

SCENARIO-BASED TASK DESIGN FOR AIRLINE PILOT ANTICIPATORY BEHAVIORS: ASYNCHRONOUS ASSESSMENT OF COMPLEX COGNITIVE SKILLS

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OUR TEAM

PRESENTATION TOPICS

01

BACKGROUND OF THE STUDY

02

RESEARCH QUESTION

03

SCENARIO-BASED TASKS

04

METHODOLOGY & SCENARIO
DESIGN

05

PRELIMINARY IMPRESSIONS

06

PLANNED ANALYSIS

07

CONCLUSIONS

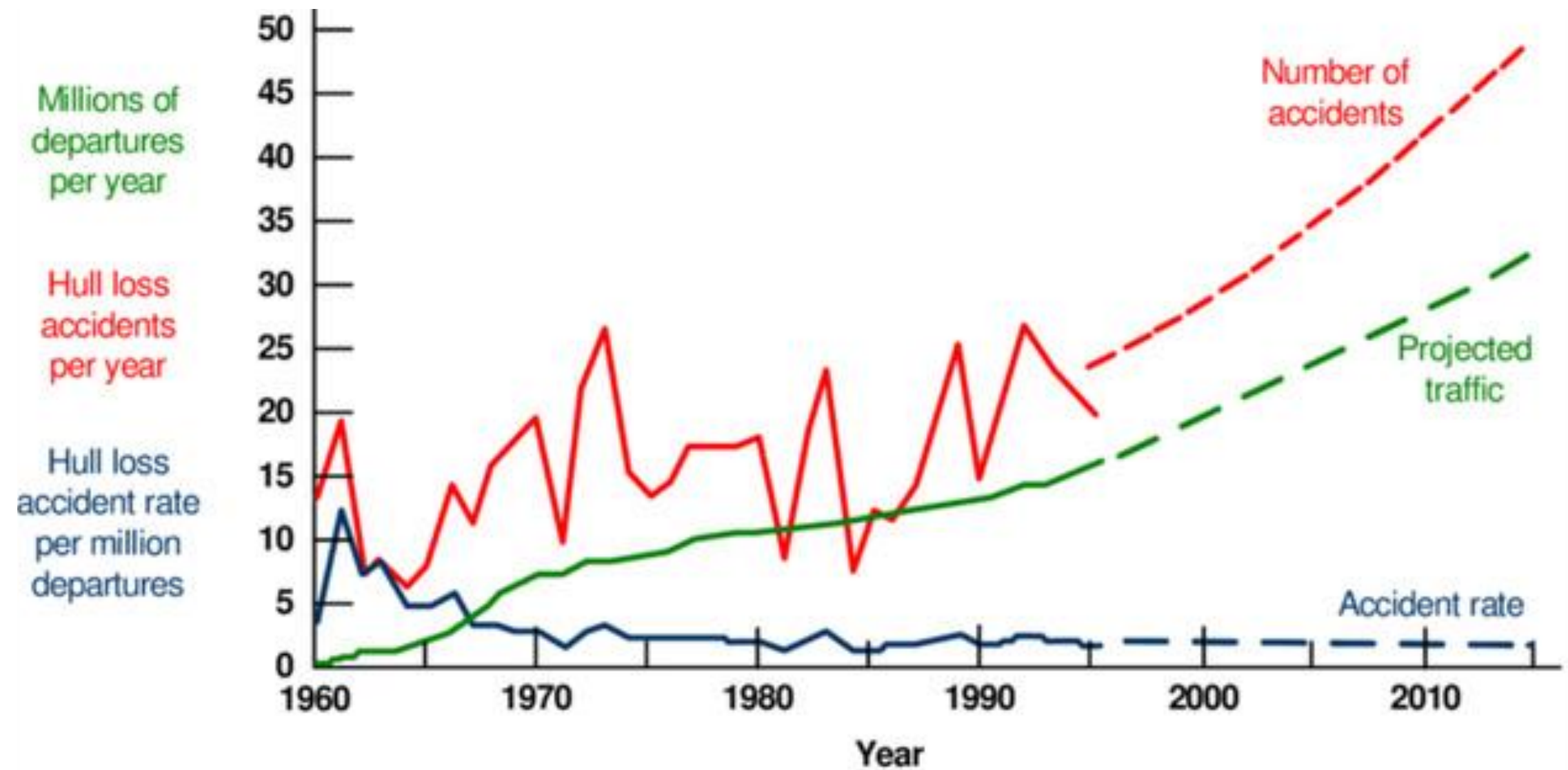
**What is
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2023: 4.2 Billion passengers
35 Million departures
1 Fatal accident

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35 Million departures
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**How do
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“What went wrong?”



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80% of accidents are caused by pilot error!*

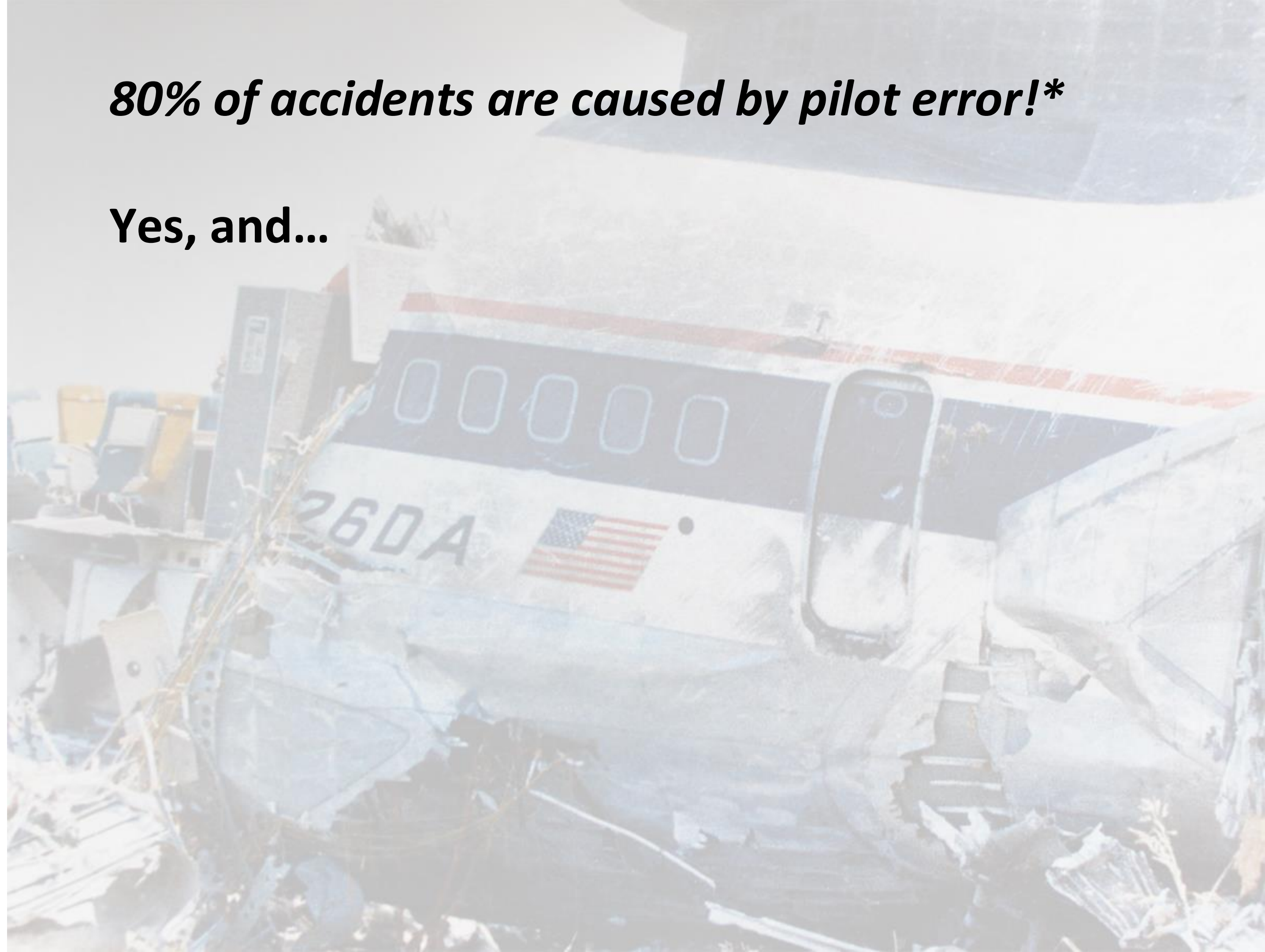


How do
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Yes, and...



