Enhancing Flight Training through Gamification

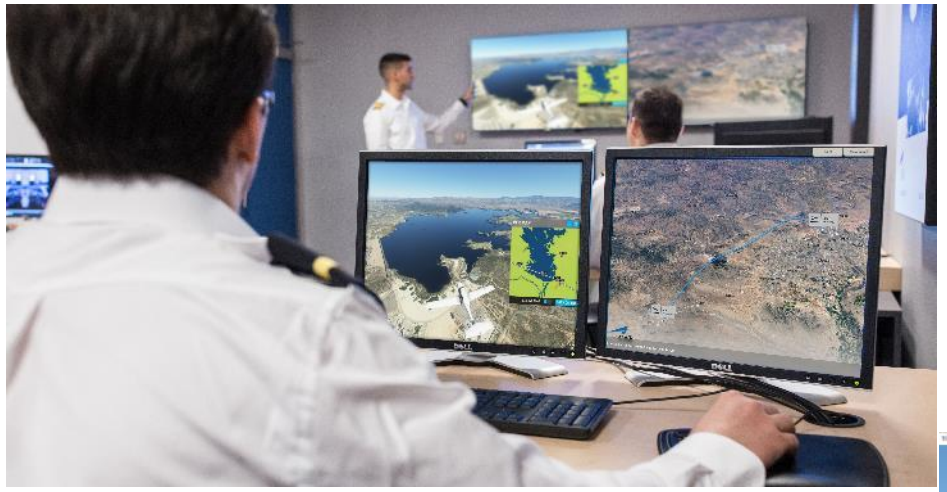
European Airline Training Symposium (EATS) - November 2023

Christopher Ranganathan, CAE Inc. Chief Learning Officer

Bringing value to flight training

- **Grad Speed: Training Throughput**
- **Faster Grads = Less Hotels**
- **Safety Events Reduction**
- **Failure Rate Decrease**
- **CSAT Score Improvement**
- **Airline's Costs**
- **Remedial Training Reduction**
- **Ground School Time Reduction**

