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Investigating In-flight Startle and Pilot Performance in General Aviation

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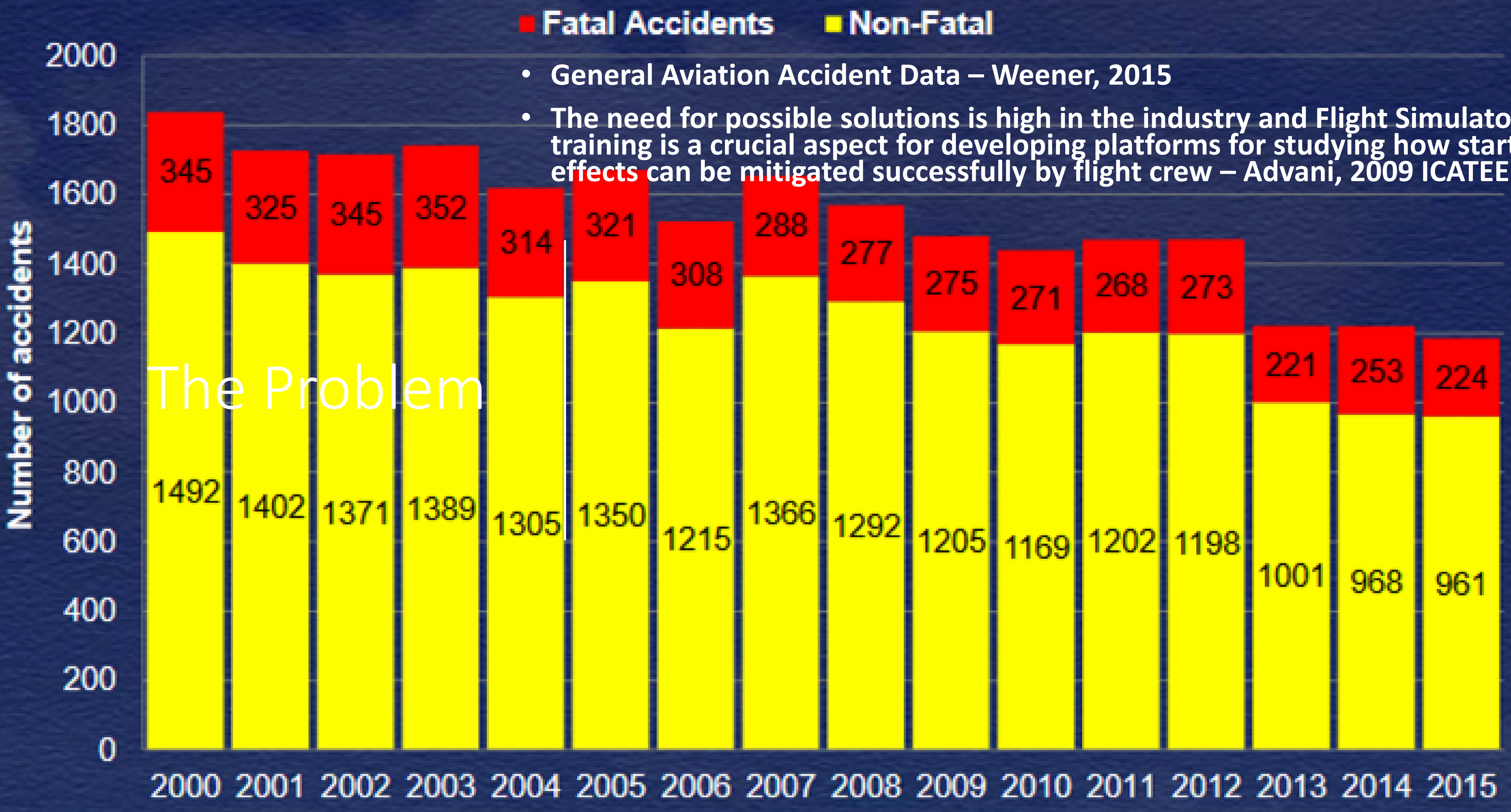
Aim:
Investigate the effect of Startle on In-Flight performance of pilots in a GA Flight Simulator.