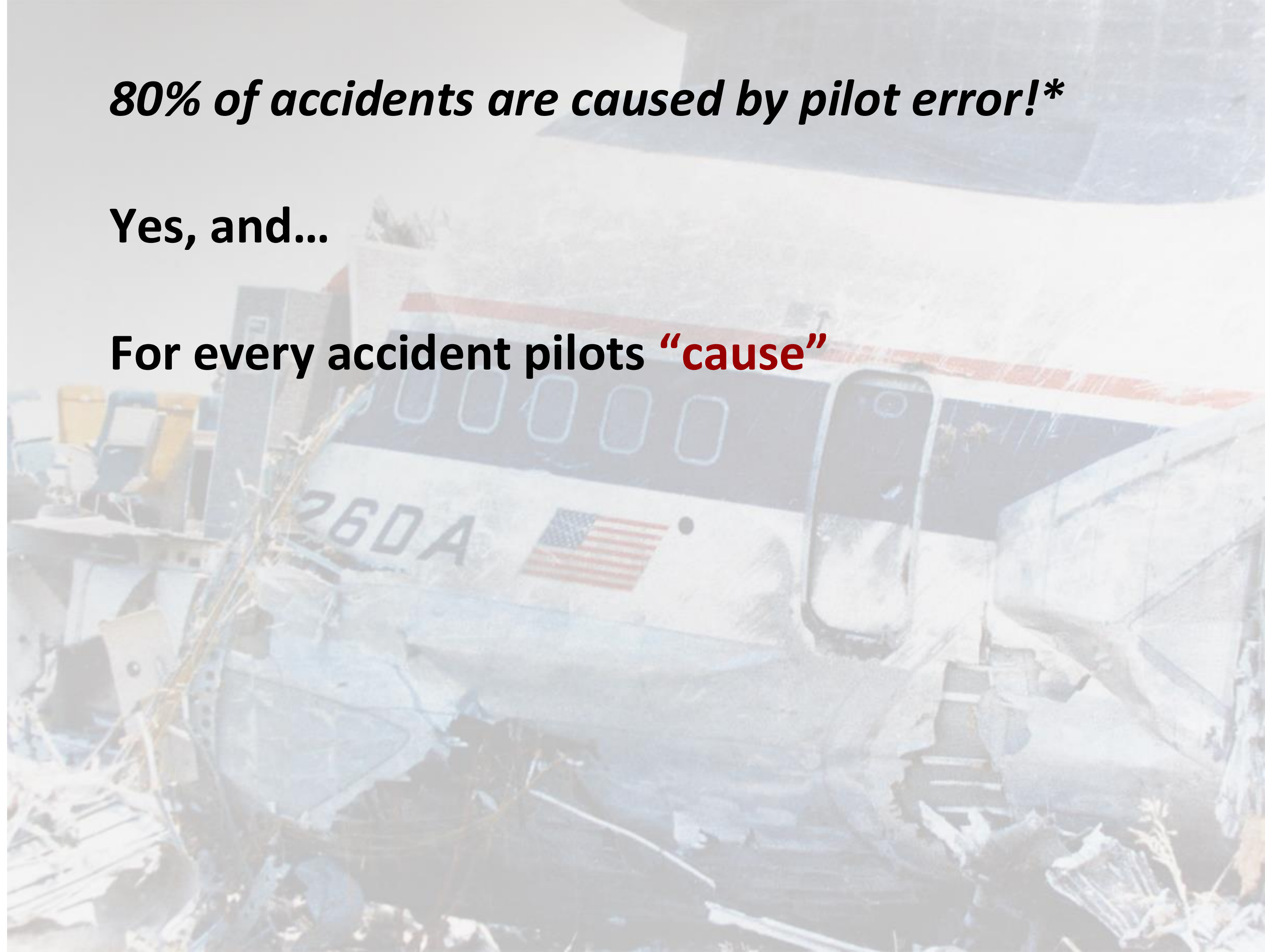
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Yes, and...

For every accident pilots **“cause”**



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“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
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flight
safety?

“What went wrong?”

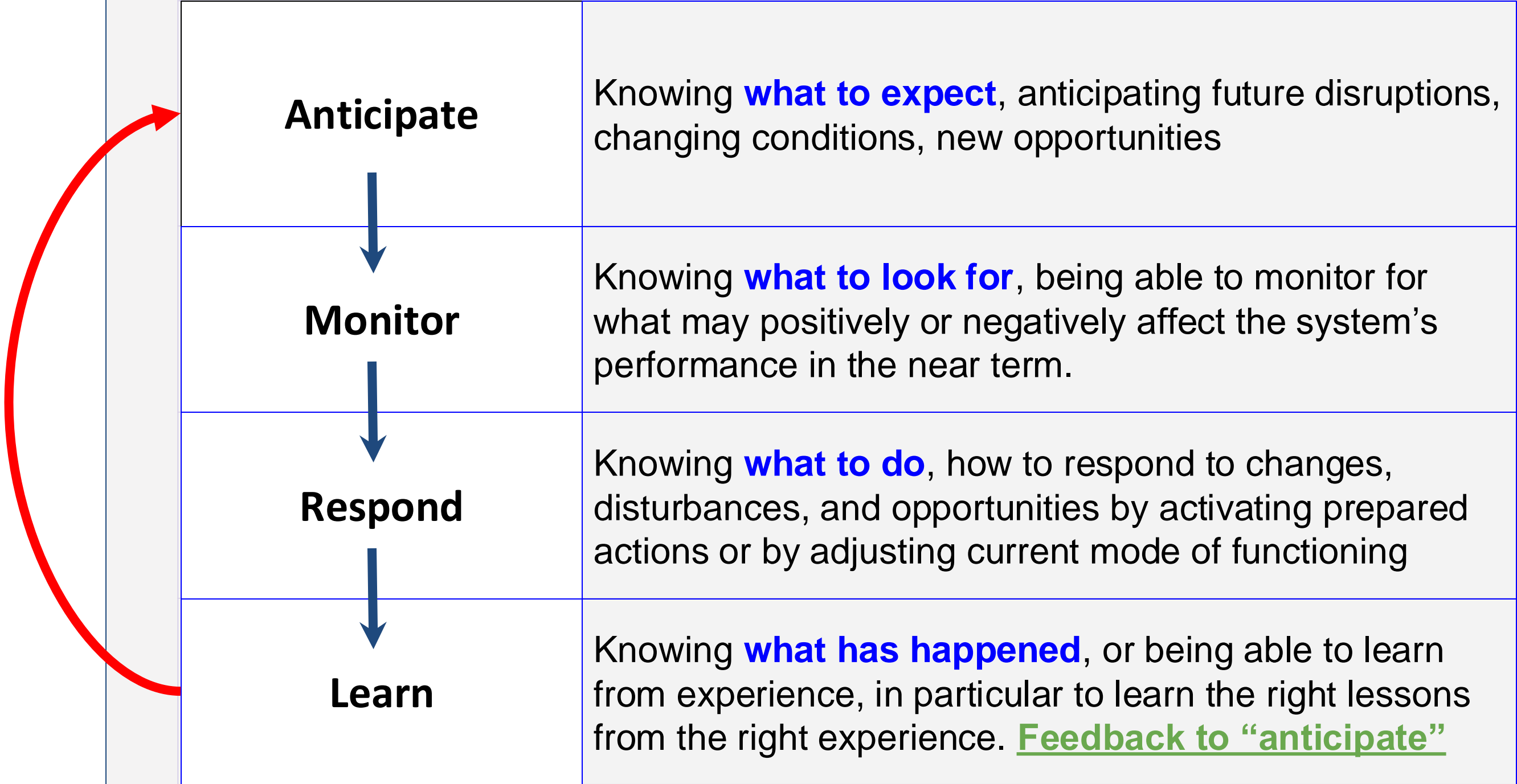
	Safety I	
Safety definition:	As few things as possible go wrong	
Safety principle:	Reactive: respond when something happens or emerges	
View of the human factor:	Humans are predominantly a liability/hazard to be minimized	
Risk assessment strategy:	Identify the failures and malfunctions that cause accidents	

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
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about
improving
flight
safety?