Adding FS2020 to CAE's ecosystem of learning tools

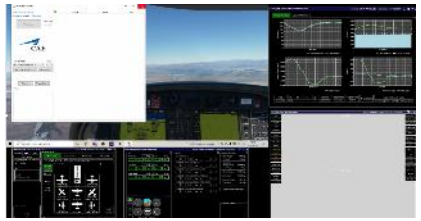


Capabilities – Sample

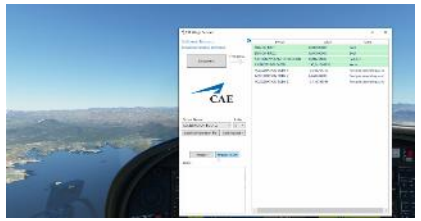
For the Instructor

Scenario Selection

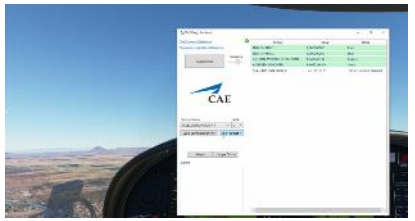
IOS Sim Control



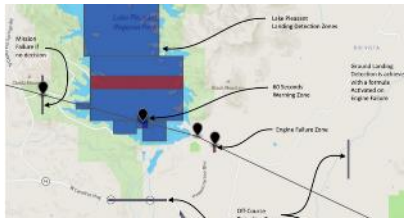
Malfunction control



Parameter Monitoring



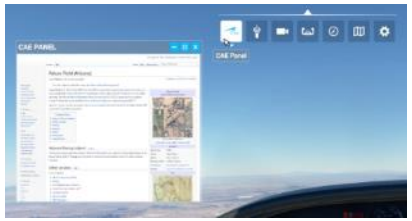
Lesson Plan Editing



For the Student pilot

Cockpit Manipulation

Flight Panel & Tiles

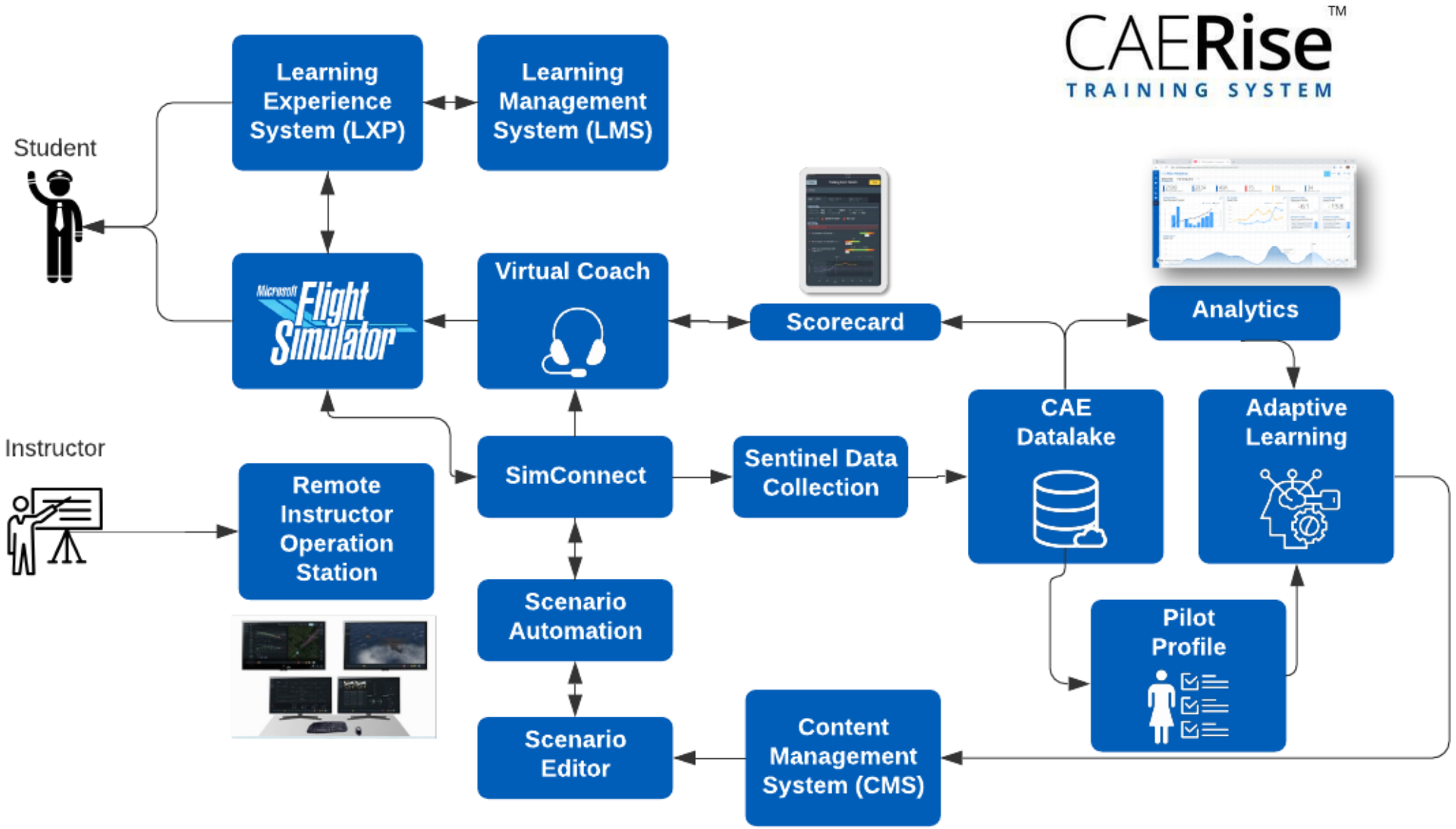


Highway Landing

Airport Landing

Lake Landing

System overview

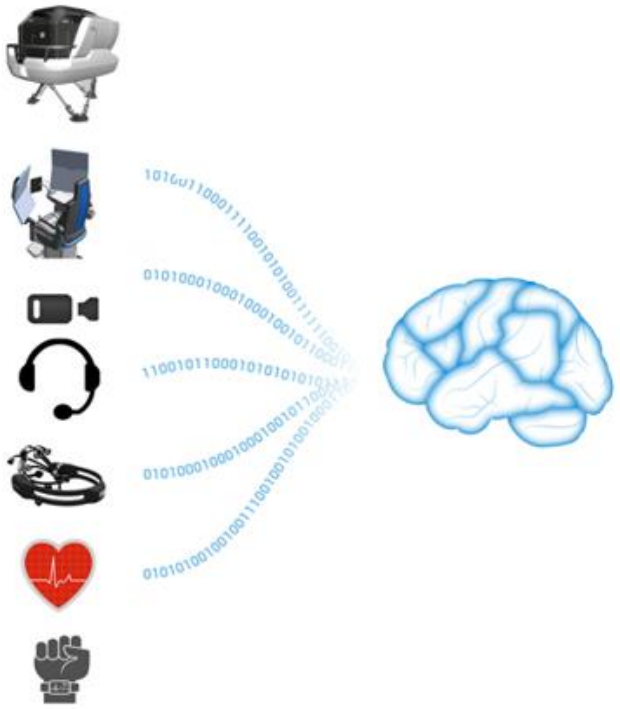


