SCENARIO-BASED TASK DESIGN FOR AIRLINE PILOT ANTICIPATORY BEHAVIORS:

ASYNCHRONOUS ASSESSMENT OF COMPLEX COGNITIVE SKILLS

MELISSA PETERSON, BARTH BARON, JR., LUCAS CUSANO, RANDALL J. MUMAW, P. CHRISTINE CORRY, DANIEL HOFFMAN, DORRIT O. BILLMAN

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SJSU SAN JOSÉ STATE UNIVERSITY

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OUR TEAM

MELISSA PETERSON,
SJSU, UH MĀNOA

BARTH BARON, JR.,
SJSU, UH MĀNOA

LUCAS CUSANO,
SJSU

RANDALL J MUMAW,
SJSU

P. CHRISTINE CORRY,
SJSU

DANIEL HOFFMAN,
UH MĀNOA

DORRIT O BILLMAN,
NASA

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02

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What is the current level of flight safety?

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2023: 4.2 Billion passengers

35 Million departures

1 Fatal accident

Safety Report 2024 Edition. (n.d.). https://www.icao.int/safety/Documents/ICAO_SR_2024.pdf

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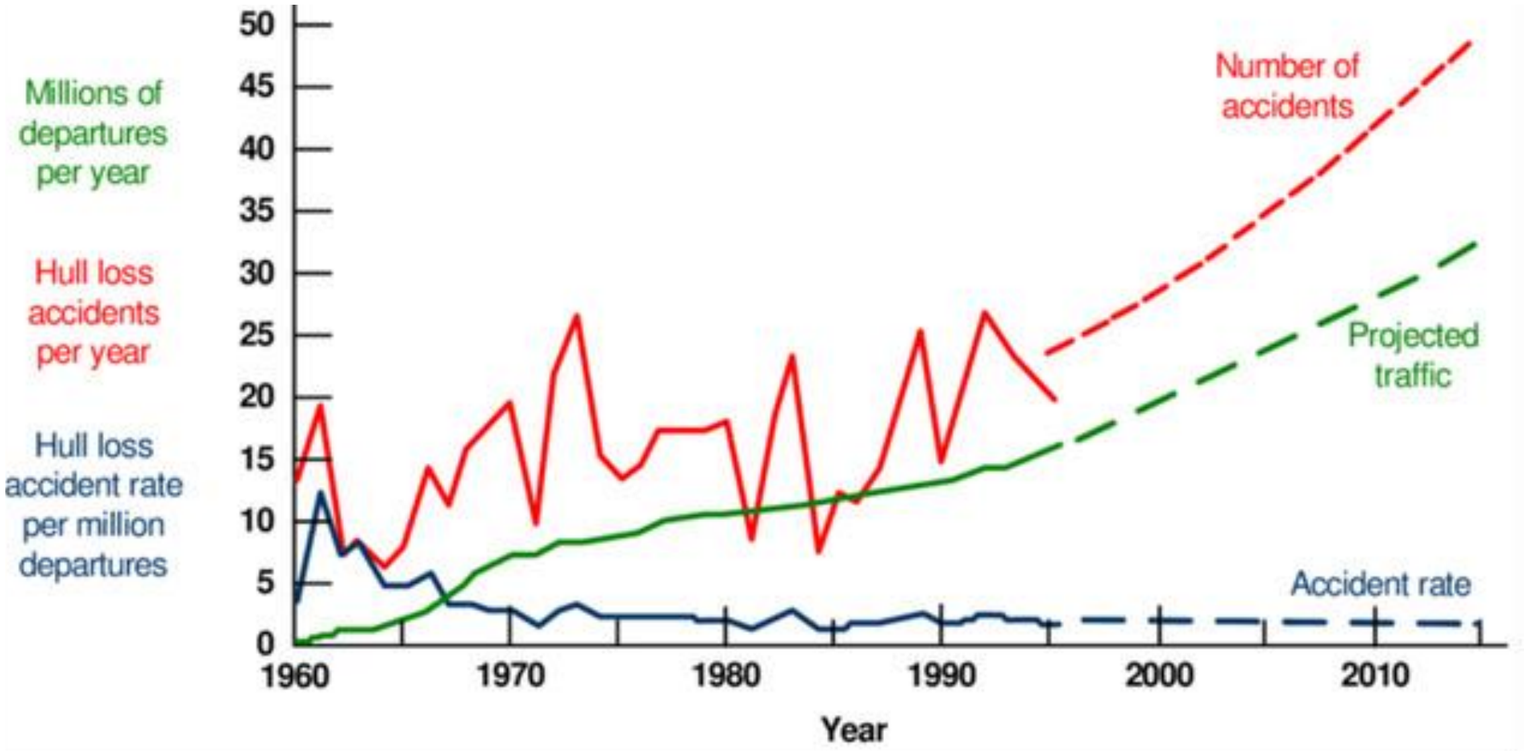

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How do

we think

about

improving

flight

safety?

How do we think about improving flight safety?

Public domain image sourced from National Transportation Safety Board

How do we think about improving flight safety?

“What went wrong?”

Public domain image sourced from National Transportation Safety Board

How do we think about <u>improving</u> flight **safety?**

“What went wrong?”

80% of accidents are caused by pilot error!*

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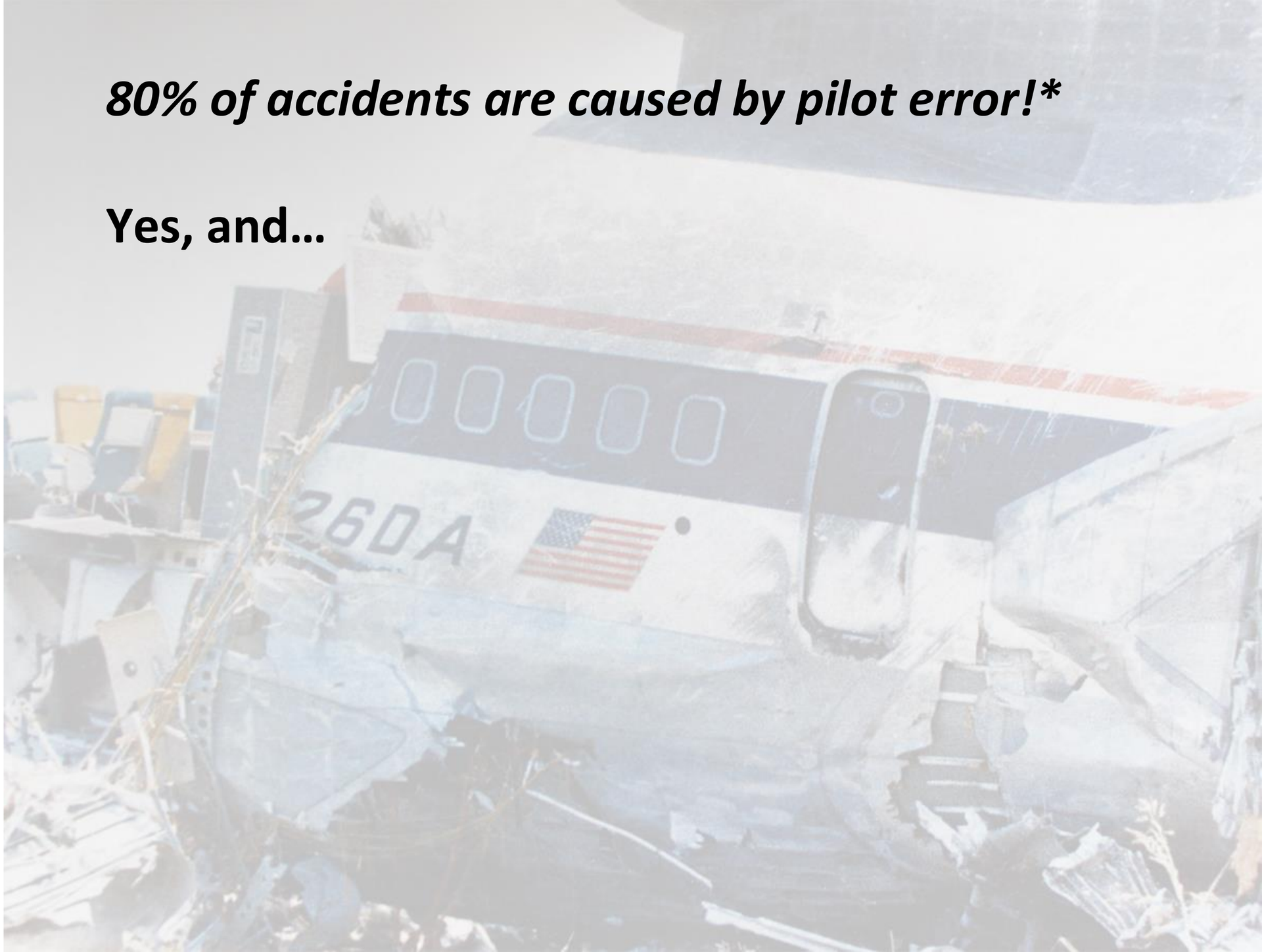
Yes, and…