Resilience Analysis Grid:

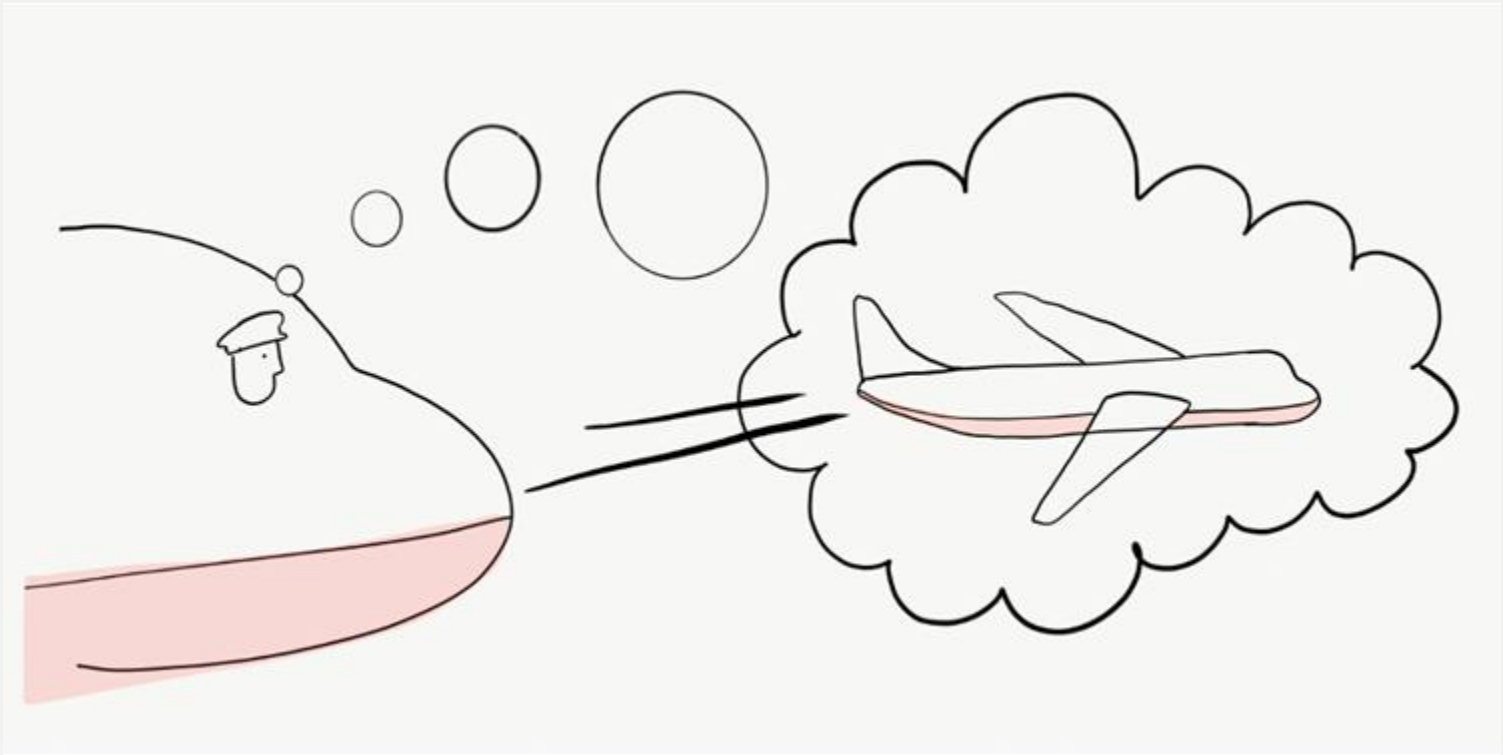


Hollnagel, E. (2011). "RAG – The resilience analysis grid." In: E. Hollnagel, J. Pariès, D.D. Woods and J. Wreathall (Eds). Resilience Engineering in Practice. A Guidebook. Farnham, UK: Ashgate.

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.



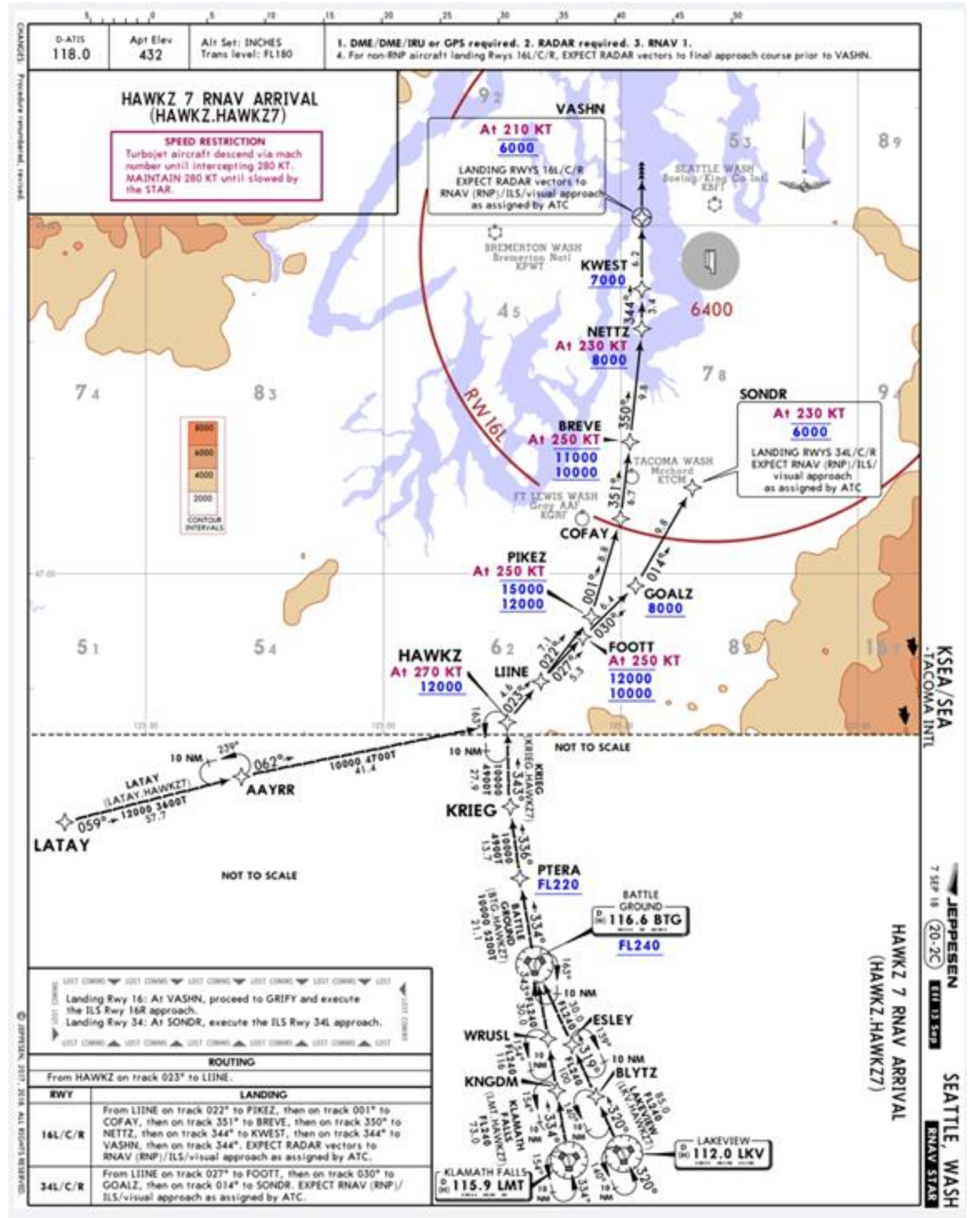
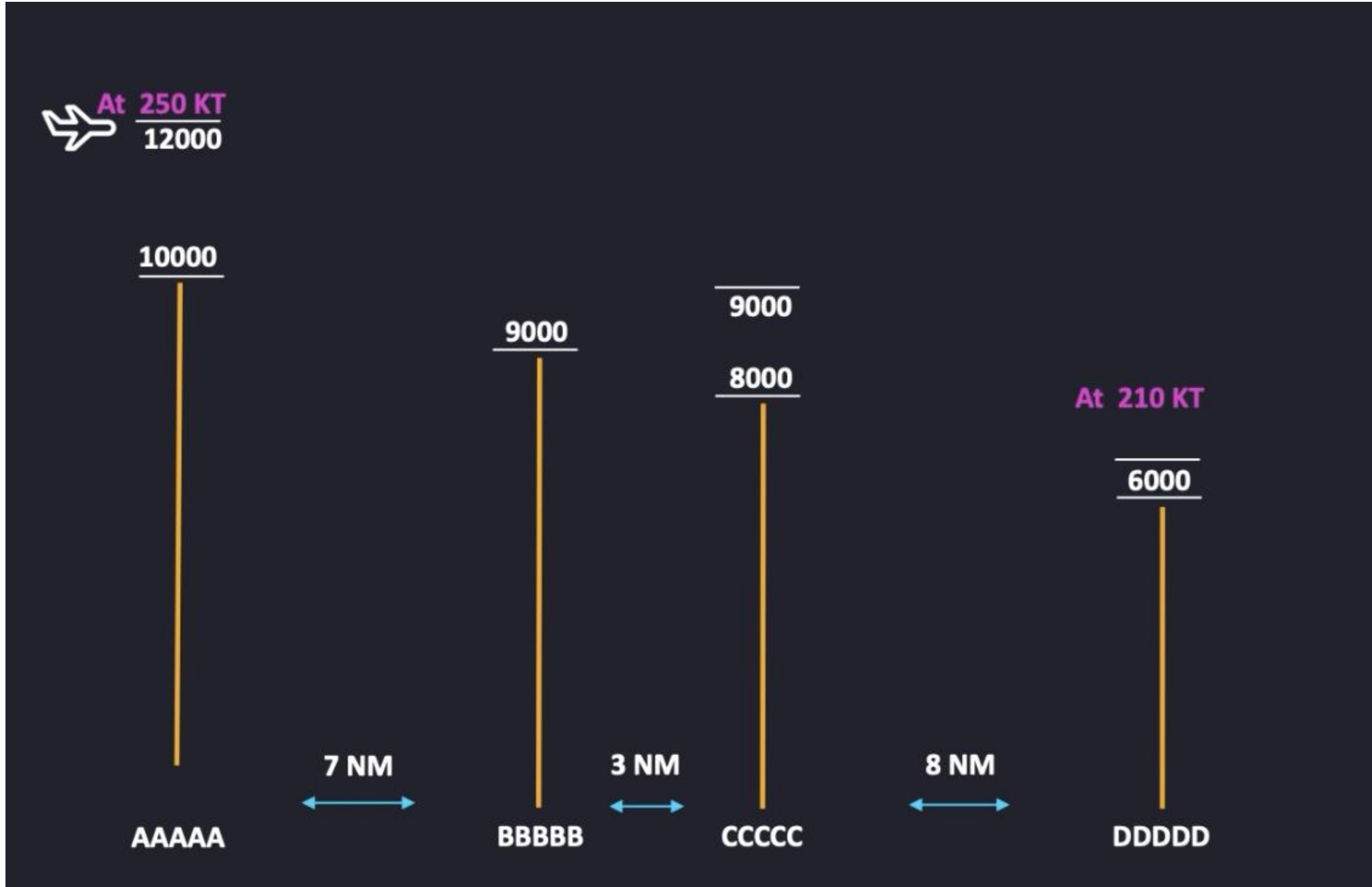
How might we measure anticipation?