Using Biometrics Sensors to validate FS2020 technology insertion uncertainties

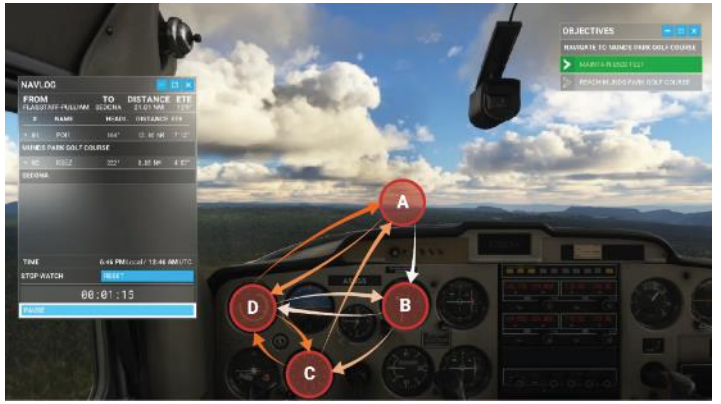
Scientific Challenge

Measure, during the learning experience, the emotional and cognitive state of learners.

Biometric measure



Immersive Environment



Ensuring technology does not get in the way of learning!

Does how we provide instruction, impact the learning experience?

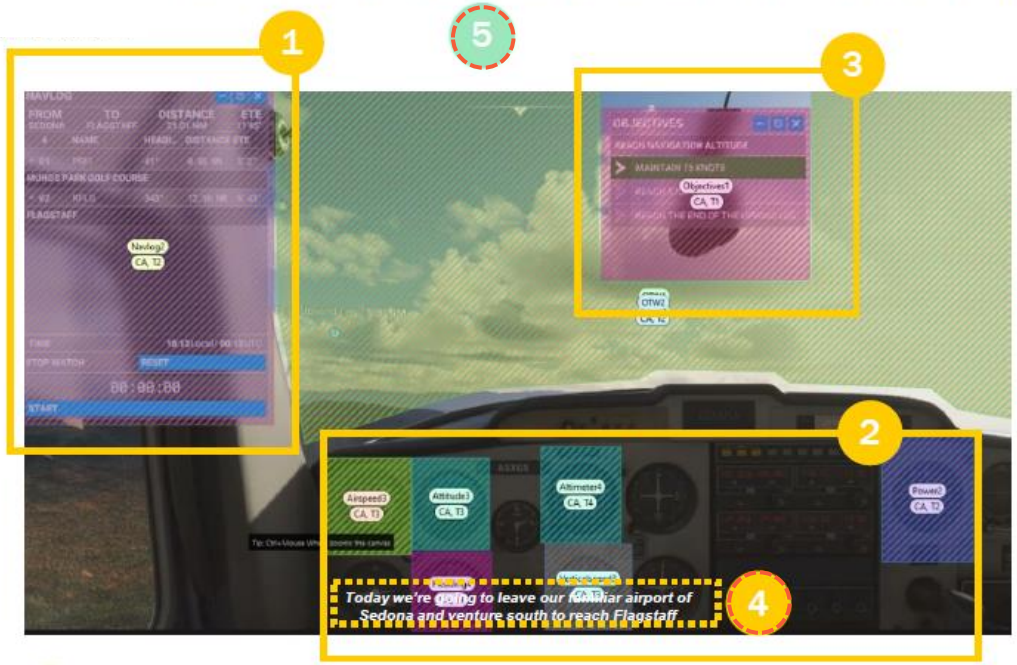
Research questions

1. To what extent does the modality of training instructions affect pilots' learning state and user experience?
2. To what extent does the modality of training instructions affect user ocular behaviors and visual strategies?

