can enable resilient performance

Method

SOTERIA flight simulations/scenarios were used



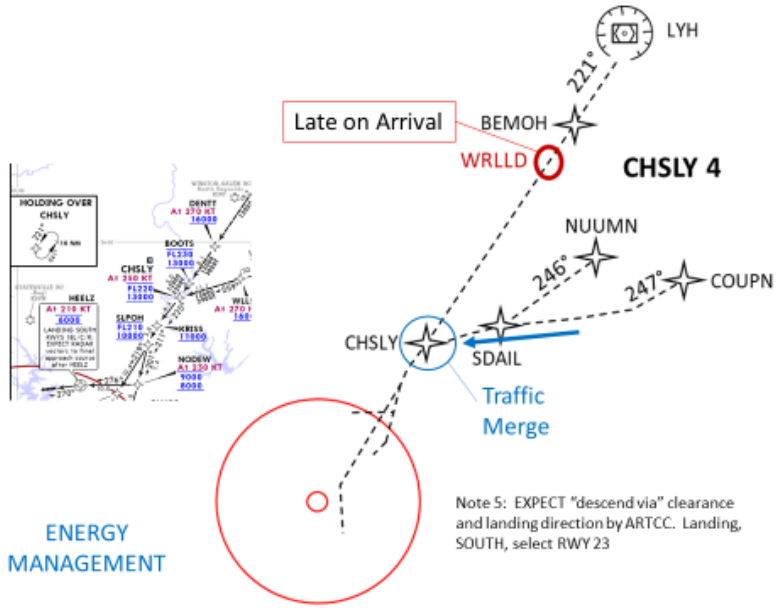


Method

Used five scenarios each approximately 20mins

Example of SOTERIA scenario

Scenario 1a – Event 1



ASRS Reports 1517588, 1527071, 1444706

Issue: Energy Management Issue for 737-800 nominally for CHSLY 4 Between CHSLY (FL220 – 13000 at 250) to NODEM (9000 – 8000 at 230)

Start: WRLLD FL320 at 320 KT. Landing SOUTH. RWY 23 in use (ATIS, ARTCC)

Workload Modulator: Traffic Merging (SDAIL to WLLSH at 16000 at/above at 270)

ATC giving significant profile changes: *"Given lots of changes from profile: maintain speed, speed up, slow down; heading from fix, then modified again; given climb for traffic, etc. (1444706)"*

ATC: Cleared descend via cross CHSLY at or above 18000 slow at 250. Expect RWY 23. To create space for merging traffic

Challenge: Compression – separation issues

Opportunity: ATC issues consistent slow to and cross at or above at CHSLY. Early slow of A/C or request of ATC

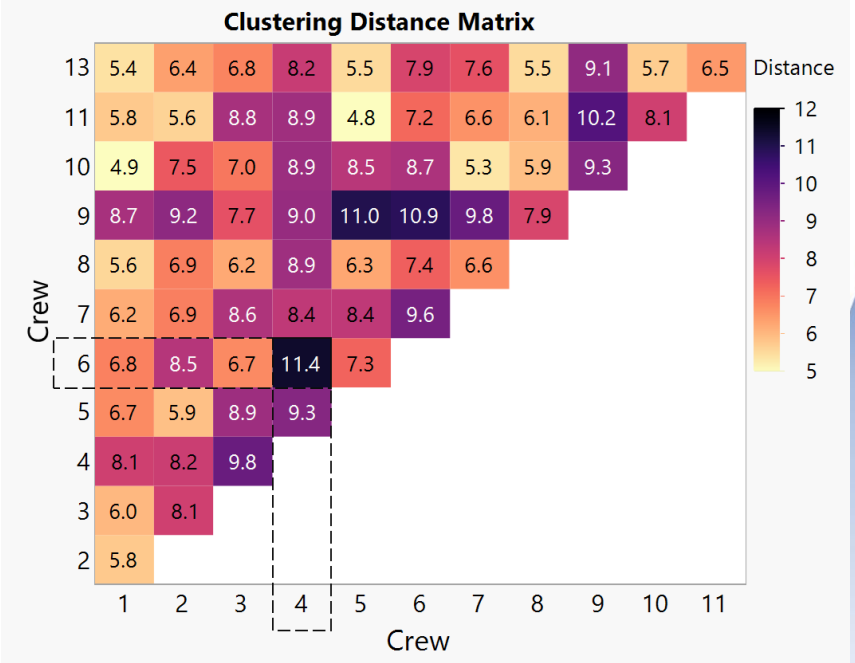
Other Action: Request HOLD over CHSLY if required

Method

Two crews (four pilots) compared: *Low Workload* vs *High Workload*

Clustering graphic

TLX scores determined workload and clustering was used to categorize the crews as either low or high.