- Objectives
  - Evaluate current work in the field of startle research
  - Identify and select the key requirements for the simulation environment incorporating the eye tracking method
  - Build an experimental flight Simulation platform
  - Carry out experiments using the flight simulator and Eye tracker,
  - Evaluate findings to provide qualitative and quantitative recommendations for further development

The Problem

- General Aviation Accident Data – Weener, 2015
- The need for possible solutions is high in the industry and Flight Simulator training is a crucial aspect for developing platforms for studying how startle effects can be mitigated successfully by flight crew – Advani, 2009 ICATEE



Loss of Control Inflight (LOC-I)

"Nearly half of all general aviation accidents are caused by loss of control in flight. To prevent unintended departures from flight and better manage stalls, pilots need more training and a better awareness of the technologies that can help prevent these tragedies." NTSB, 2015

LOC Causal factors, grouped into Environmental, System and Human factors.

Crucial Statistic: 2001 – 2011 – 40% of Fatalities (LOC-I)

Opportunities for LOC-I Startle

The most common type of LOC involves a stall, and a subsequent post-stall spin, which can occur when the pilot allows the aircraft to enter a flight regime outside its normal flight envelope.

Although LOC happens in all phases of flight, approach to landing, manoeuvring, and **initial climb** are, statistically, the deadliest phases of flight for LOC accidents. ***(NTSB, 2016)***

What can be done to stem Startle related LOC?

Andrew Taylor et al , 2014

- ***Analysis of data from 1,007 U.K. general aviation (GA) accidents demonstrates the predominant cause of accidents is loss of control, exacerbated by a lack of recent flying experience.***

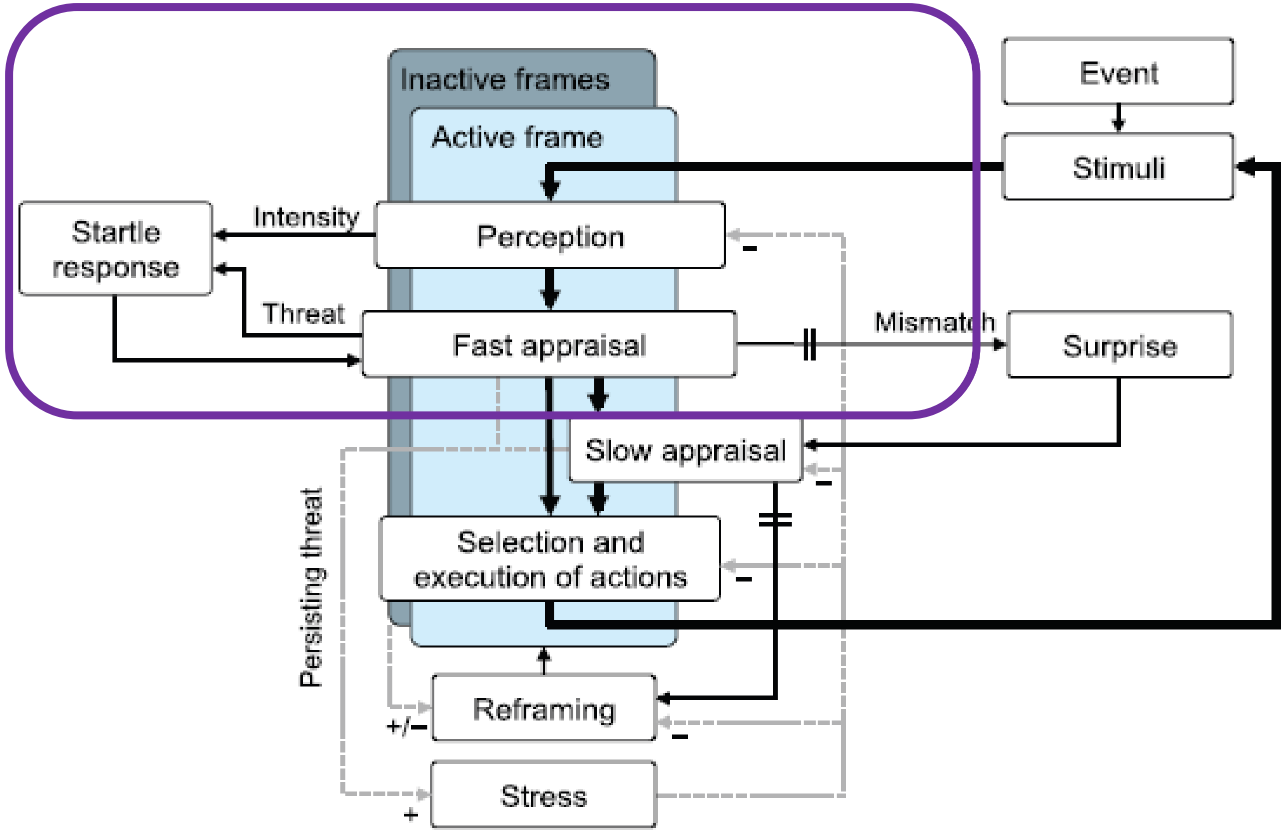
This can be targeted effectively with simulation training.