MODALITIES
Bimodal: audio **and** text
Unimodal: audio **or** text

Rochon, L. J.,Karran, A. J., Bouvier, F., Coursaris, C. K., Sénécal, S., Delisle, J. F., & Léger, P. M., Improving Learnability Capabilities in Desktop VR Medical Applications, International Conference on Human-Computer Interection (pp. 318-336), Springer

Experimental conditions



1 **Navigation Log –** Plan to execute in flight

2 **Flight Deck –** Altimeter, Attitude Indicator, Airspeed Indicator, Heading Indicator, Vertical Speed Indicator, Power Indicator

3 **Objectives window –** Presents various flight objectives sequentially.

4 **Flight Instructions (Text) –** Human-like text instructions are provided to the user.

All participants flew a “dual” flight and then a “solo” flight.

3 conditions tested :

Flight Instructions

11 participants	10 participants	9 participants
5 3	5	3 4
Condition A (bimodal)	Condition B (audio)	Condition C (text)

5 **Flight Instructions (Audio) –** Human-like audio instructions are provided to the user.

1 2 *Other navigation tools*

Visual

Audio

Tools and measures : Physiological data

We retrieve the video stream from the webcam jointly with the video stream from the laboratory's computer screen.

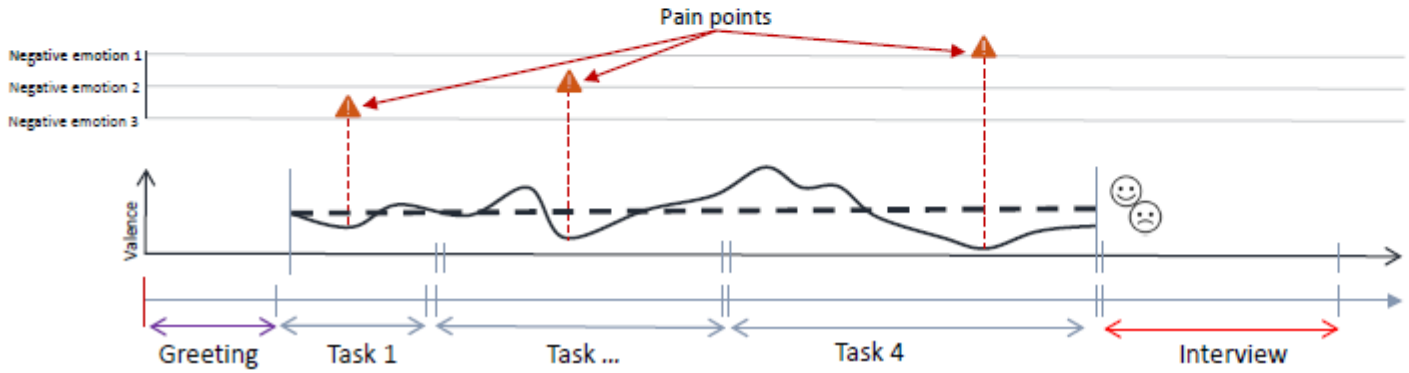
The facial expressions of the participants are analyzed to detect the intensity of emotions from facial micro-movements.

We then triangulate subjective measurements (questionnaires and interviews) with objective measures that will inform on the unconscious physiological reactions of the participants throughout the experiment.

Screen recording of participant

Automatic facial expressions detection using FaceReader

Overview of automatic facial expression detection during the tasks



Physiological Pain points are calculated based on the peak intensity of negative emotions and high cognitive load

Emotional valence is aggregated by task, based on the mean intensity of positive emotions minus the negative emotions, which gives a value between -1 and 1.

Results

RQ1: To what extent does the modality (bimodal – audio and text –, or unimodal – audio or text) of training flight simulator instructions affect pilots' learning state and user experience?

Text only flight instructions put the subjects in an appropriate learning state.

- Bimodal flight instructions and audio flight instructions act as an interruptive task to the aircraft operating task, which hinders learning; more than visual instructions.
- The ephemeral (temporary) nature of audio instructions makes this modality less efficient than the visual modality.