LIT Proficiencies Subset

Applied prior knowledge (that I brought with me to the simulation) to solve a problem	**Learn**	Intervened to address or resolve an unwanted condition.	**Adapt**
Verbally shared prior knowledge/experience with the other crewmember.	**Learn**	Changed automation or system to respond to an unanticipated new pressure.	**Adapt**
Heightened my own awareness/focus to prepare for an impending challenging task.	**Adapt**	Cross-checked other pilot's actions, over and above SOP-required cross-checking.	**Coordinate**
Monitored aircraft status in response to a detected anomaly, surprise, or inconsistency.	**Coordinate**	Initiated an action to decrease my own or other crewmember's workload/task load.	**Adapt**
Discussed expected actions before an anticipated challenging task.	**Plan**	Asked external source (e.g., ATC) for input/assistance.	**Coordinate**
Developed "what if" scenarios to support a possible change in plan.	**Plan**	Asked other pilot for input/assistance.	**Coordinate**
Gathered information to support a possible change in plan.	**Plan**	Managed time effectively to complete tasks.	**Adapt**
Identified countermeasures to an identified problem/pressure.	**Adapt**	Debriefed what happened after a problem occurred.	**Learn**

Behavior Collection Form

- Verbally shared prior knowledge/experience w/ other crewmember.
- Heightened their own awareness/focus
- Monitored aircraft status in response
- Discussed expected actions before an anticipated challenging task
- Developed "what if" scenarios
- Gathered information
- Identified countermeasures to an identified problem/pressure.
- Intervened to address or resolve an unwanted condition.
- Changed automation or system
- Cross-checked other pilot's actions, over and above SOP-required cross-checking.
- Asked external source (e.g., ATC) for input/assistance.
- Asked other pilot for input/assistance.
- Managed time effectively
- Debriefed what happened after a problem occurred.
- reduced crewmember's workload / taskload.

FO Monitoring

FO Flying

Description

Goal type

Stated	Inferred	Unknown

Goal

Outcome

- 1
- 2
- 3
- 4
- 5
- No Longer Relevant
- Unknown

Outcome Description

Pressure

Hypotheses

1. Observed resilient strategies can be identified and cataloged.
2. Pilots that display more resilient behaviors will show lower workload self-assessment scores.
3. Self-reported performance will increase with increased resilient behaviors.

Chi Square goodness of fit test performed to detect differences in counts

Results

Table 1. Self-Reported Workload Scores by Success and Relevance

Behavior Type	*Count for Low Workload Crew*	*Count for High workload Crew*
All Behaviors	49	42
Successful Behaviors	28	19
All Workload Behaviors	26	18
Successful Workload Behaviors *	16	6

* Statistically significant

Note: proportions of success vs. totals are not indicative of percent failed due to coding methods.