Key Conclusion

- GA safety would benefit from implementation of regulated simulation training particularly with regard to inflight startle.

A Conceptual Model of Startle and Surprise – Basis of Study

Annemarie Landman et al – Delft University Netherlands - 2017



- Conclusion: Their Proposed model can be used to design experiments & training simulations to teach and assess meta cognitive skills

Capturing Data 1: Simulator Space Fidelity

1

Simulation must be immersive – This means the flight simulation MUST have a sufficient enough feeling of realism as visually perceived by the pilot

2

MUST provide visual stimulation above 40fps as a minimum in line with baseline eye perception models which prescribe frame rates >30fps for realistic impact on visual perception.

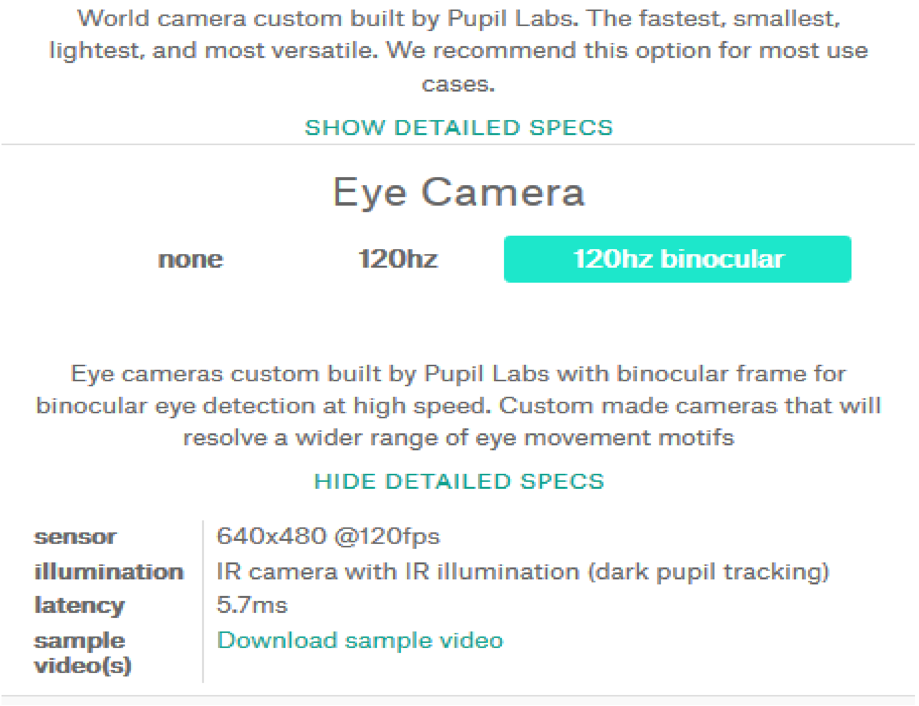
3

The Simulator space MUST simulate sufficiently the General Aviation Aircraft of choice (in this case the Cessna 172SP variant)

Capturing Data 2: The Eye Tracker

The Pupil Labs Eye Tracking Platform is chosen based on its open source nature which allows for user tweaks

- The Eye Tracker provides World View capture as well as Eye tracking capabilities which then enables capture of gaze behaviour during task performance



World camera custom built by Pupil Labs. The fastest, smallest, lightest, and most versatile. We recommend this option for most use cases.