Results

RQ2: To what extent does the modality of training flight instructions affect user ocular behaviors and visual strategies?

The flight instructions and their modality will greatly influence the ocular behaviors and visual strategies of learners during the learning phase:

- Visual flight instructions complexify the scan patterns, and lead to a less “focal” dispersion of the subjects’ visual attention.
- Audio flight instructions result in simpler visual scan patterns, and more “focal” visual attention dispersion.

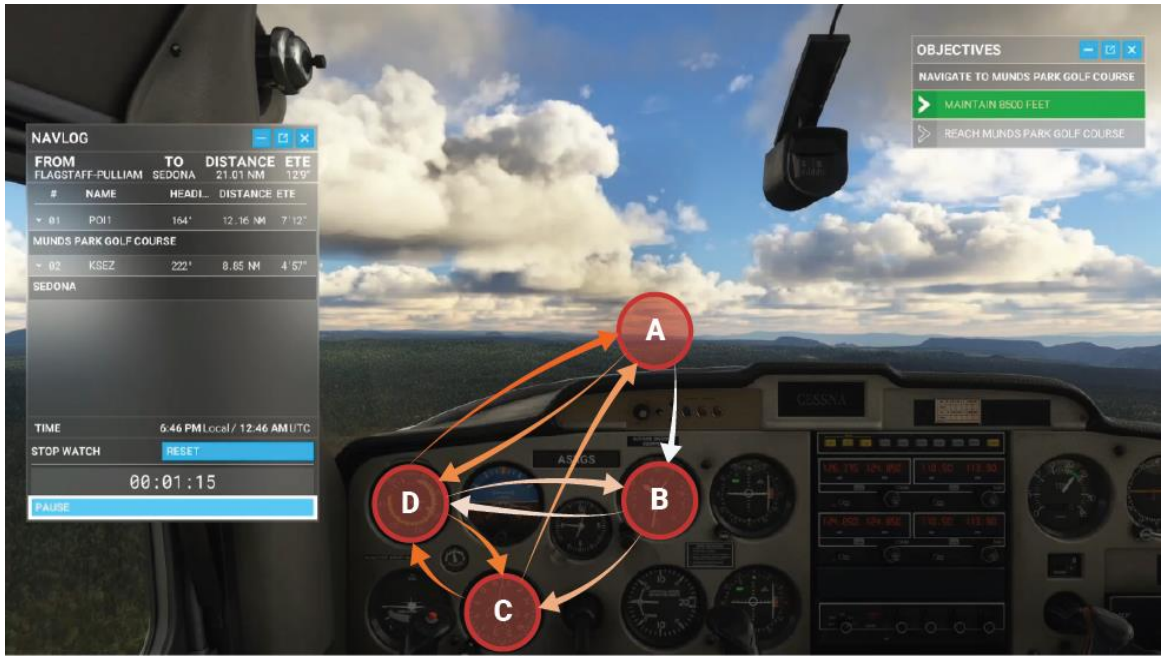
Flight segments influence ocular behaviors and visual strategies:

Our results show that the flight segments influenced the levels of measures of Gaze Transition Entropy and Attention Span Dispersion.

- Further research should be pursued to assess at a finer level of granularity how each flight segment (flight procedure/maneuver) impacts learners’ ocular behaviors and visual strategies in a flight simulator.