During flight, pilots **monitor**:

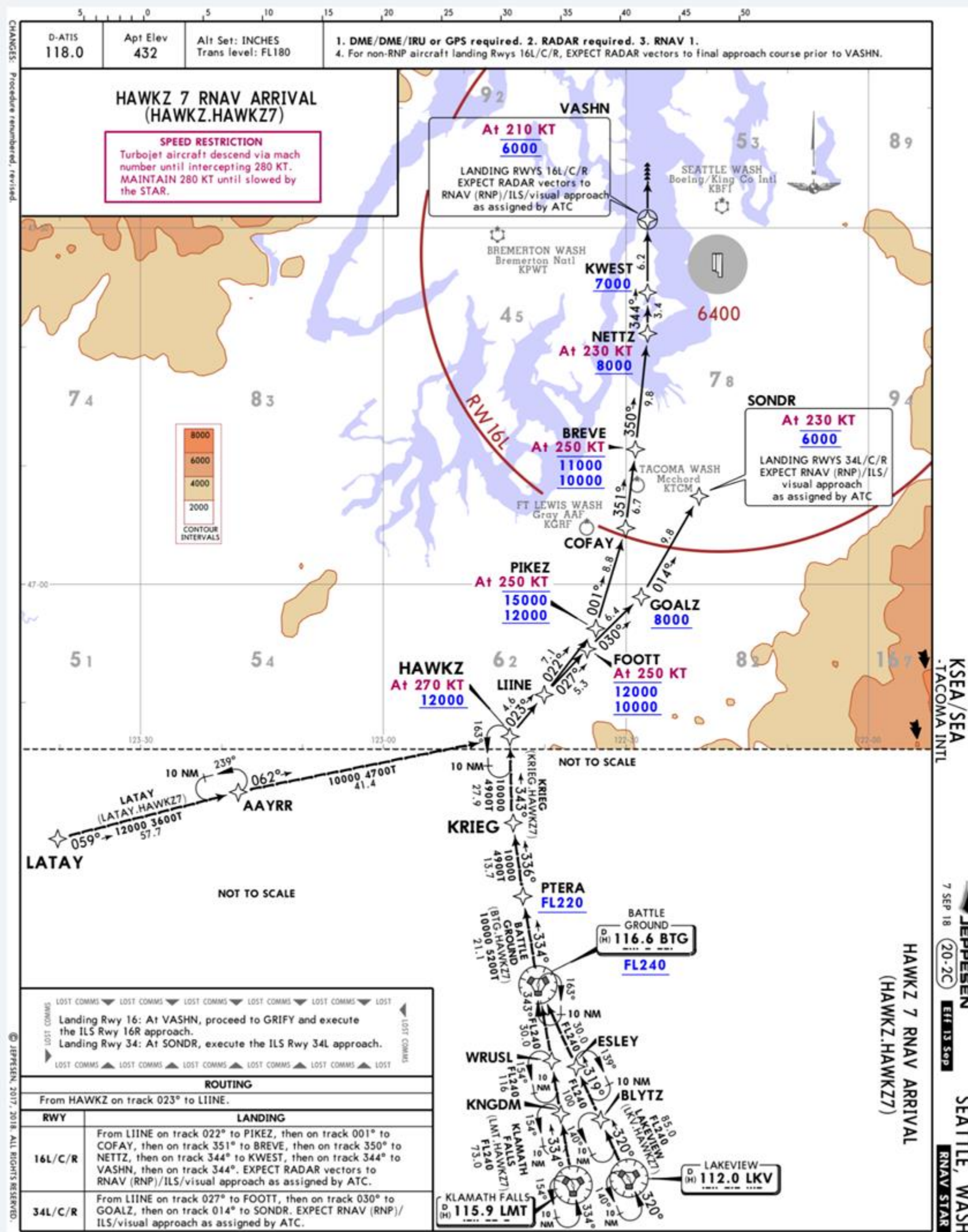
- Autoflight modes
- Flight path (trajectory)
- Speed
- Altitude
- Fuel status
- Aircraft status
- Weather
- Other traffic
- Terrain

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?

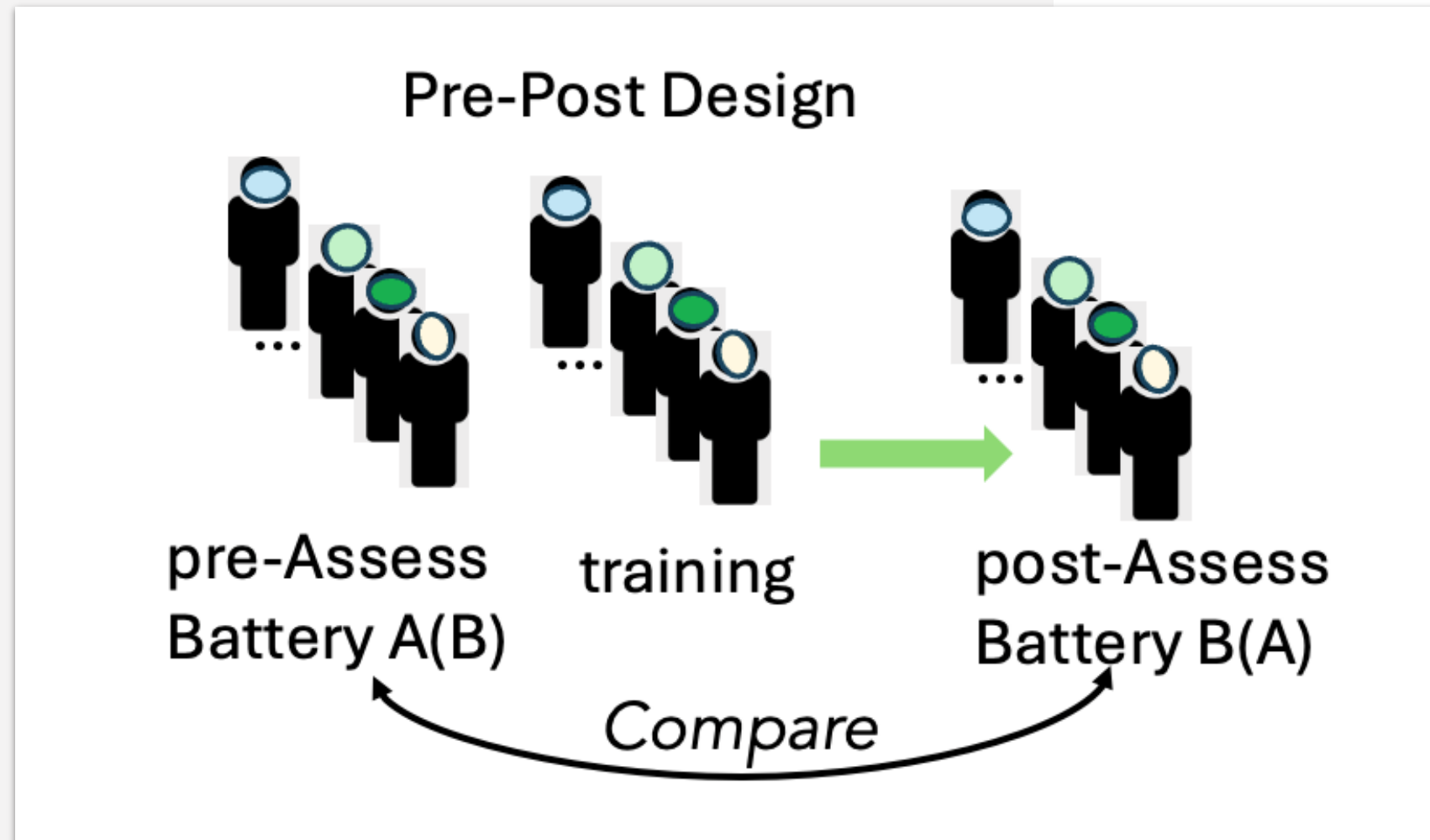
- Future of safety involves measuring anticipatory behaviors
- Simulators are too expensive for developmental research