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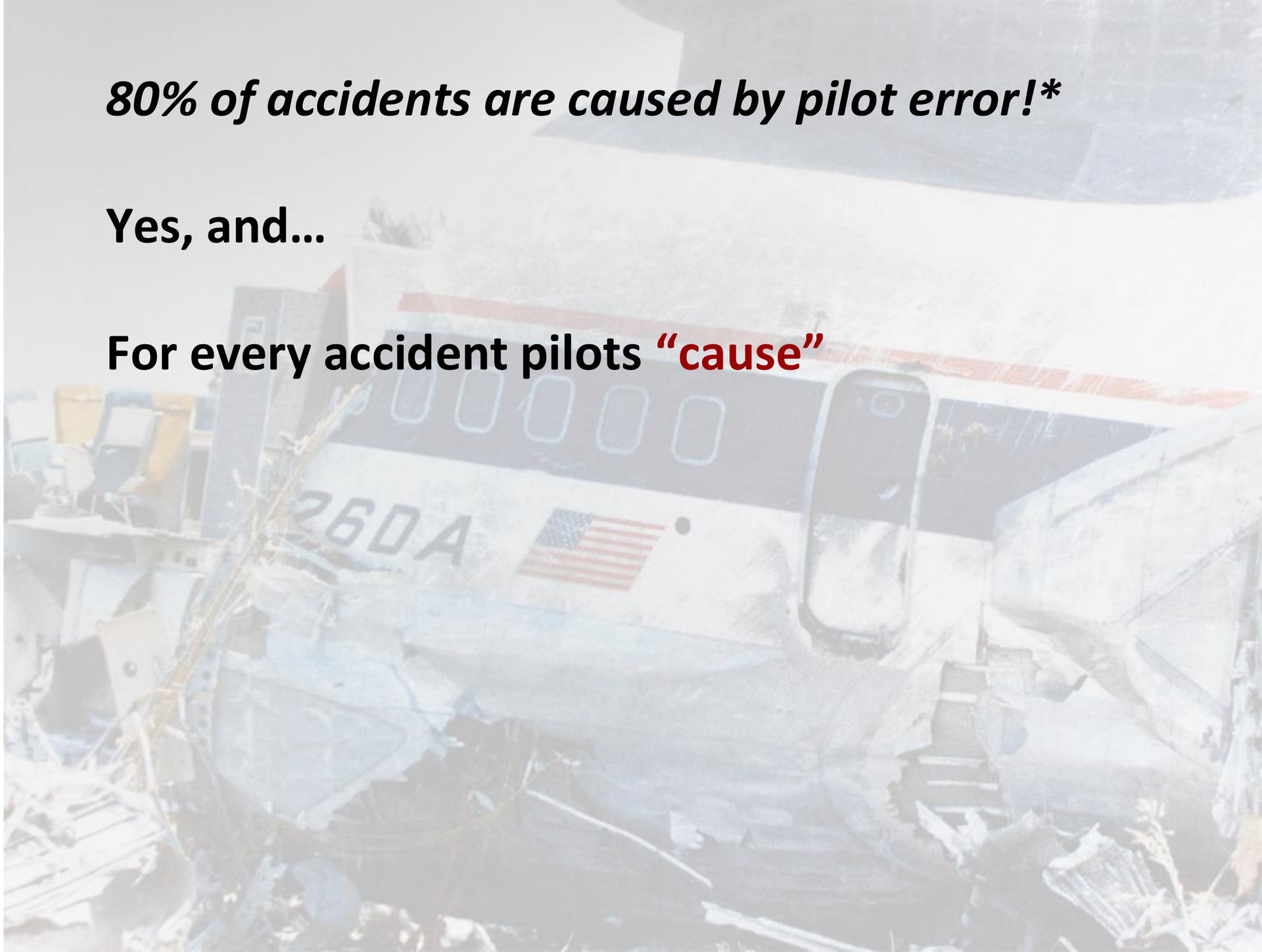
How do we think about <u>improving</u> flight safety?

"What went wrong?"

80% of accidents are caused by pilot error!*

Yes, and…

For every accident pilots "cause"



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How do we think about <u>improving</u> flight **safety?**

"What went wrong?"

80% of accidents are caused by pilot error!*

Yes, and…

For every accident pilots "cause"

They successfully manage 157,000 challenging events

*Sometimes "pilot error" is used when there's much more to the story

"Accident" includes: "substantial aircraft damage"

How do we think about improving flight safety?

“What went wrong?”

	Safety I	
Safety definition:	As few things as possible go wrong	
Safety principle:	Reactive: respond when something happens or emerges	
View of the human factor:	Humans are predominantly a liability/hazard to be minimized	
Risk assessment strategy:	Identify the failures and malfunctions that cause accidents	

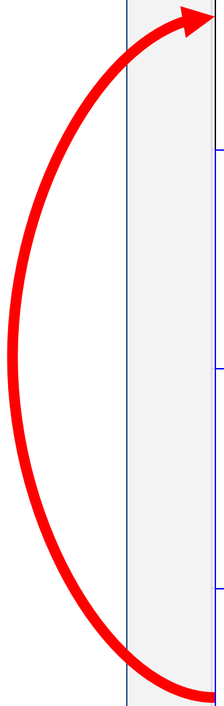
How do we think about improving flight safety?

“What went right?”

	Safety I	Safety II
Safety definition:	As few things as possible go wrong	As many things as possible **go right**
Safety principle:	Reactive: respond when something happens or emerges	**Proactive:** anticipate threats before they impact operations
View of the human factor:	Humans are predominantly a liability/hazard to be minimized	Humans are a resource providing **flexible solutions** to many potential problems.
Risk assessment strategy:	Identify the failures and malfunctions that cause accidents	Understand the conditions where **performance variability becomes difficult** to monitor or control

How do we think about improving flight safety?

Resilience Analysis Grid:



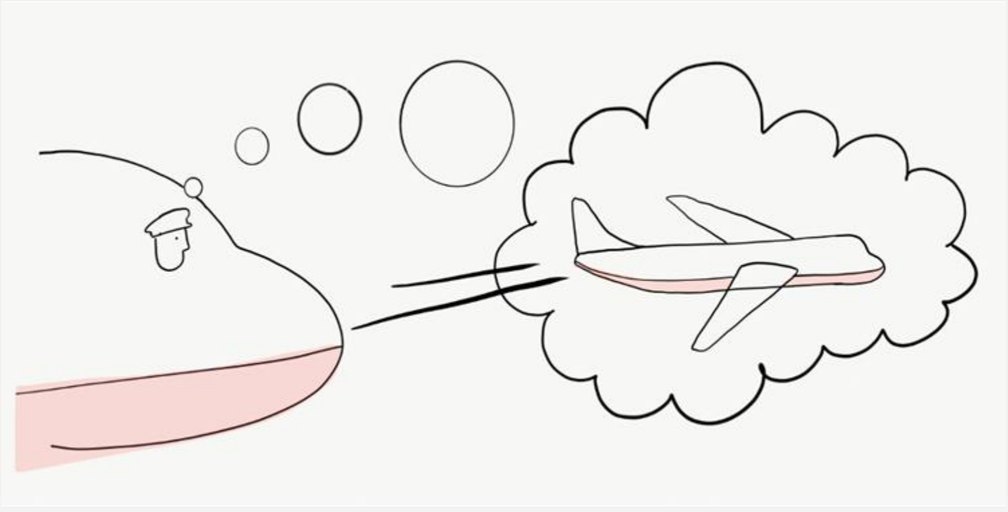
Anticipate	Knowing **what to expect**, anticipating future disruptions, changing conditions, new opportunities
Monitor	Knowing **what to look for**, being able to monitor for what may positively or negatively affect the system's performance in the near term.
Respond	Knowing **what to do**, how to respond to changes, disturbances, and opportunities by activating prepared actions or by adjusting current mode of functioning
Learn	Knowing **what has happened**, or being able to learn from experience, in particular to learn the right lessons from the right experience. **Feedback to "anticipate"**

Hollnagel, E. (2011). "RAG – The resilience analysis grid." In: E. Hollnagel, J. Pariès, D.D. Woods and J. Wreathall (Eds). Resilience Engineering in Practice. A Guidebook. Farnham, UK: Ashgate.

How might we measure anticipation?