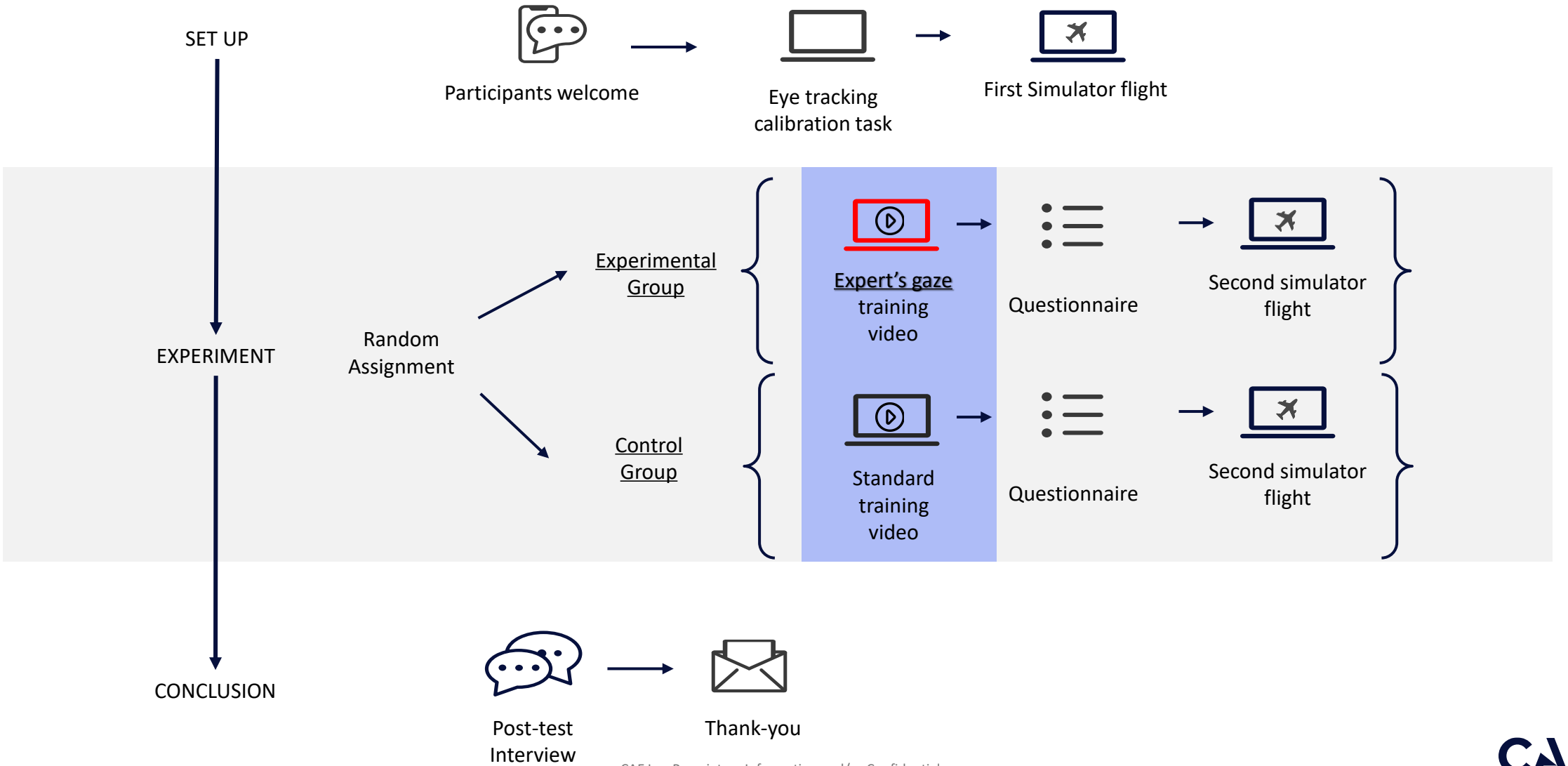
Research question :

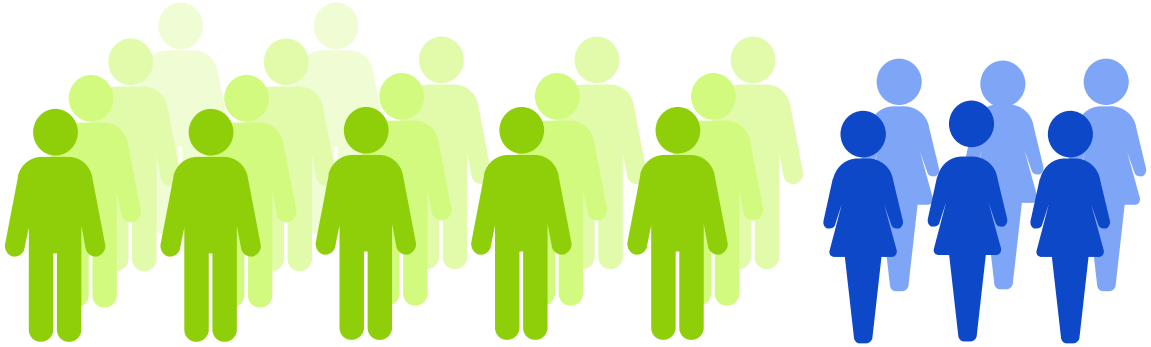
To what extent does the exposure to an expert's gaze during a training video have an impact on visual behaviour and manual flight performance of novice pilots ?