RESEARCH QUESTION FOR TODAY

**How do we measure anticipatory behaviors
asynchronously?**

METHODOLOGY

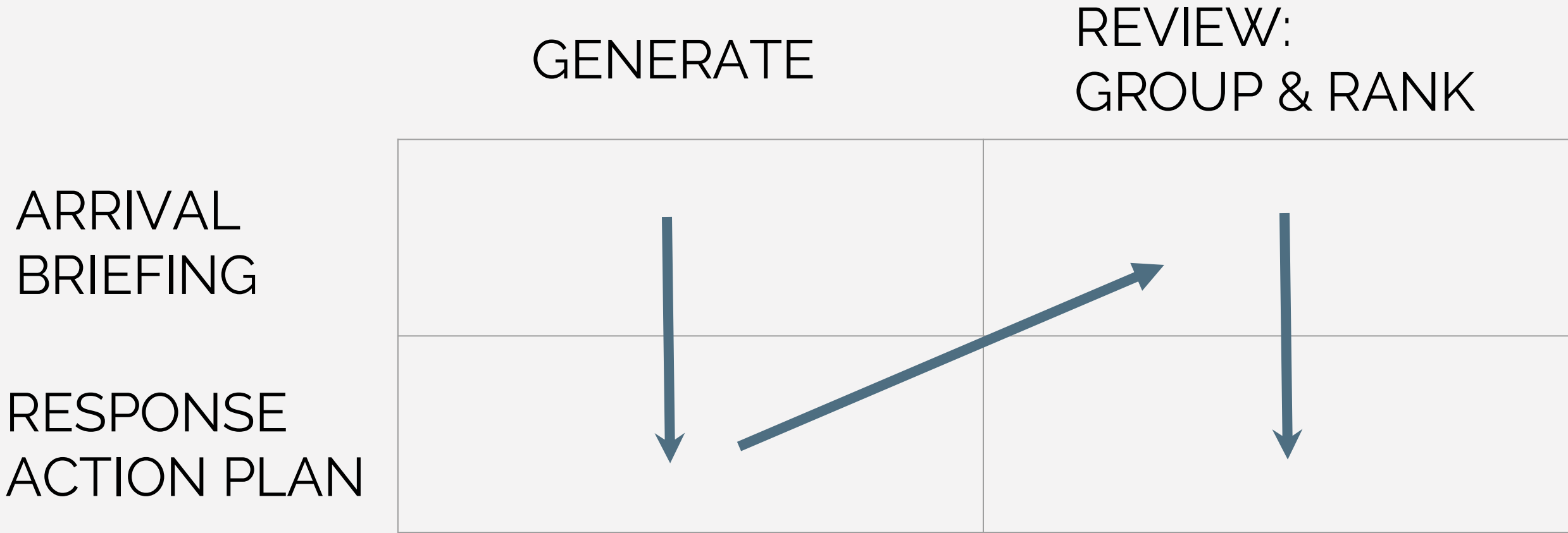


- Subjects: Current Airline Pilots
- Real-World Scenarios Outside of a Simulator
- Pre-test, Intervention, Post-test
- Most Data collected in Qualtrics


SCENARIO-BASED TASKS

	GENERATE	REVIEW: GROUP & RANK
ARRIVAL BRIEFING		
RESPONSE ACTION PLAN		

SCENARIO-BASED TASKS



SCENARIO-BASED TASKS

Collect your briefing info by clicking on **ALL**  buttons



**ATIS/NOTAMS
Company info**

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INFO R.



Jepp Charts



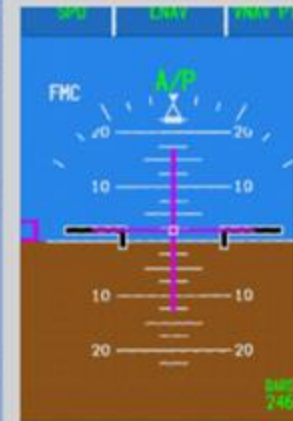
FMC Pages



Nav Display



PFD



**BRIEFING & ACTION PLAN
GENERATIVE**

SCENARIO-BASED TASKS



BRIEFING & ACTION PLAN
GENERATIVE

Items	Effective Briefing Items (by importance)
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?	
	Trash Can

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.

Collect your briefing

ATIS/NOTAMS Company info

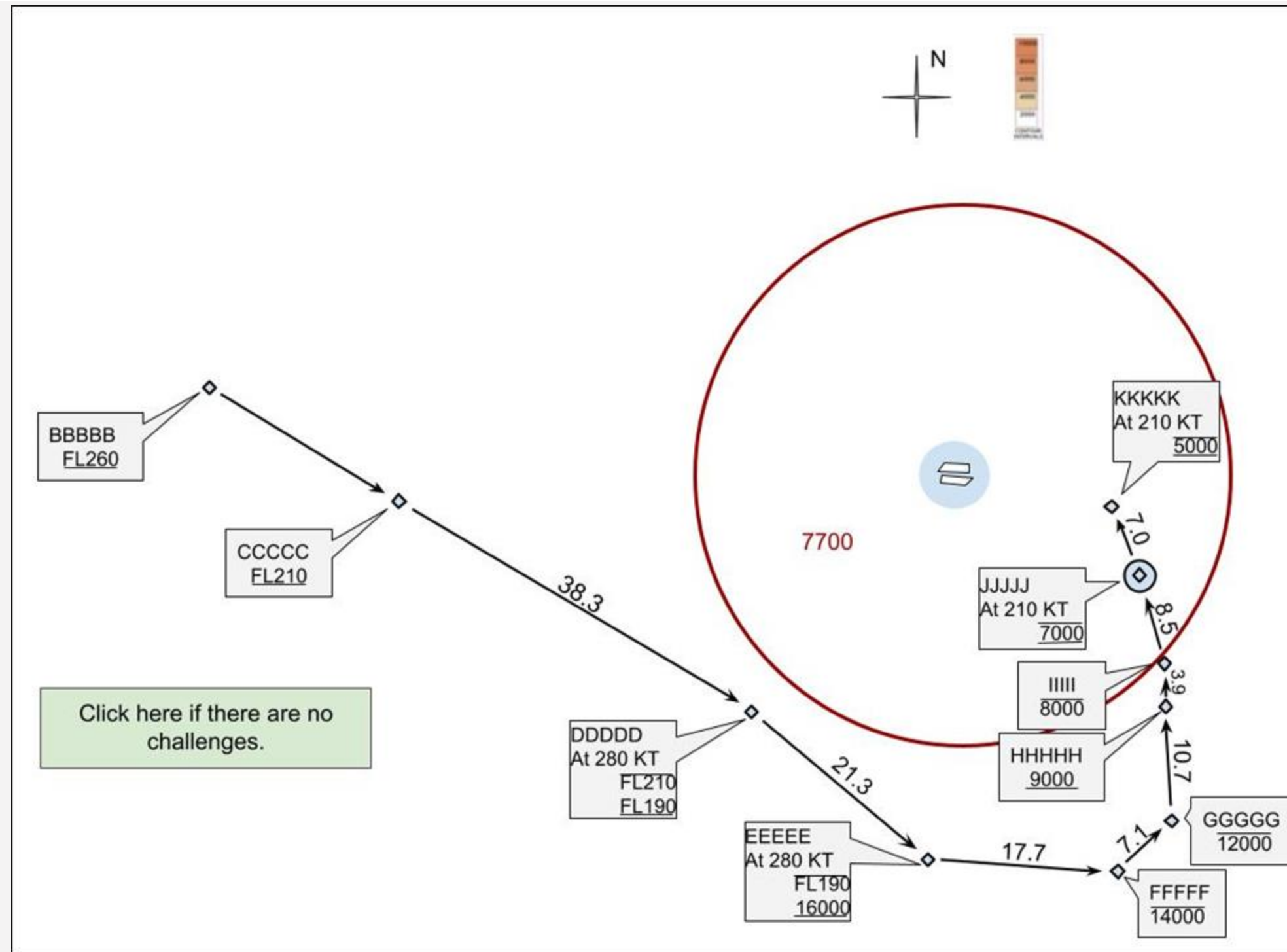
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Jepp Charts

A snippet of a Jepp chart showing various flight paths and altitudes. Key labels include: NETZ A1 230 KT 8000, BREVE A1 230 KT 11500, COFAY, PIKEZ A1 230 KT 15000, GOALZ 8000, AWKZ 270 KT 12000, LINE, FOOT A1 230 KT 12000, and FOOT A1 230 KT 15000. A note at the bottom says 'NOT TO SCALE'.