Our study seeks to evaluate anticipation by the airline pilots

Anticipate:	Knowing what to expect, anticipating future disruptions, changing conditions, new opportunities
Monitor:	Knowing what to look for, being able to monitor for what may positively or negatively affect the system's performance in the near term.



How might we measure

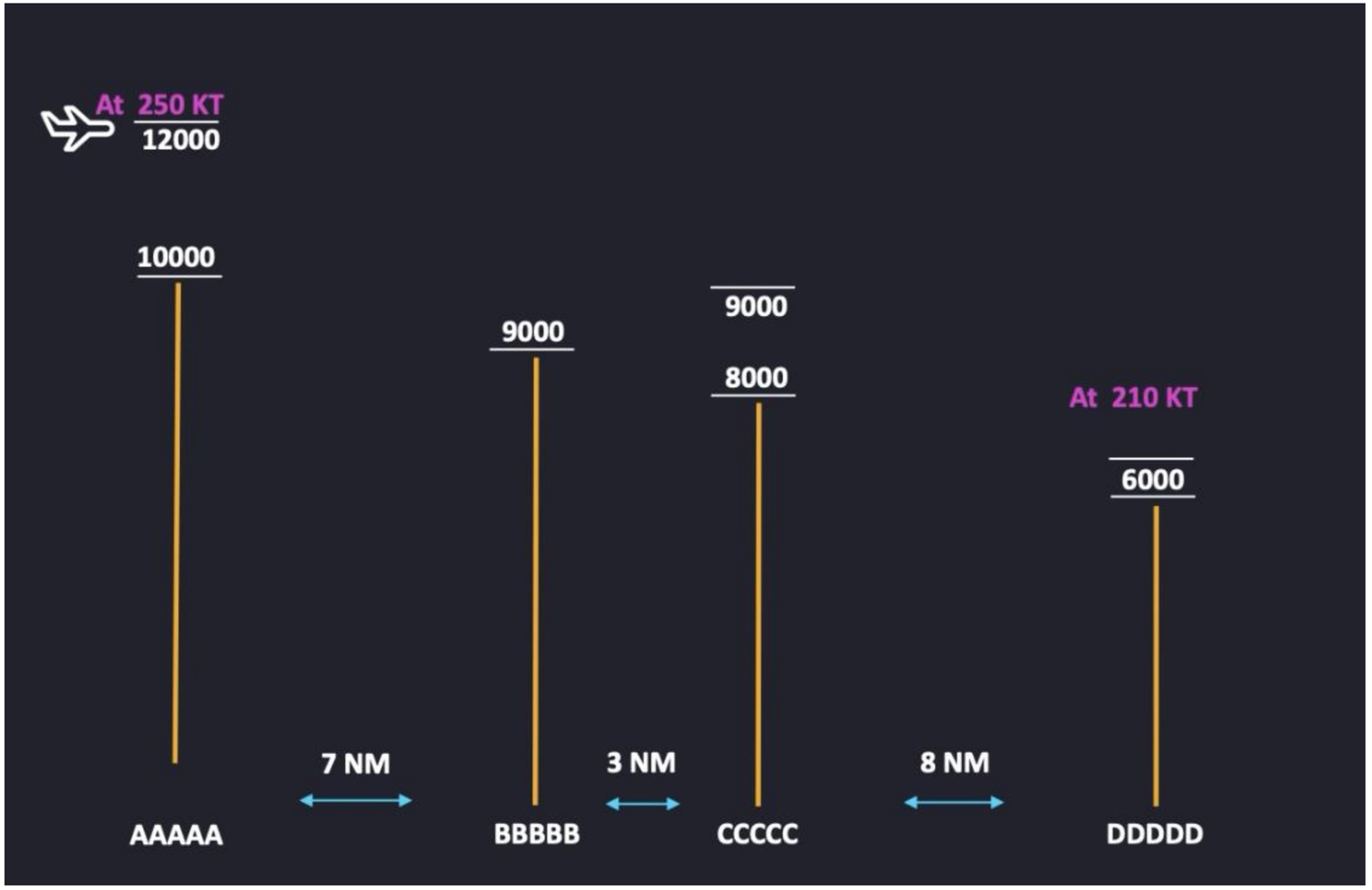
anticipation?

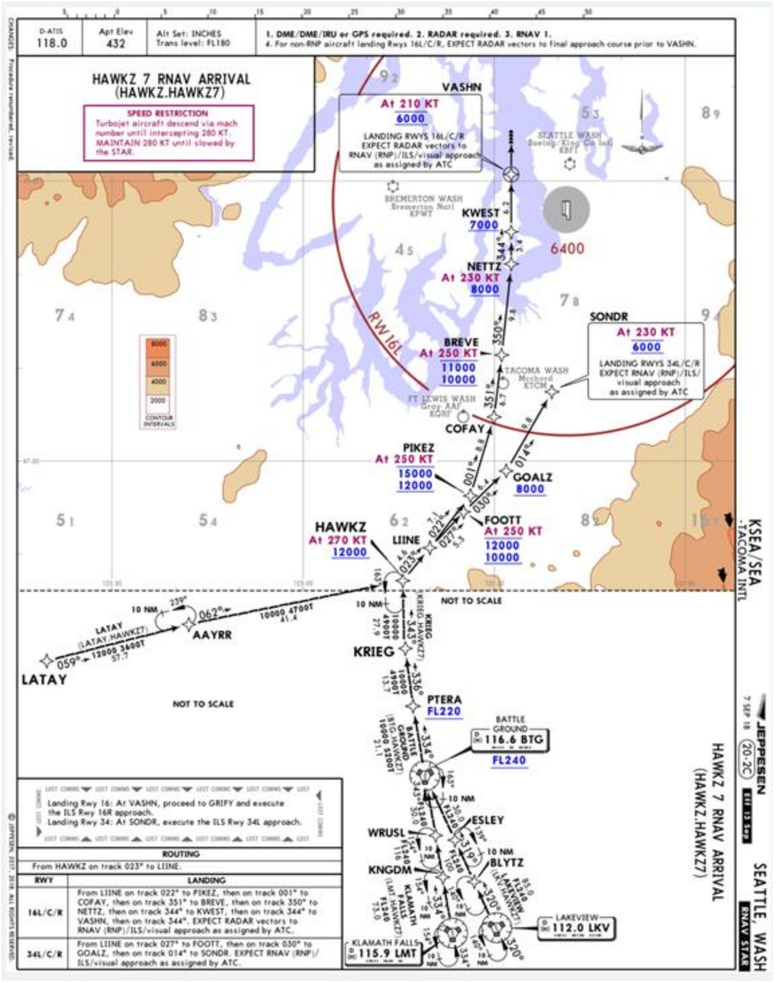
Image from Barth Baron

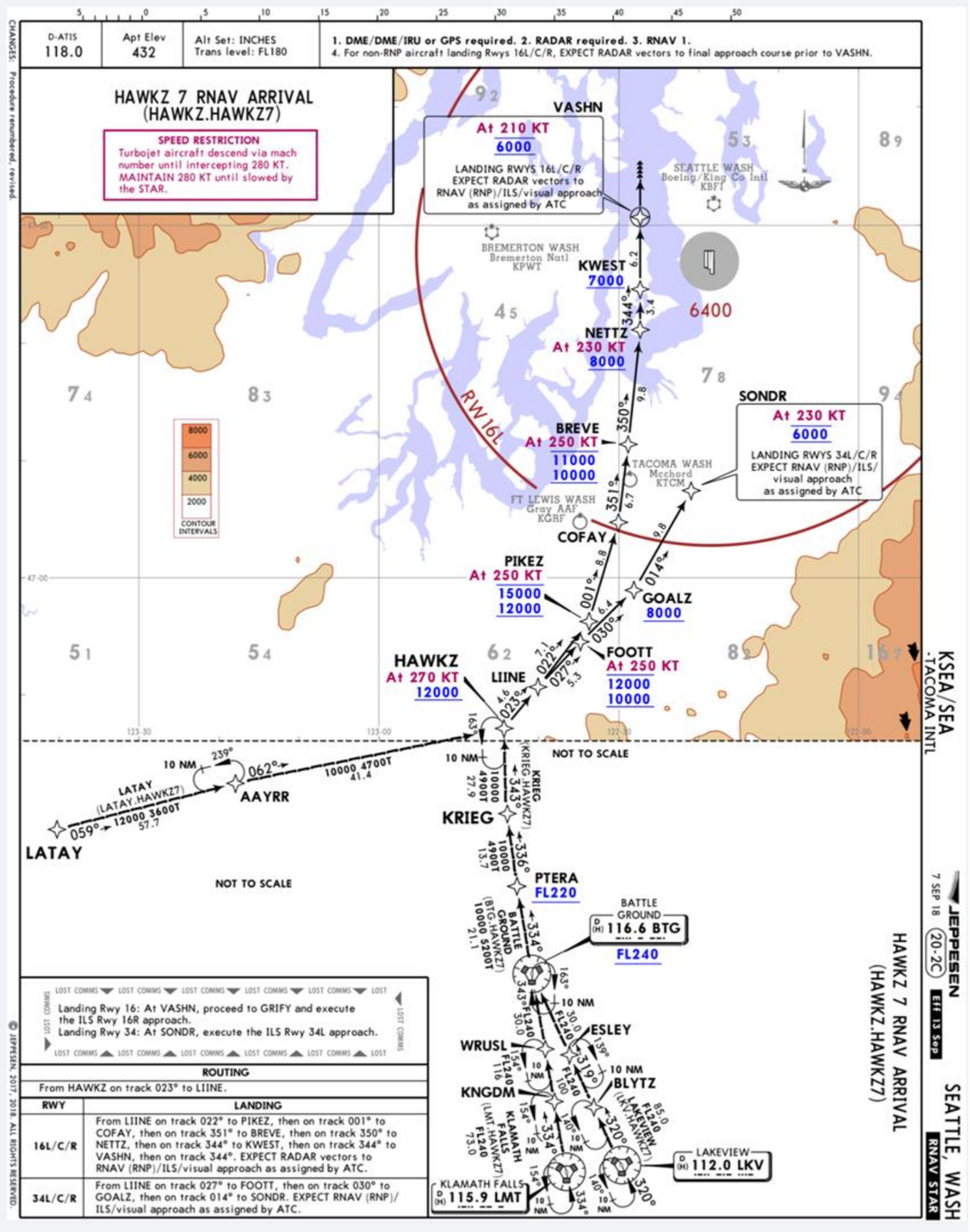
During flight, pilots monitor:

- Autoflight modes
- Flight path (trajectory)
- Speed
- Altitude
- Fuel status
- Aircraft status
- Weather
- Other traffic
- Terrain

Monitoring for flight path management during descent and arrival:







ANTICIPATORY BEHAVIORS

- What runway are we planned to land on?
- Are the winds changing?
- If we land on a different runway because of the changing wind, will that impact my energy management?
- If Air Traffic Control slows us down because of traffic, will that make it hard for us to comply with the next constraint?
- What altitude do I need to cross “here” to be ok “there?”

AS YOU MIGHT GUESS:

COMPLEX COGNITIVE SKILLS ARE HARD TO ASSESS!

SO, WHAT'S THE PROBLEM?

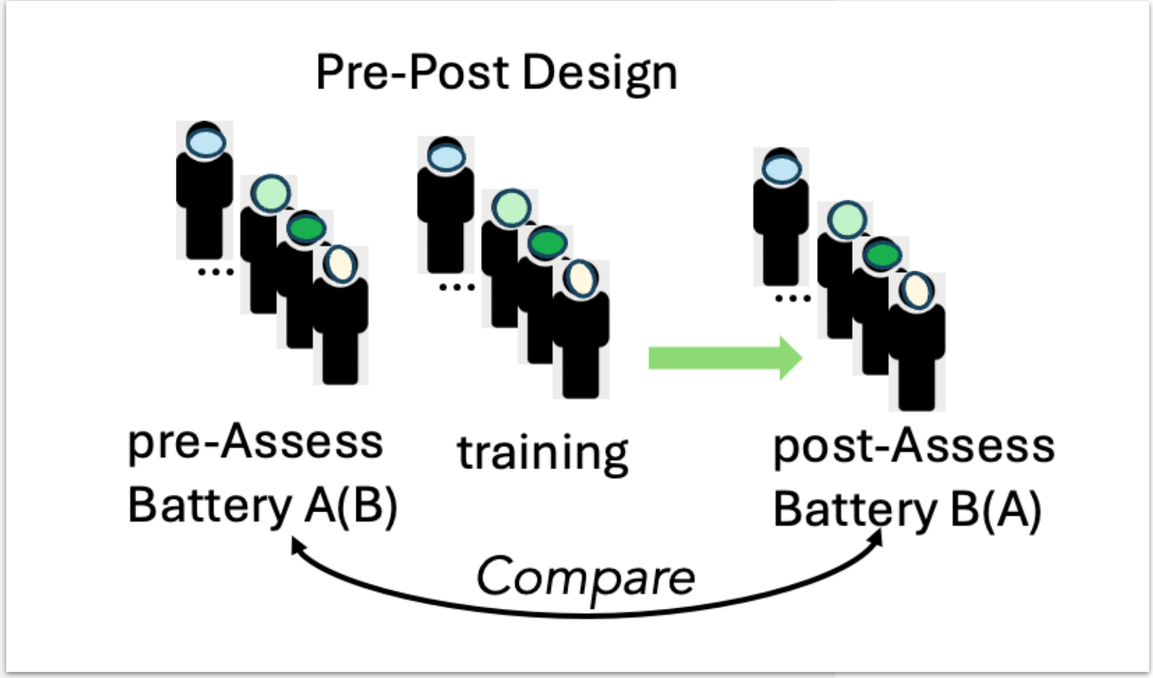
SO, WHAT'S THE PROBLEM?

- Future of safety involves measuring anticipatory behaviors
- Simulators are too expensive for developmental research

RESEARCH QUESTION FOR TODAY

How do we measure anticipatory behaviors asynchronously?

METHODOLOGY

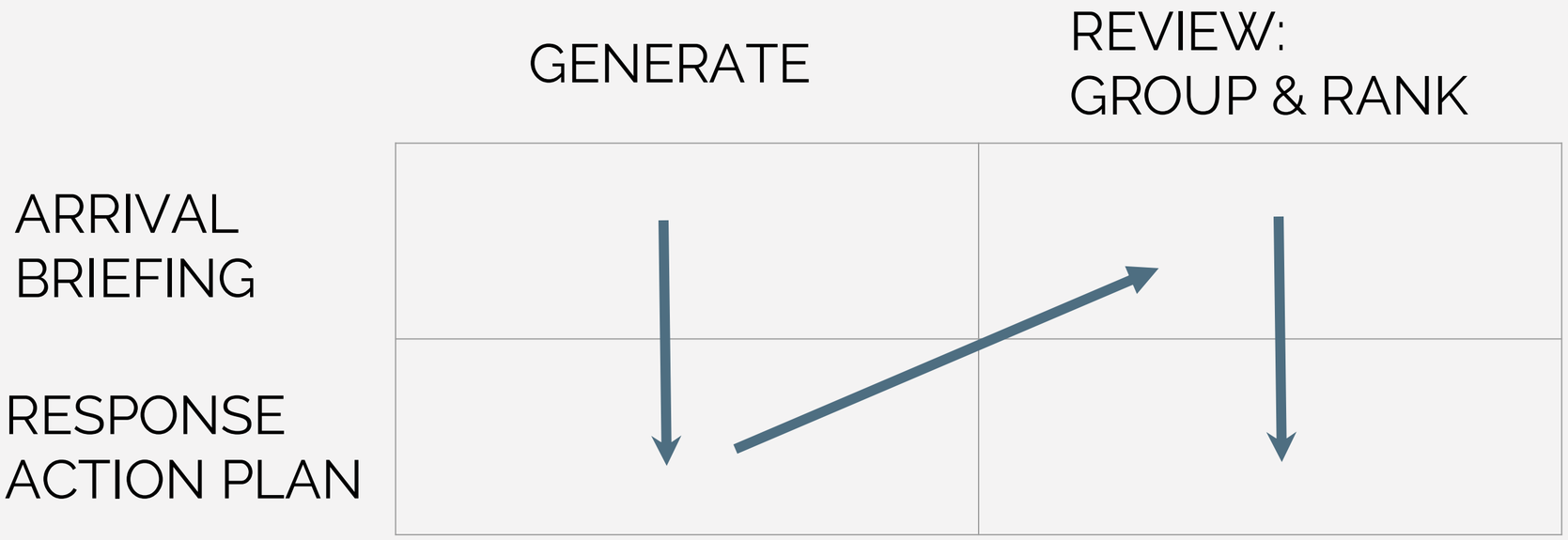


- Subjects: Current Airline Pilots
- Real-World Scenarios Outside of a Simulator
- Pre-test, Intervention, Post-test
- Most Data collected in Qualtrics