François Cormier, UX Master Student, Pierre-Majorique Léger, Ph.D., Sylvain Sénécal, Ph.D, Constantinos K. Coursaris, Ph.D., Alexander John Karran, Ph.D.

Experiment comparing results between groups





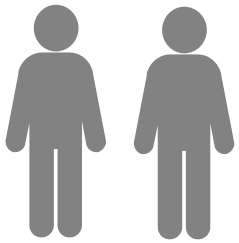
23 student pilots were recruited

A total of 23 unlicensed pilots were recruited (avg. age 23 ±5).

Flight experience ranged from 0 to 200 flight hours, with the majority having 25 hours or less.

Flight simulator experience was valid experience when considered for inclusion criteria.

2 participants gaze data was lost due to software error, leaving a total of 21 participants gaze Data.



2 expert pilots

2 professional airline pilots completed the same simulator tasks as the participants to gather reference data.

Both pilots were active professional pilots with a Canadian Airline Transport Pilot licence.

Oculometry, telemetry and questionnaires

Participants performed tasks in a lab setup similar to a home flight simulator.

1

- Eye tracking data
  Tobii pro
- Gaze location every 1/60th of a second

2

Aircraft telemetry

- Flight recorder tool for MFS 2020.
- Over 50 plane parameter every 1/60th of a second

3

Questionnaire

- Qualtrics questionnaire via iPad
- Perceived usefulness, after training video.

The experiment's setup, from a participant's point of view.

Experimental manipulation - Training video

Control group

Duration : 9 min. 29 sec.

Control training video – Takeoff phase excerpt

Experimental group

Duration : 9 min. 29 sec.

Experimental training video – Takeoff phase excerpt

Participants saw the exact same video with the difference of the representation of an expert gaze.

Both version included audio describing adequate scanning strategies and general mistakes to avoid.

Eye tracking data interpreted through 14 Areas of interest (AOI).

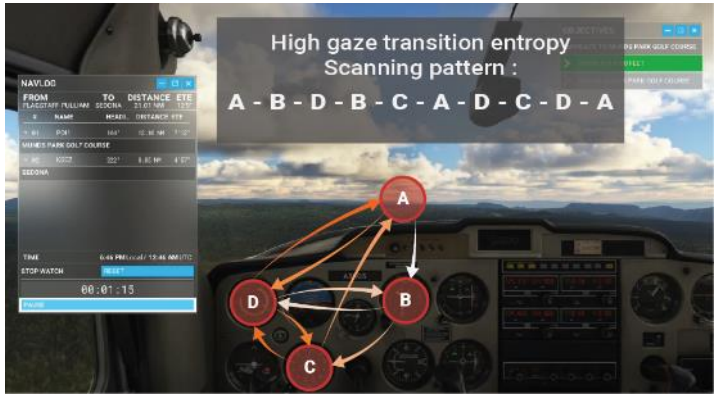
- The fixation distribution per area of interest (AOI) is used as one of two measurement of visual behavior.

- The proportional fixations time per area of interest is an indicator of attention distribution of pilots in the cockpit.

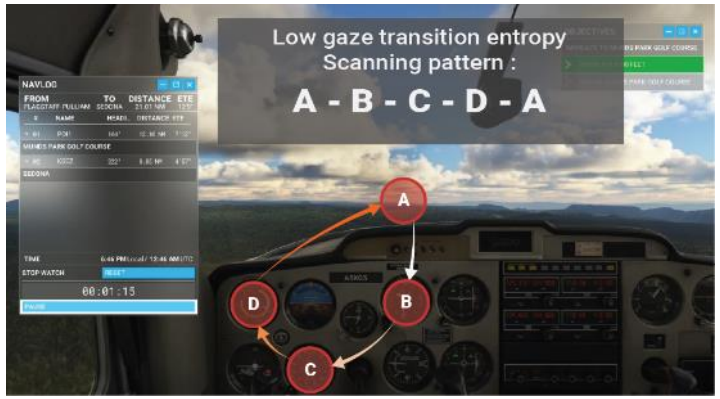
- We expect the novices exposed to the expert gaze to exhibit a stronger imitation of the expert's attention distribution.