A Jepp chart showing flight paths and altitudes for MURAH 3 RNAV arrival. The chart includes various waypoints and altitudes, such as MURAH A1 280 KT 17000, JASKA A1 250 KT 9000, BECTA 6000, BOSHY 9000, HEDIK 8000, MOVIE A1 220 KT 7000, IMAGE A1 210 KT 6000, HALTO, GOLFS A1 210 KT 4000, ROHAA A1 210 KT 4000, JSTCE A1 280 KT FL280 FL190, AWLIV A1 280 KT FL220, KNEWT A1 280 KT FL280 FL190, JTUNE A1 280 KT FL280 FL190, BMART A1 280 KT FL240, DRLER A1 280 KT FL240, MPYRE A1 280 KT FL240, and MOMMY A1 280 KT FL280 FL190. The chart also shows various altitudes and speeds, such as 17000, 11000, 9000, 6000, 4000, 3000, 2500, 2000, 1500, 1000, 500, 250, 100, 50, 25, 10, 5, 2.5, 1.25, 0.625, 0.3125, 0.15625, 0.078125, 0.0390625, 0.01953125, 0.009765625, 0.0048828125, 0.00244140625, 0.001220703125, 0.0006103515625, 0.00030517578125, 0.000152587890625, 0.0000762939453125, 0.00003814697265625, 0.000019073486328125, 0.0000095367431640625, 0.00000476837158203125, 0.000002384185791015625, 0.0000011920928955078125, 0.00000059604644775390625, 0.000000298023223876953125, 0.0000001490116119384765625, 0.00000007450580596923828125, 0.000000037252902984619140625, 0.0000000186264514923095703125, 0.00000000931322574615478515625, 0.000000004656612873077392578125, 0.0000000023283064365386962890625, 0.00000000116415321826934814453125, 0.000000000582076609134674072265625, 0.0000000002910383045673370361328125, 0.00000000014551915228366851806640625, 0.000000000072759576141834259033203125, 0.0000000000363797880709171295166015625, 0.00000000001818989403545856475830078125, 0.000000000009094947017729282379150390625, 0.0000000000045474735088646411895751953125, 0.00000000000227373675443232059478759765625, 0.000000000001136868377216160297393798828125, 0.0000000000005684341886080801486968994140625, 0.00000000000028421709430404007434844970703125, 0.000000000000142108547152020037174224853515625, 0.0000000000000710542735760100185871124267578125, 0.00000000000003552713678800500929355621337890625, 0.000000000000017763568394002504646778106689453125, 0.0000000000000088817841970012523233890533447265625, 0.00000000000000444089209850062616169452667236328125, 0.000000000000002220446049250313080847263336181640625, 0.0000000000000011102230246251565404236316680908203125, 0.00000000000000055511151231257827021181583340541015625, 0.0000000000000002775557561562891351059079167027053125, 0.00000000000000013877787807814456755295395835135265625, 0.000000000000000069388939039072283776476979175676328125, 0.0000000000000000346944695195361418882384895878381640625, 0.00000000000000001734723475976807094411924479391908203125, 0.000000000000000008673617379884035472059622396959541015625, 0.00000000000000000433680868994201773602981119847977053125, 0.000000000000000002168404344971008868014905599239885265625, 0.00000000000000000108420217248550443400745279961994265625, 0.000000000000000000542101086242752217003726399809971328125, 0.0000000000000000002710505431213761085018631999049856640625, 0.00000000000000000013552527156068805425093159995249283203125, 0.000000000000000000067762635780344027125465799976246416015625, 0.0000000000000000000338813178901720135627328999881232080078125, 0.00000000000000000001694065894508600678136644999406160400390625, 0.000000000000000000008470329472543003390683224997030802001953125, 0.0000000000000000000042351647362715016953416124985154010009765625, 0.00000000000000000000211758236813575084767080624925770050048828125, 0.000000000000000000001058791184067875423835403124628850250244140625, 0.0000000000000000000005293955920339377119177015623144251251220703125, 0.00000000000000000000026469779601696885595885078115721256256103515625, 0.000000000000000000000132348898008484427979425390578606281280517578125, 0.0000000000000000000000661744490042422139897126952893031406402587890625, 0.00000000