SHOW DETAILED SPECS

Eye Camera

none | 120hz | 120hz binocular

Eye cameras custom built by Pupil Labs with binocular frame for binocular eye detection at high speed. Custom made cameras that will resolve a wider range of eye movement motifs

HIDE DETAILED SPECS

sensor	640x480 @120fps
illumination	IR camera with IR illumination (dark pupil tracking)
latency	5.7ms
sample video(s)	Download sample video

Experimental Platform

- Cessna 172SP Variant is Simulated on the X Plane Platform – Currently rated in the domain as a premier solution for flight simulation training and research.
- Extendable Fixed Base Basic Aviation Training Device (BATD)

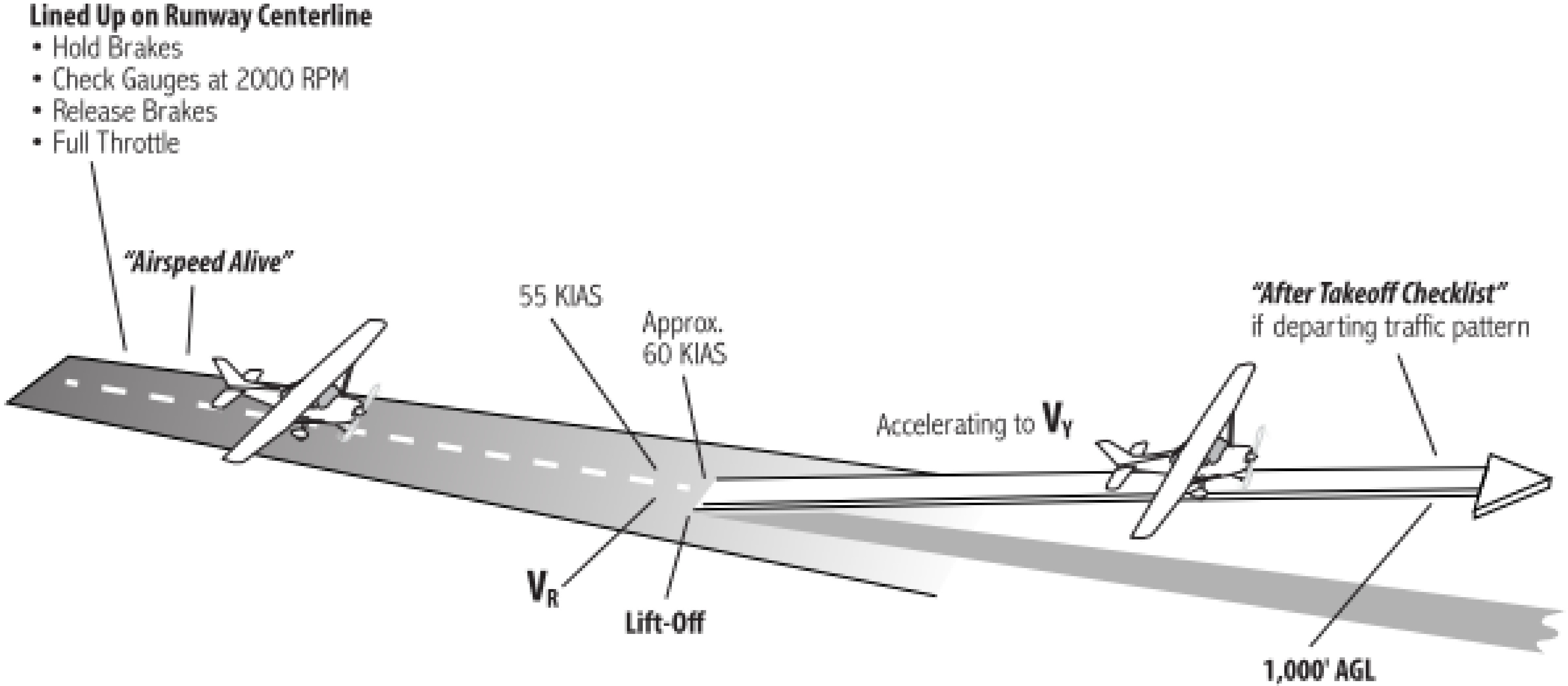
Environment to mimic the Cessna 172SP GA Aircraft Arrangement