Screen capture of the eye-tracking software, Tobii pro lab. Every colored area is a defined AOI.

To measure visual strategies randomness, Gaze Transition Entropy (GTE) was used as second visual behaviour measurement



Simplified example of high GTE scanning pattern.



Simplified example of low GTE scanning pattern.

This approach allows the measurement of the extent to which the temporal sequence of eye movements is ordered or random during a flight training exercise.

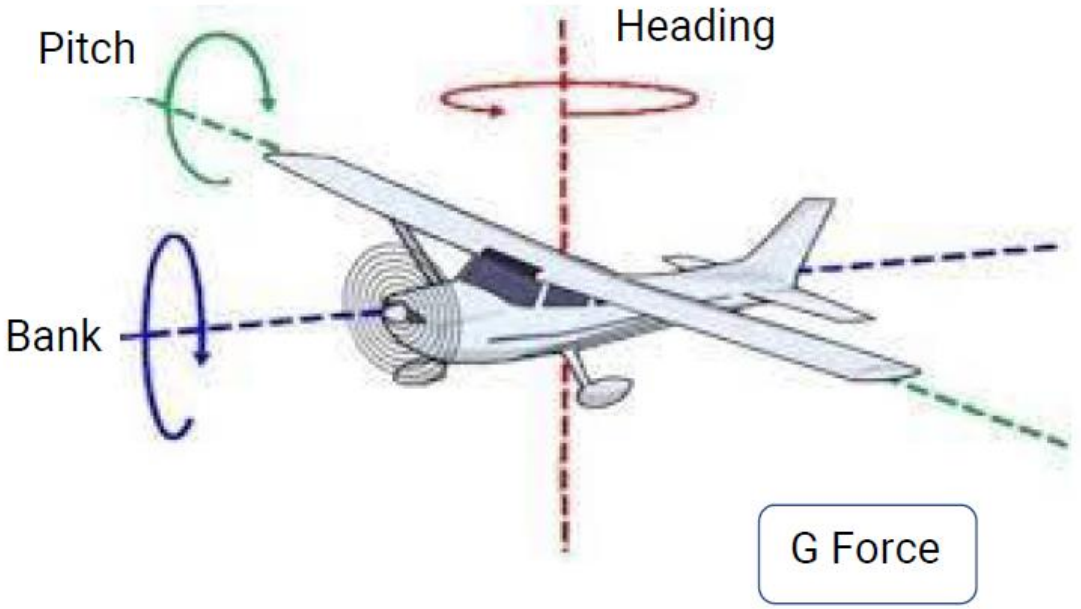
Entropy is a measure of a lack of predictability in a gaze sequence; this metric enables the evaluation of structure within the gaze of a pilot.

+	A high gaze transition entropy means lots of complexity or randomness in the visual transitions.
-	A low gaze transition entropy means simple patterns of visual transitions.
>	A novice with a higher entropy than an expert can be interpreted as a chaotic or random scanning behaviour.
<	A novice with a lower entropy than an expert can be interpreted as a lacking or overly simple scanning behaviour.

Flight smoothness was used as an indicator of manual flight performance.

This study solely investigates the smoothness of the flight by means of maximum range of flight controls and the general acceleration of the aircraft (g force).

Manual flight smoothness was compared to ideal values rather than to Golden standard, thus the improvement in flight smoothness were analyzed instead of post-performance closeness to Golden standard.



Aircrafts' axis used for smoothness analysis

The Results

The results show a clear trend in the beneficial impact of expert gaze representation in a training video.

We can observe a general tendency in the treated group to exhibit a stronger imitation of experts' behaviour with a modification of gaze transitions and attention distribution.

Some improvements in manual flight performance can be seen, although the novel measurement method might have limited the detection power of this analysis.

Those beneficial impacts are also supported by a higher perceived value of training content including this novel technology.

Many modalities could be further investigated to find the effective components of the gaze representation or the flight phase most likely to be improved by such training.

The present results point to the benefit of further research to generate actionable recommendations for the development of this promising novel technology.

Expert gaze representation appears to be a valuable training tool

Thank you!

European Airline Training Symposium (EATS) - November 2023

Christopher Ranganathan, CAE Inc. Chief Learning Officer