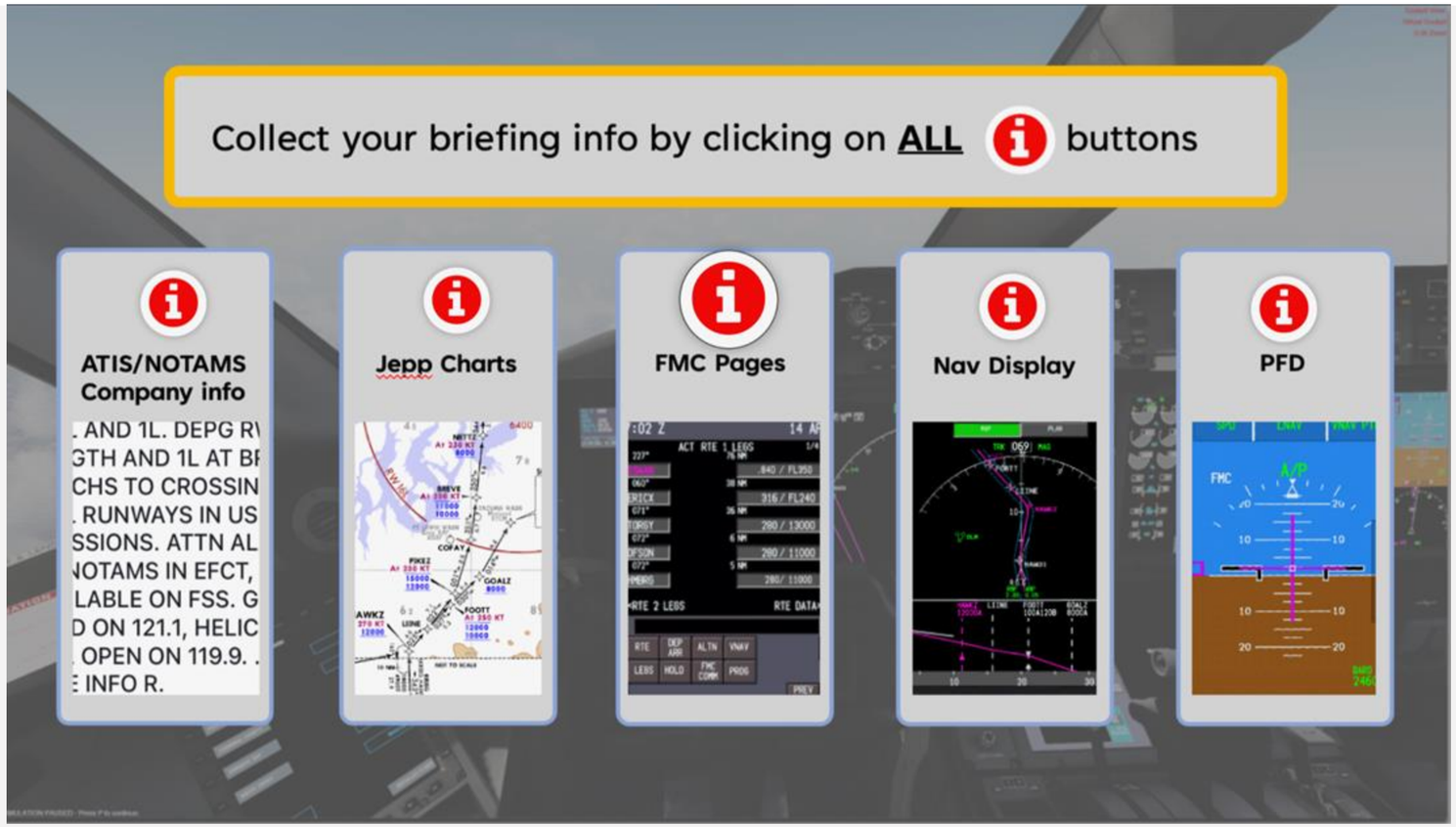
SCENARIO-BASED TASKS

	GENERATE	REVIEW: GROUP & RANK
ARRIVAL BRIEFING		
RESPONSE ACTION PLAN		

SCENARIO-BASED TASKS



SCENARIO-BASED TASKS



BRIEFING & ACTION PLAN

GENERATIVE

SCENARIO-BASED TASKS

Items

Taxiway C2 is closed.

The MSA is based off Rwy 13.

At HALTO I'd like to start slowing so we can configure.

They're reporting birds in the vicinity, so there's possibility of a birdstrike.

The first step of the missed approach is straight out.

It looks like the approach frequency will be 124.6.

Do you see any issue about making constraints at FEDRL?

Effective Briefing Items (by importance)