SCENARIO-BASED TASKS



ARRIVAL CHART
ANALYSIS

ARRIVAL SCENARIOS

01

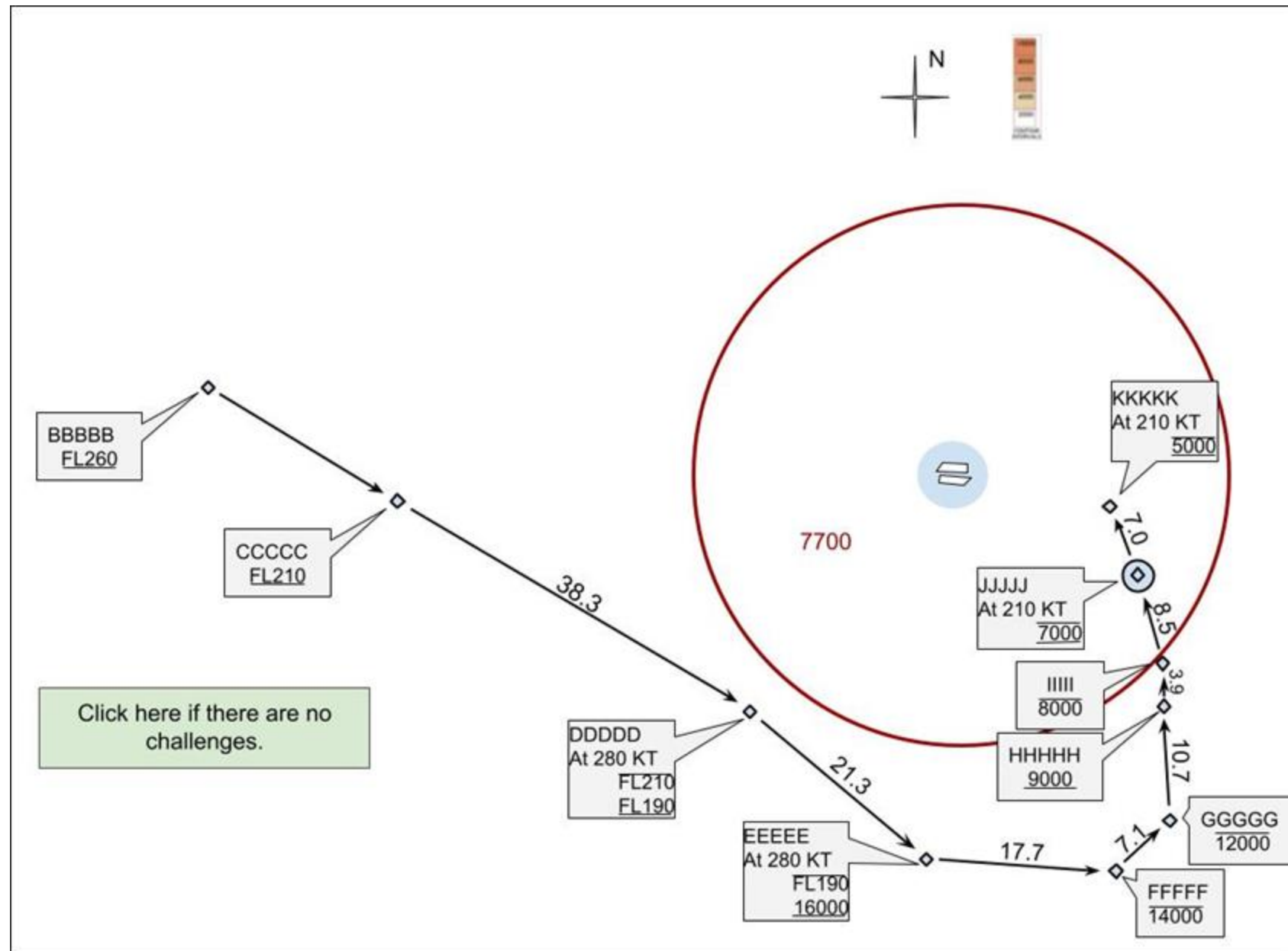
SHORTCUT
& STEEP DESCENT

02

STEEP DESCENT
& TERRAIN

03

NONE



ARRIVAL SCENARIOS

01

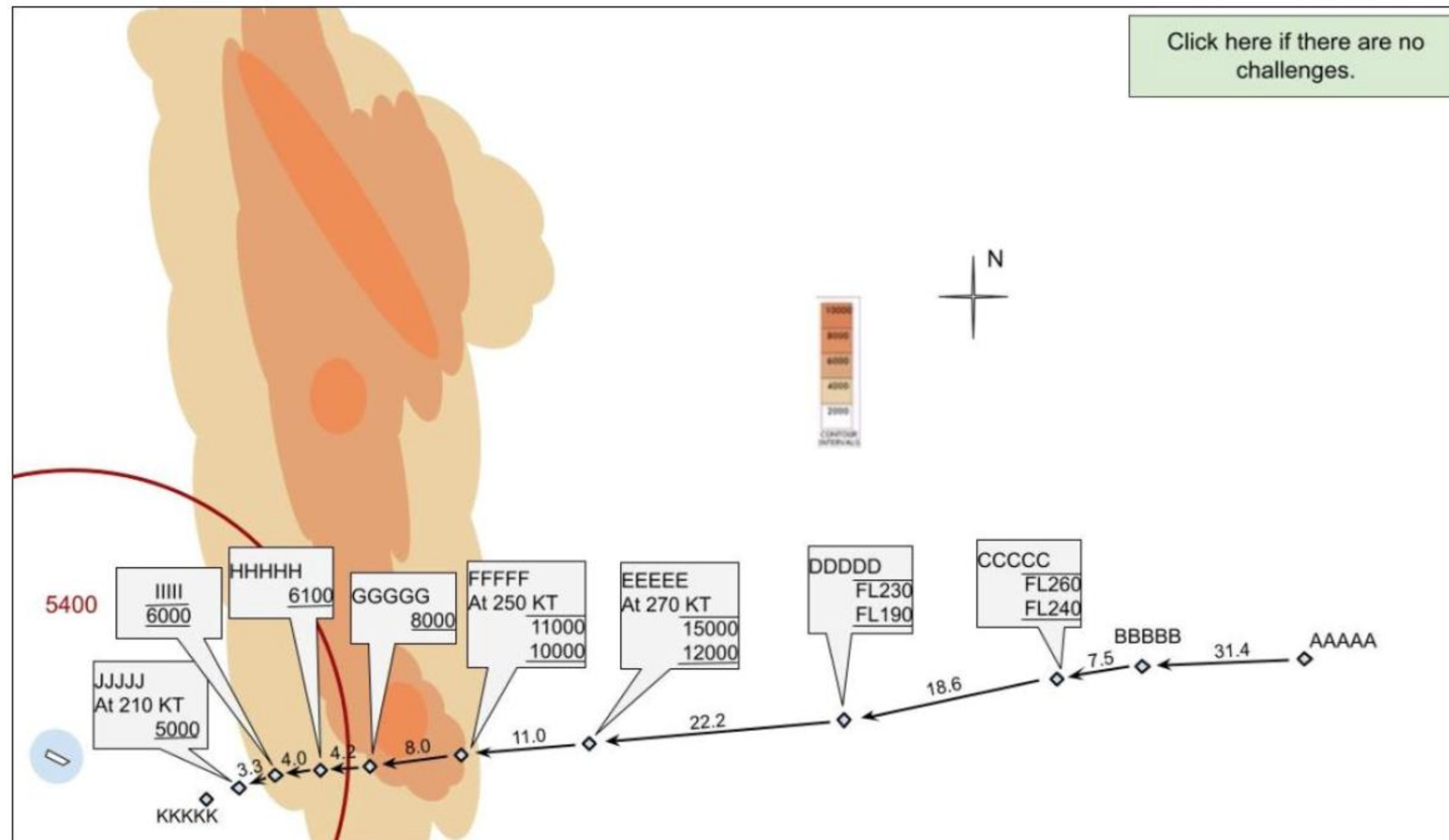
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ARRIVAL SCENARIOS

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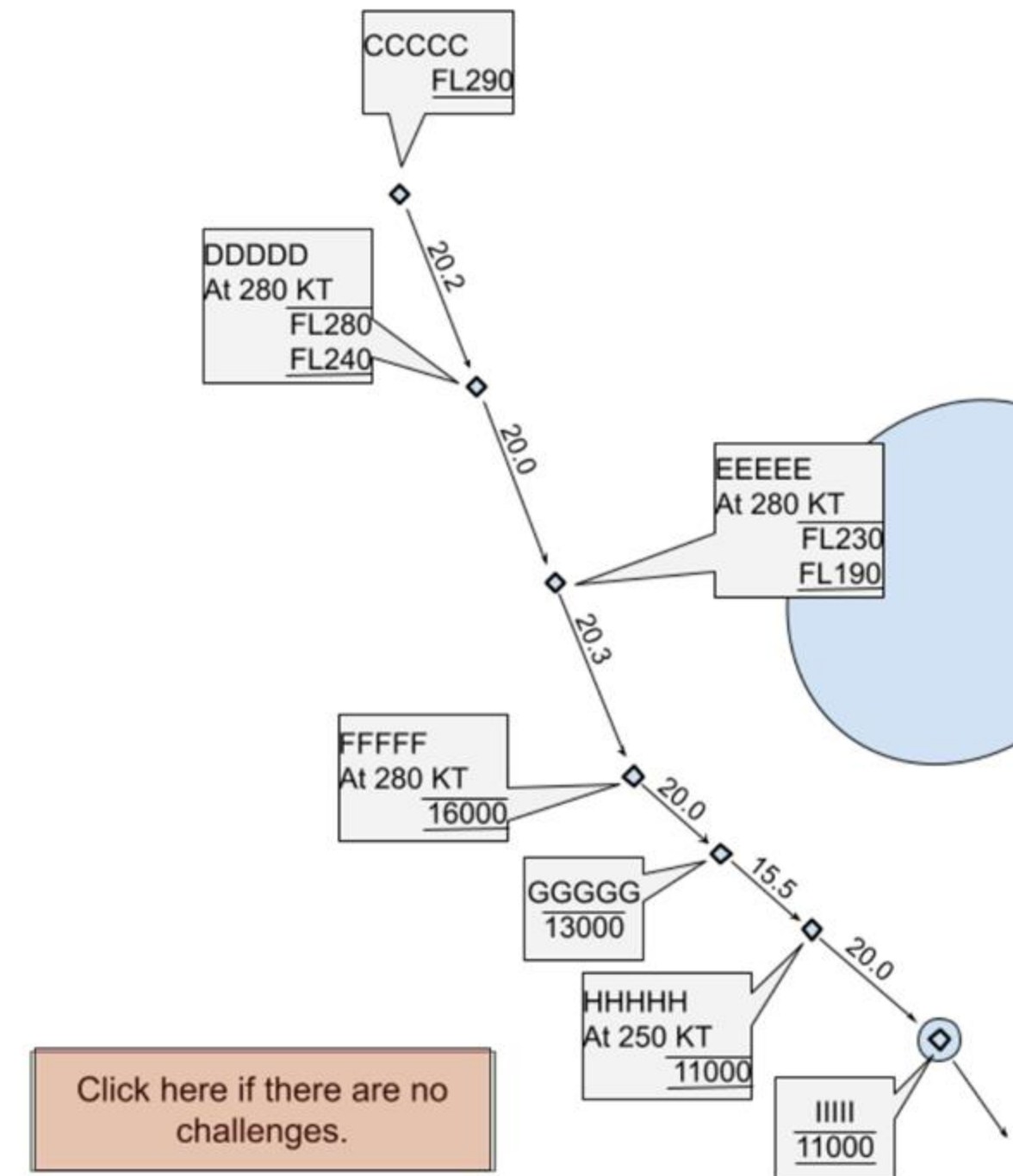
SHORTCUT
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02