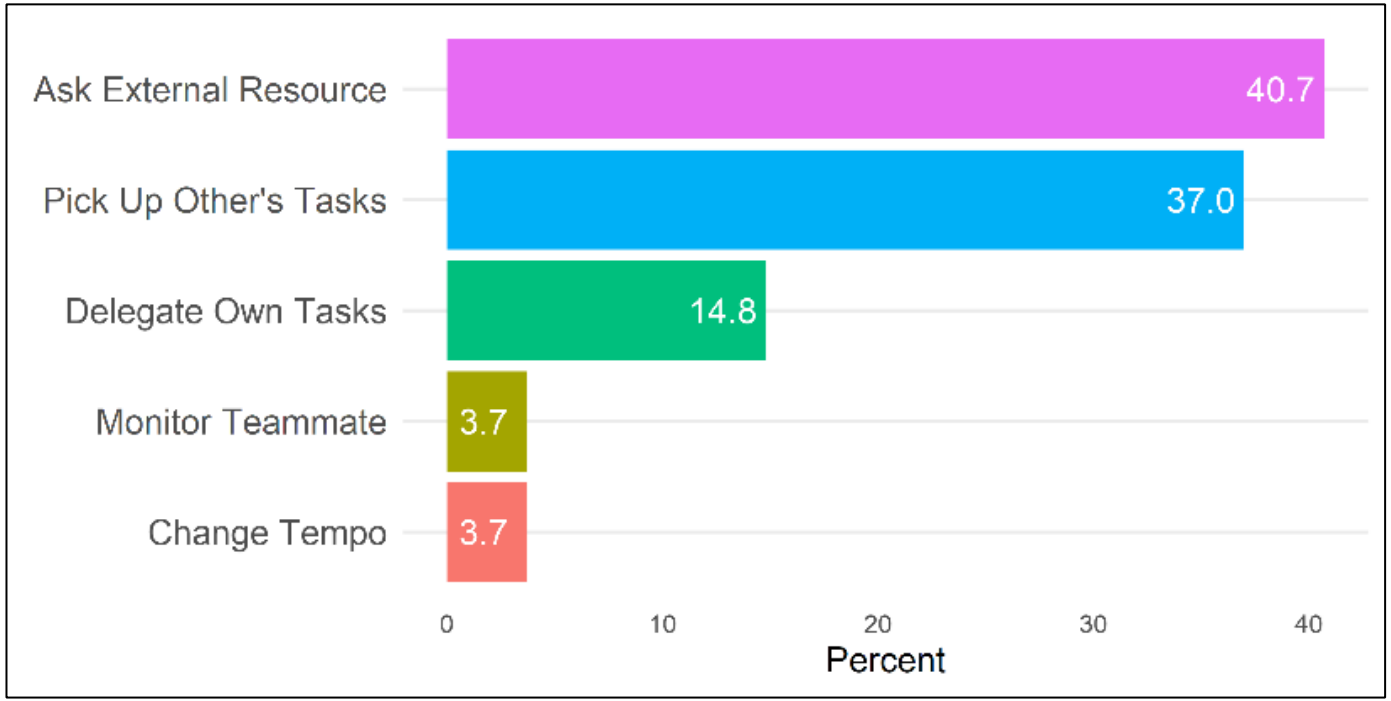
Results

Table 2. *Observed Resilient Behaviors Related to Workload*

Observed Behavior	*Inferred Goal*	*Possible Strategy*
Pilot manipulating autopilot controls for other pilot	Assuming other pilot's additional tasks for maintaining teammate's workload at acceptable level	[1]Pick-up other's tasks (offer your additional resources)
Pilot asked ATC to square the vectored pattern	Lengthening the mileage to approach and creating more time to prepare by changing the rate of externally driven events	Change tempo
Asked other pilot whether they were in the "green"	Explicitly inquire about teammate status	Monitor teammate
Pilot asked ATC for turbulence ahead	Seek information not easily or accurately obtainable within the aircraft	[1]Ask external resource
Asked other pilot what the ATC instructions were	Ensure correct flight path by using other pilot's memory/attention	[1]Delegate own tasks (conserve own resources)

[1] LIT codebook behaviors that were observed as successful workload behaviors.

Results


Ask External Resource
40.7
Pick Up Other's Tasks
37.0
Delegate Own Tasks
14.8
Monitor Teammate
3.7
Change Tempo
3.7
0
10
20
30
40
Percent

Discussion

Outcomes:

Initially, we did not know how successful we would be in capturing outcomes. Now we believe outcomes are critical to understanding resilient performance.

Potentials Resilient Performance:

Behaviors that fit the description of resilient performance only have the potential to produce it – they do not guarantee it.

Crew performance and TLX granularity:

We found that crews work as a team and help modulate one another's workload. The TLX is also measuring workload in aggregate while the modulation occurs during finer grained intervals. It might not be the best tool.

Discussion

Limitations

Statistical Power: possible type-I error and additional participant data are required to validate this result.

Scenario comparability: although scenarios were highly scripted, the complexity of flying made each crew handle things slightly differently.

TLX Self-reported Performance Issue: performance measurement on the TLX is inverted (lower is better) and participants required reminding. Thus, data validity could be an issue in this category.

Conclusion

Self-reported workload measures could be used after standardized training events can help identify how experienced crews manage workload for enhancing flexibility, performance, and ultimately safety.

Next Steps:

Perform again on larger sample from SOTERIA

Determine trainability of behaviors

Start to gain information on success rates for behaviors in real operations