Trash Can

BRIEFING & ACTION PLAN GENERATIVE

BRIEFING & ACTION PLAN REVIEW

BRIEFING & ACTION PLAN SCENARIOS

01

Raleigh-Durham

02

Oklahoma City

BRIEFING & ACTION PLAN SCENARIOS

01

Raleigh-Durham

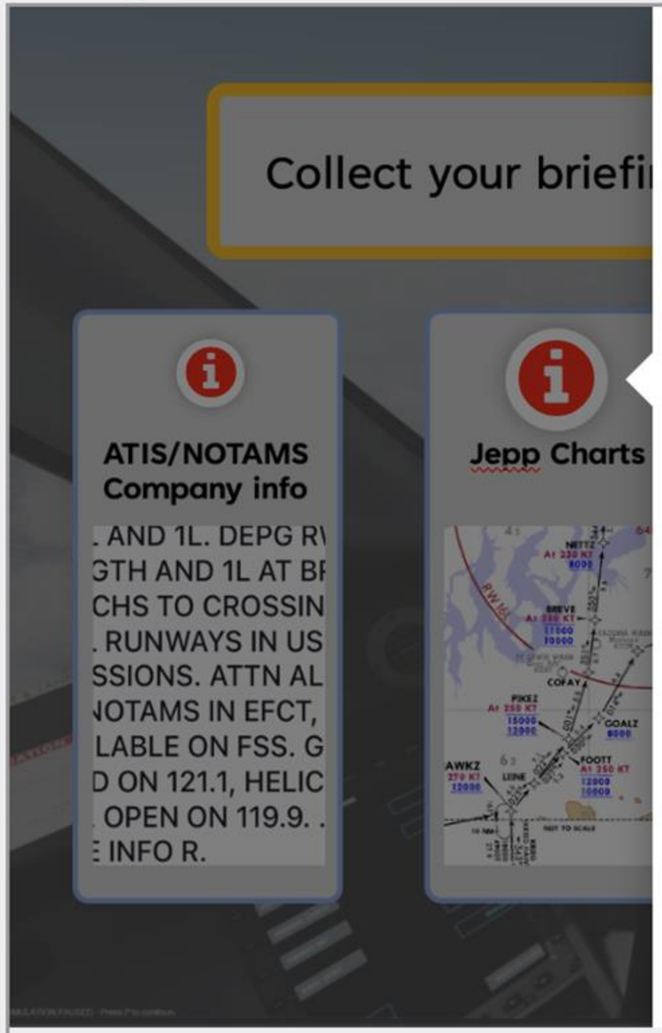
02

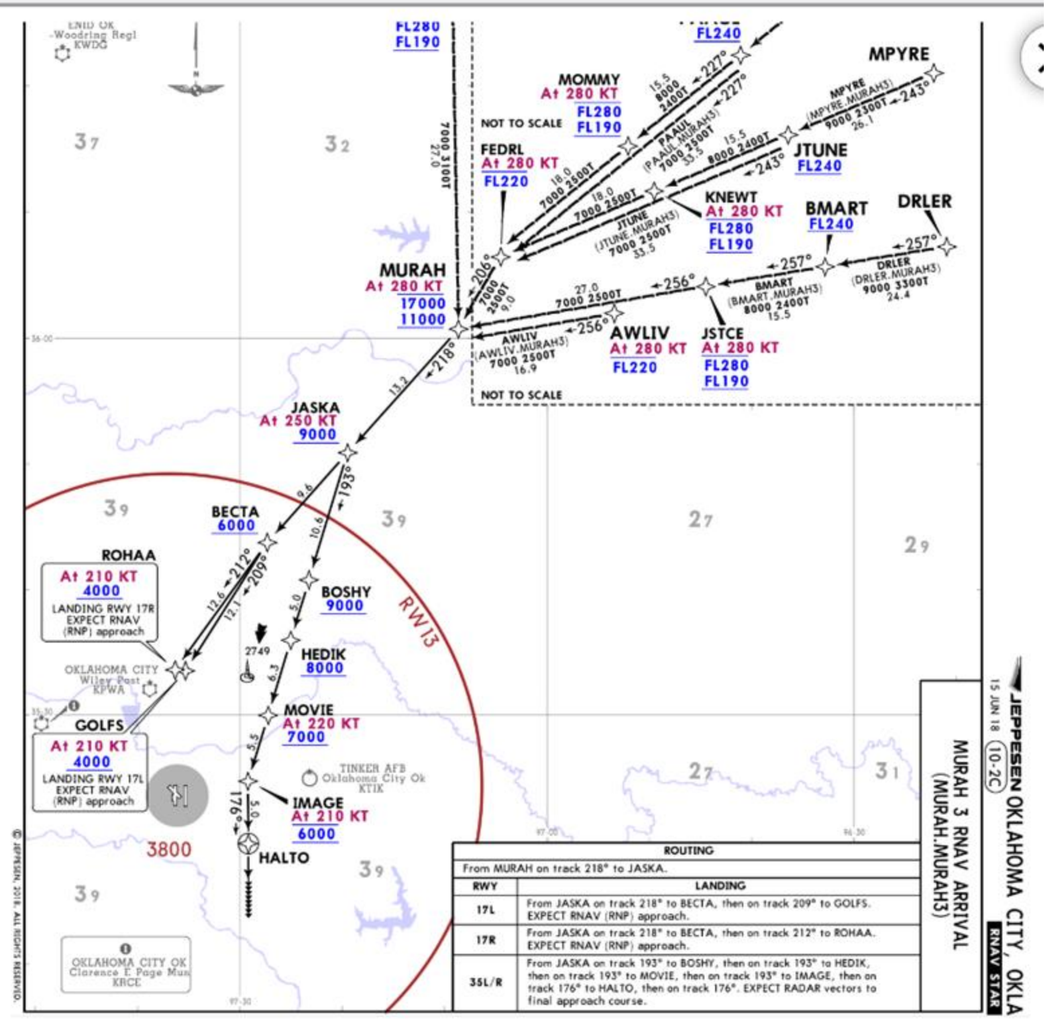
Oklahoma City

- Potentially difficult segments
- Two or more potential approaches
- Places to **plan ahead** to comply with flight path requirements

BRIEFING & ACTION PLAN SCENARIOS

You're at cruise level, approaching Oklahoma City from the North. Gather your briefing information by clicking c
and taking notes in the box below.





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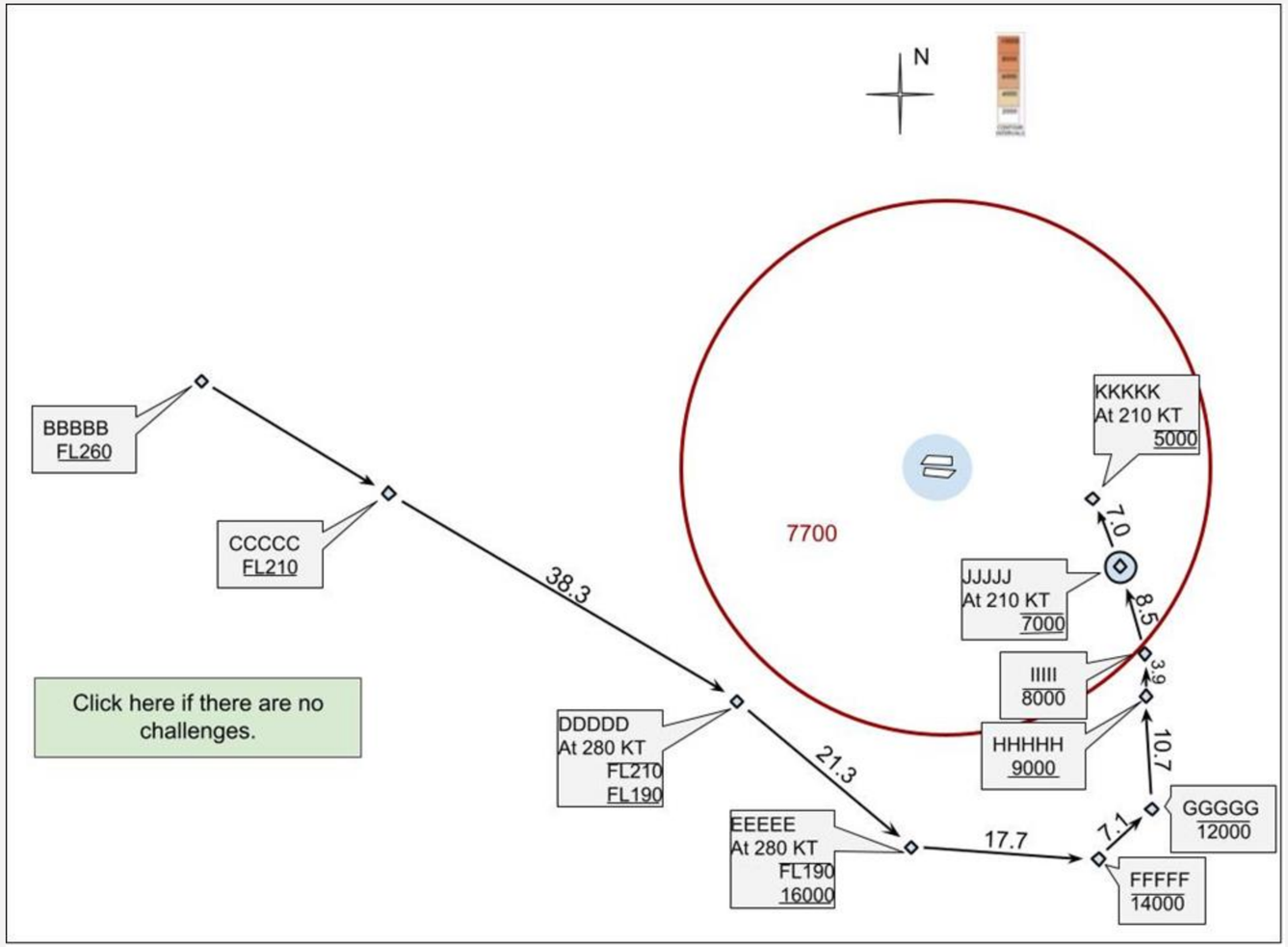