STEEP DESCENT
& TERRAIN

03

NONE



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

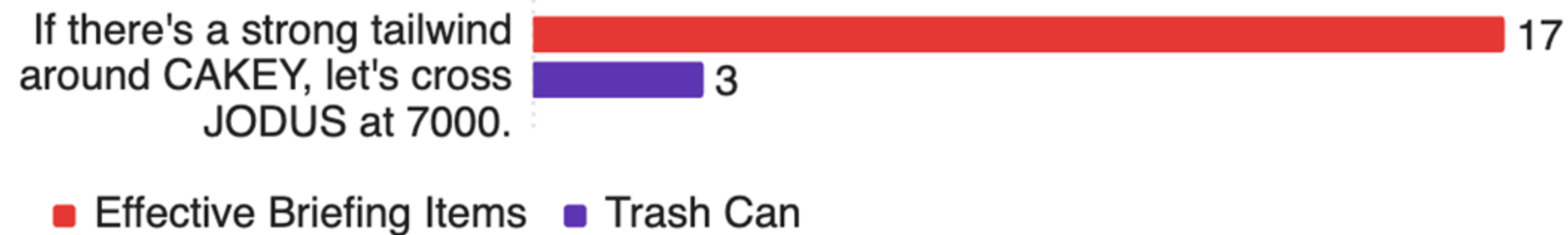
- To the human eye:
 - Improvements
- According to participants, the tutorial was:
 - “Important”
 - “Good information”
- These tasks generated a LOT of data (to date ~600 columns in R)

PRELIMINARY IMPRESSIONS

pre-test (n=28)



post-test (n=20)



BRIEFING

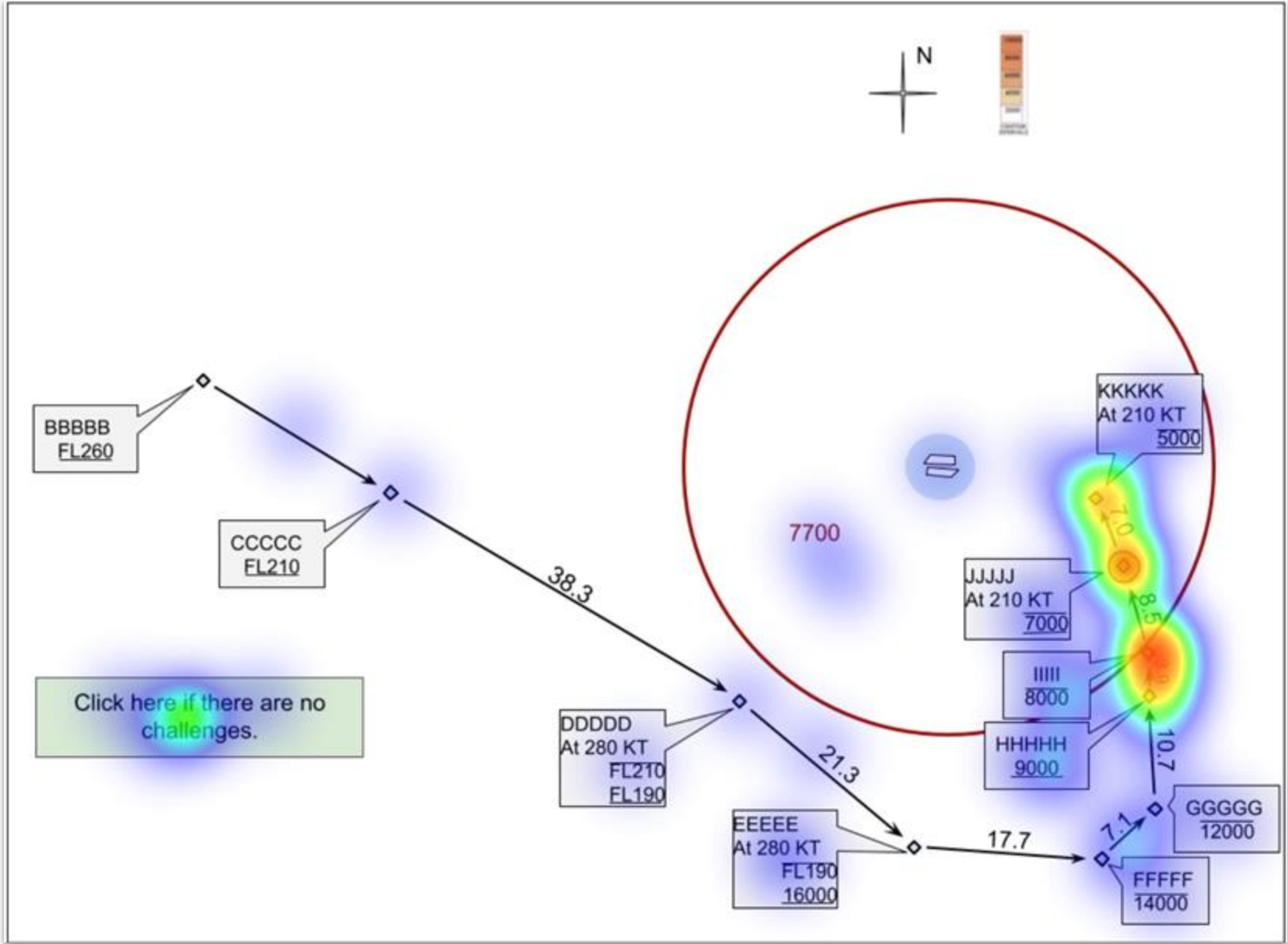
REVIEW

PRE vs. POST

EXAMPLE

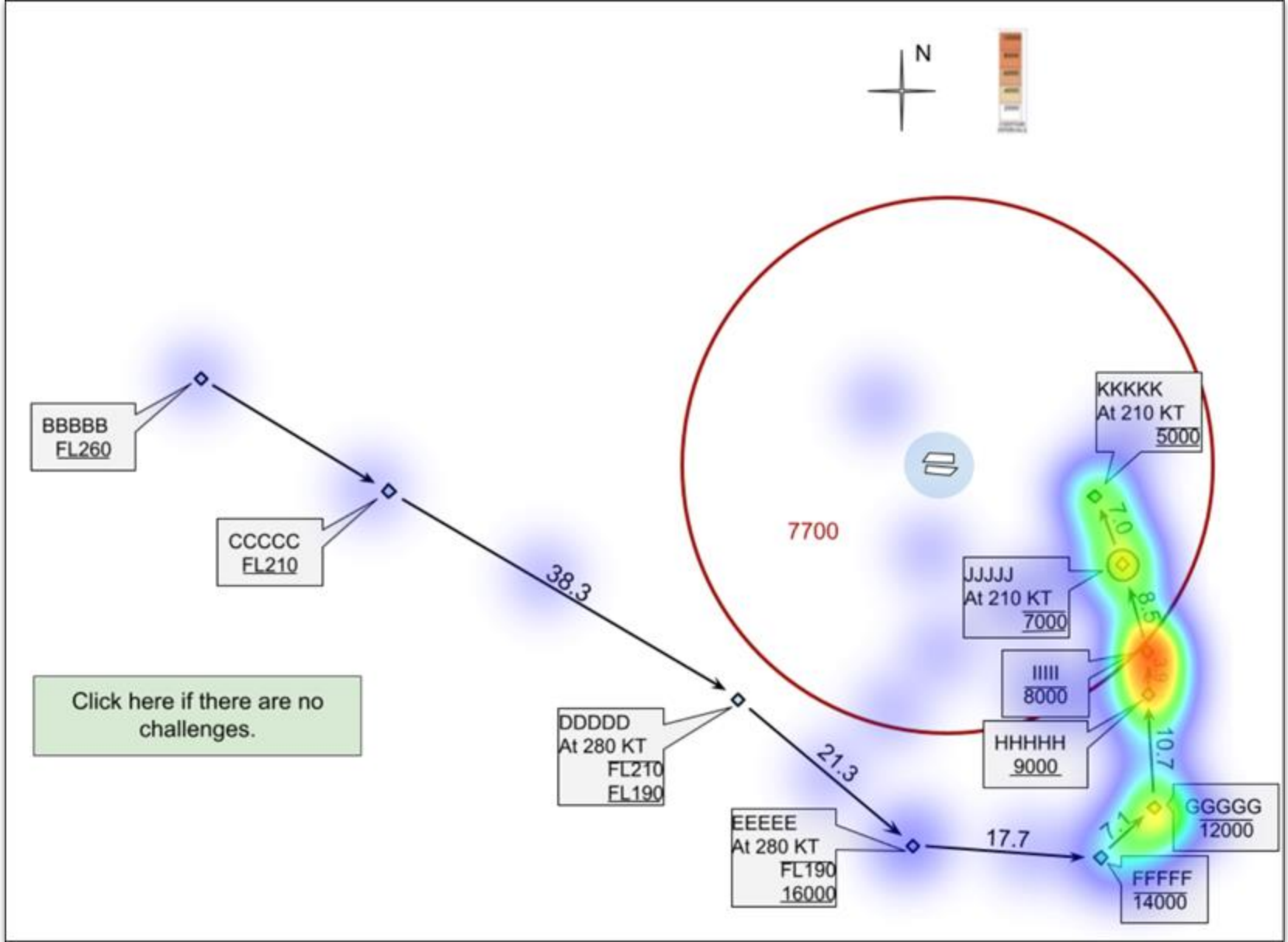
STAR ANALYSIS

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