ARRIVAL CHART

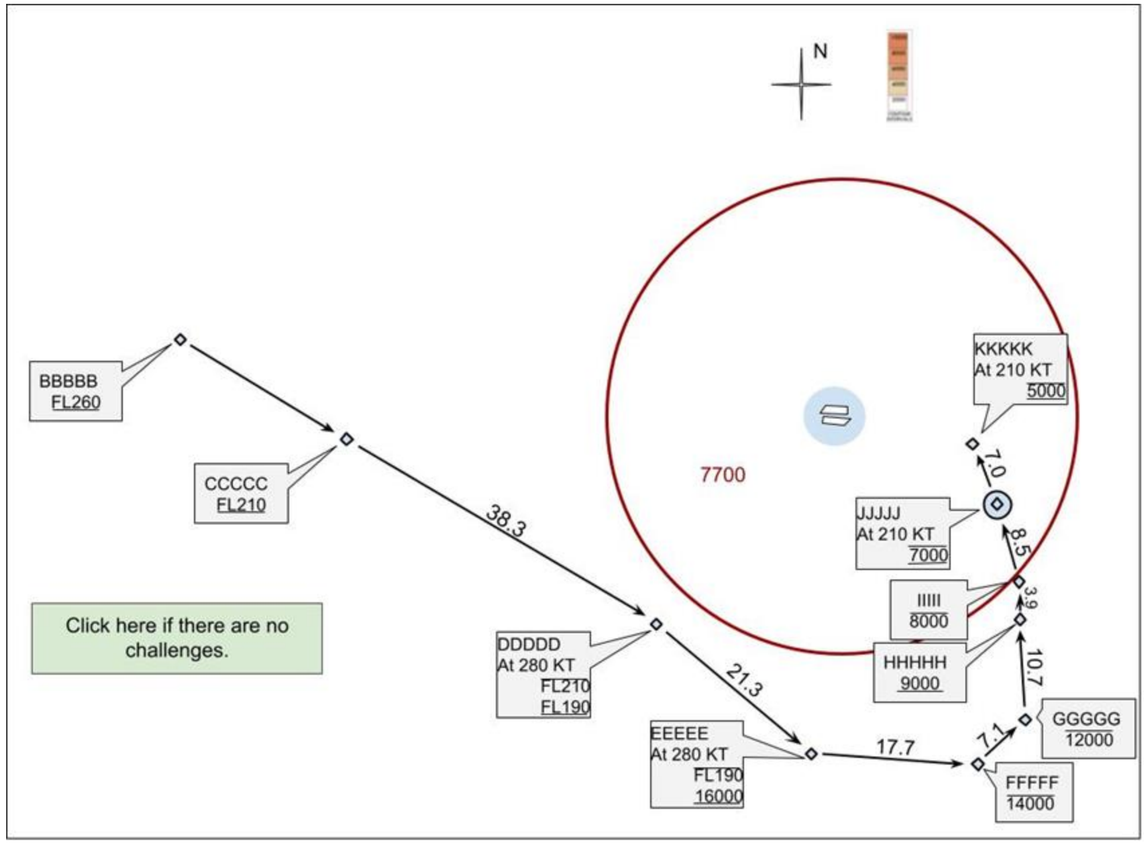
ANALYSIS

ARRIVAL SCENARIOS

01 SHORTCUT & STEEP DESCENT

02 STEEP DESCENT & TERRAIN

03 NONE

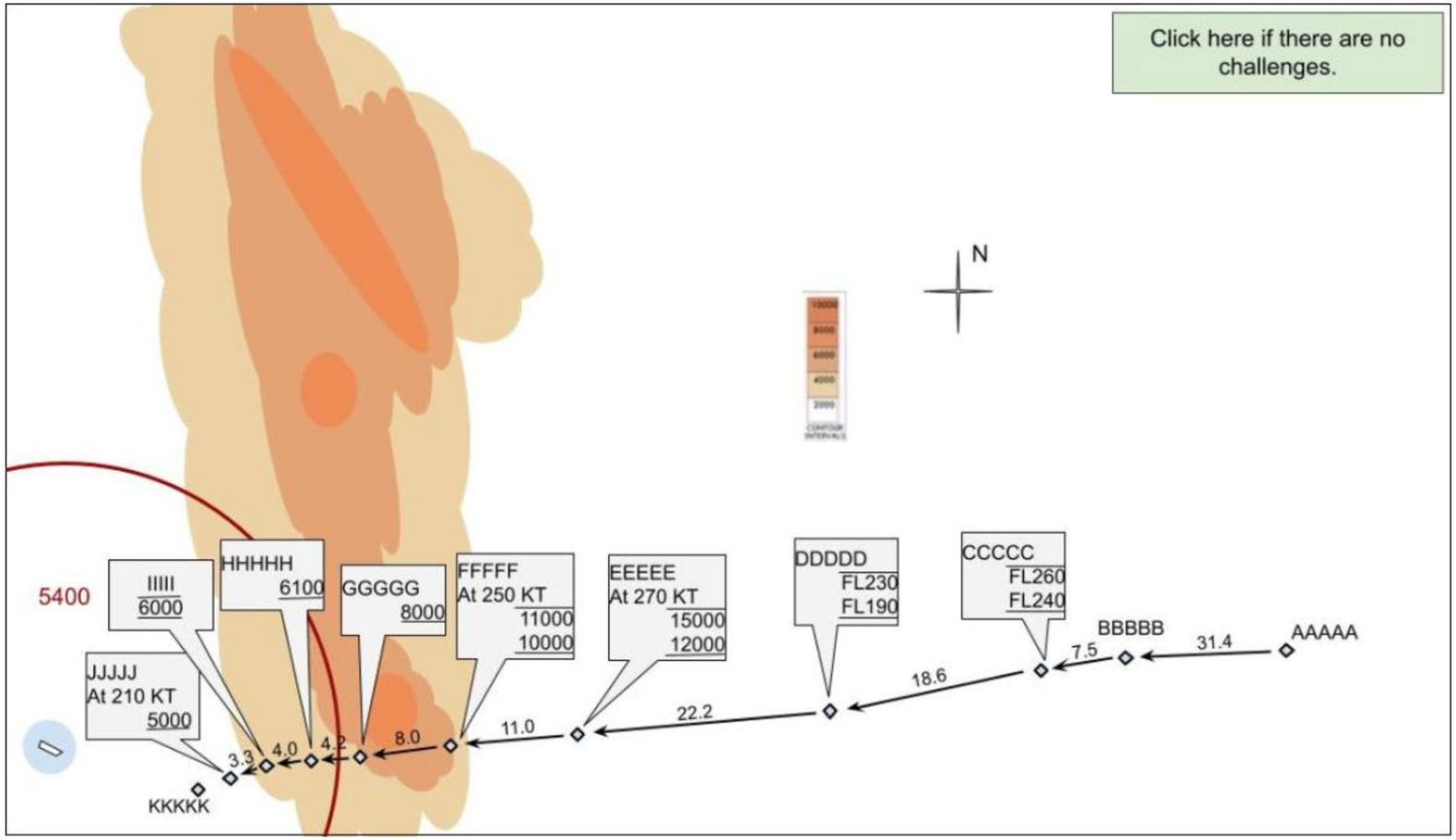


ARRIVAL SCENARIOS

01 **SHORTCUT & STEEP DESCENT**

02 **STEEP DESCENT & TERRAIN**

03 **NONE**



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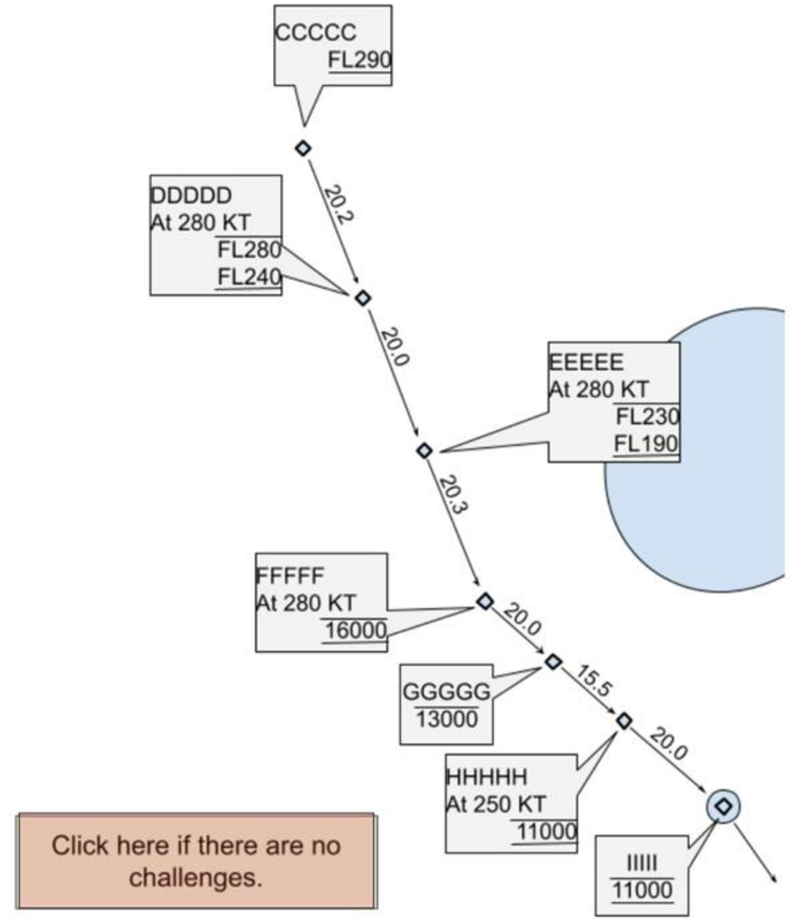
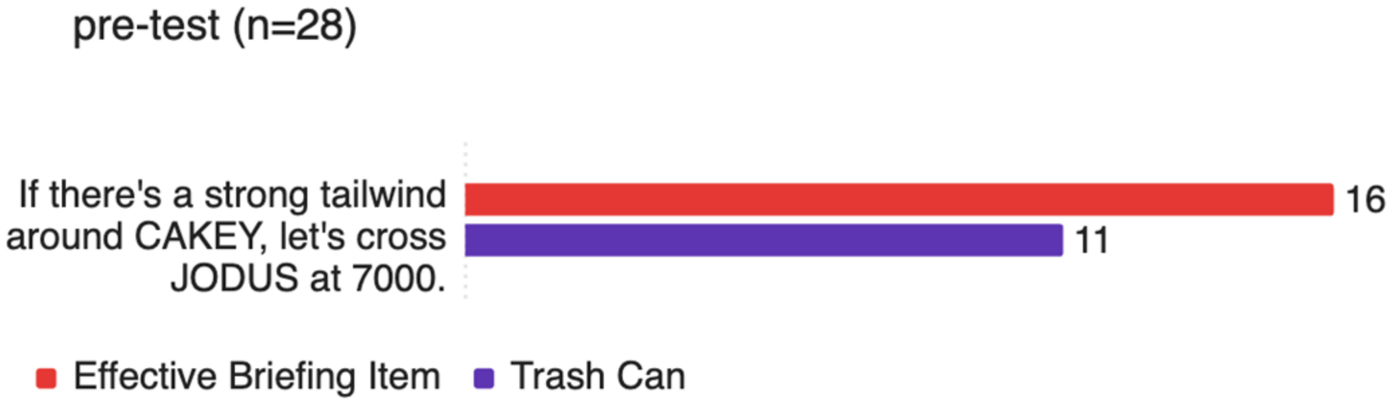


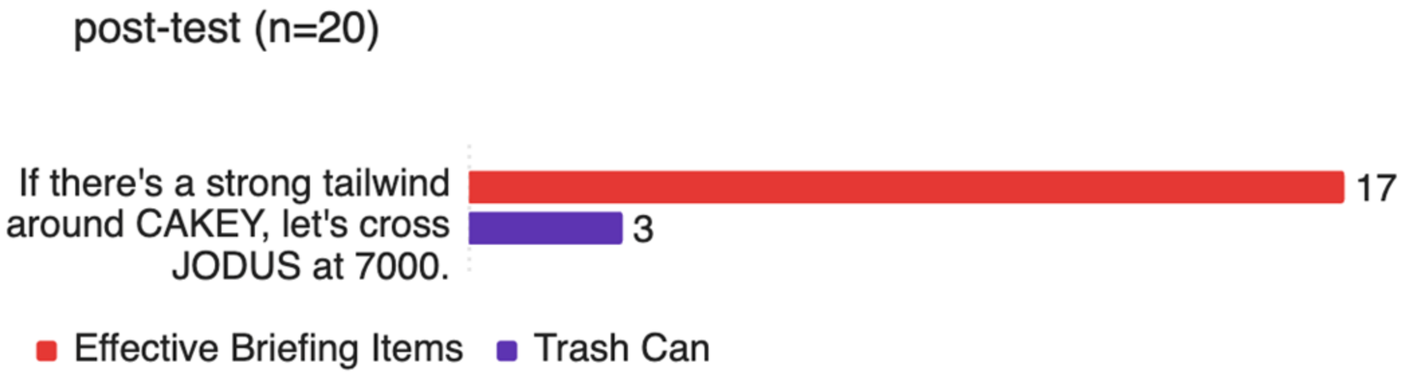
PLANNED ANALYSIS (non-exhaustive)

- Distance Analysis of STAR Analysis Task
- Coding of Briefings and Action Plans
- Scoring of Briefing and Action Plan Review by group and rank
- Comparison of Coding and Review Tasks

PRELIMINARY IMPRESSIONS

- To the human eye:
  - Improvements
- According to participants, the tutorial was:
  - “Important”
  - “Good information”
- These tasks generated a LOT of data (to date ~600 columns in R)

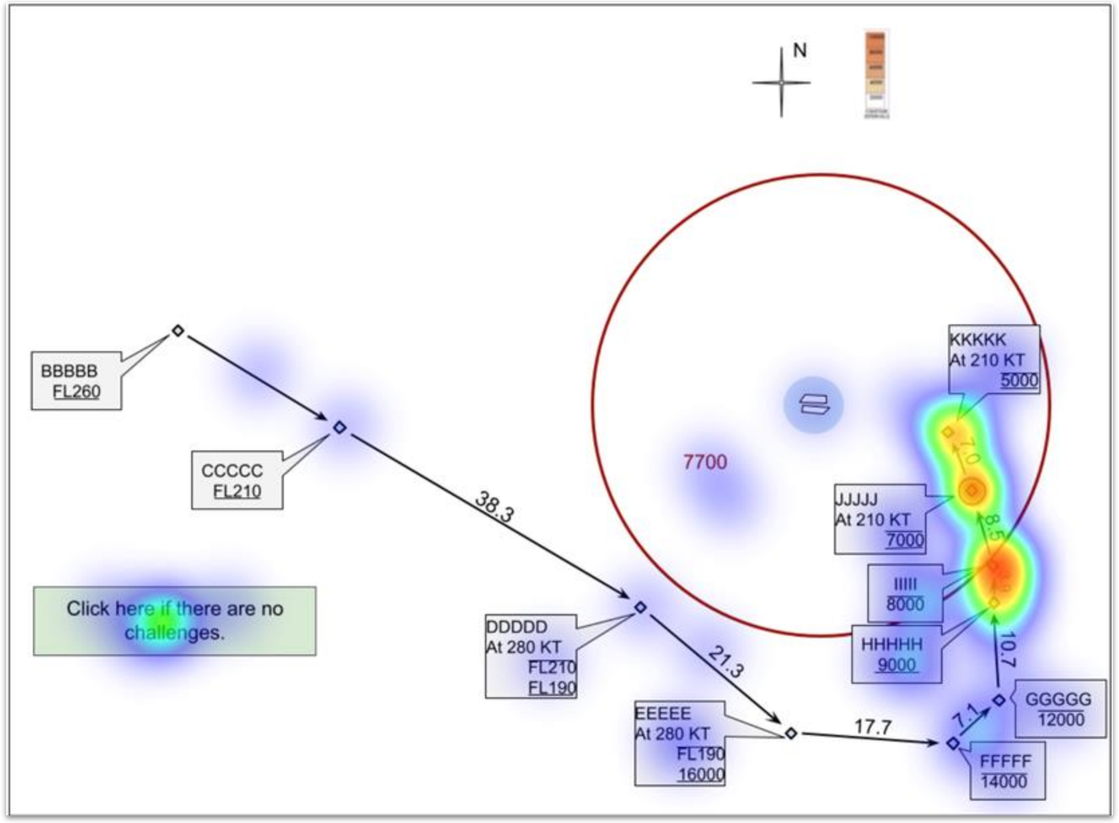




BRIEFING REVIEW PRE vs. POST EXAMPLE

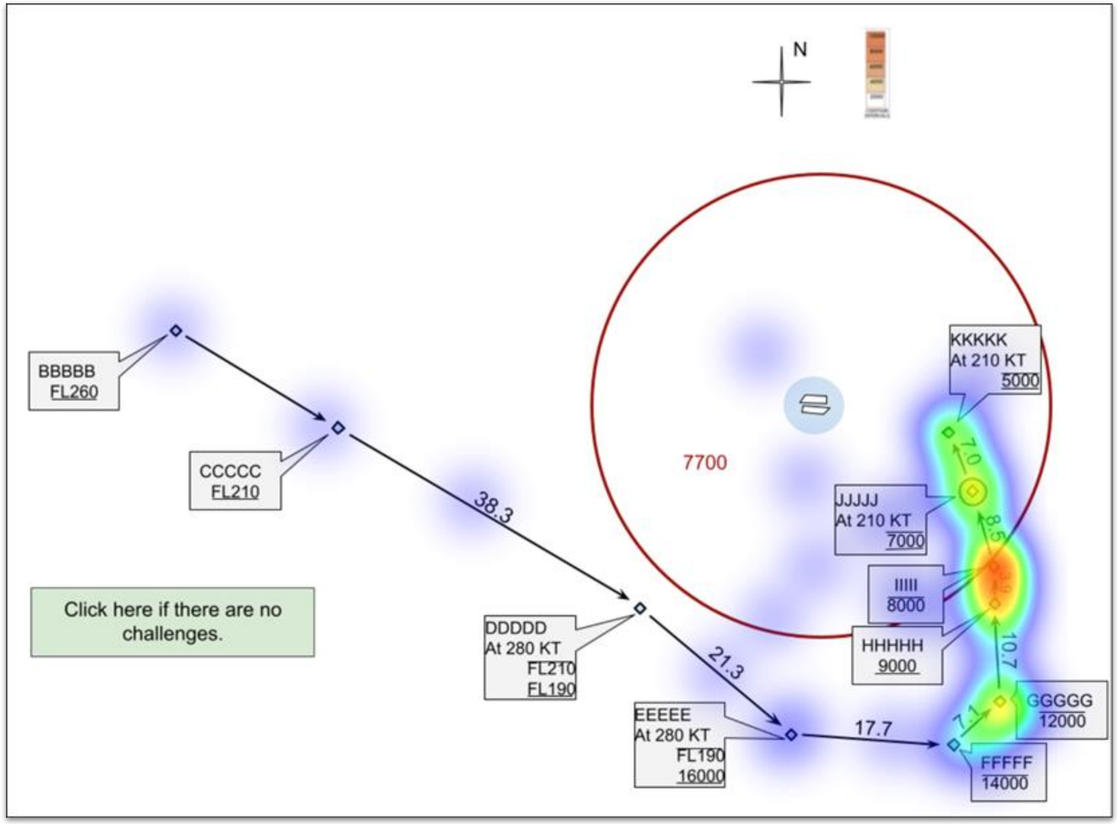
STAR ANALYSIS

PRE vs. POST EXAMPLE



Pre Training - Aggregate Heat Map Data

vs.



Post Training - Aggregate Heat Map Data

CONCLUSIONS

- Encouraging results
- Seemingly quite sensitive measures

Future Directions:

- Does this correlate with simulator performance?
- How does this method potentially impact pilot learning and assessment?

SO WHAT?

How can research into human contributions to safety transfer to your context?

- Suspect a broader need for assessing cognitive skills used in complex systems
- Matching user's environment with deeply contextual scenario-based tasks when synchronous assessment is not feasible

THANK YOU

Any questions?

Melissa Peterson

Barth Baron,

SJSU SAN JOSÉ STATE UNIVERSITY

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