- Overview
  - Environment: Basic Aviation Training Device (BATD)

- Head Mounted Pupil Labs Eye Tracker, with world view camera.
- Test Participant sitting at about 60cm from the FOV

- High Immersion using 3x 27” HD Screens at approx. 130 degrees for Immersion
- Throttle Quadrant
- Radio and NAV Stack
- Control Column and Rudder Pedals for Pitch, Roll & Yaw Input

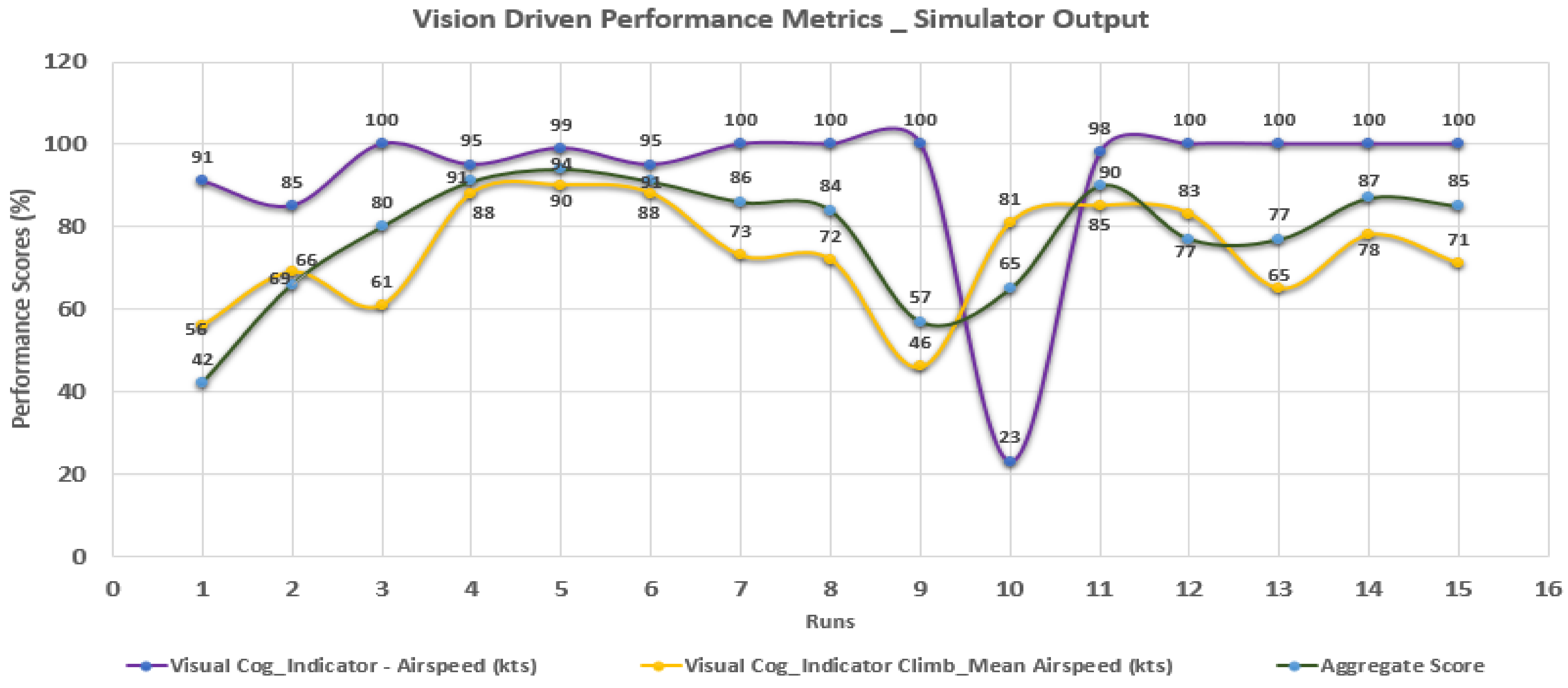
Task Profile – Take-Off Profile – Cessna 172SP



Task Segregation

Task Stage 1 (*ROLL OUT, TAKE OFF)*	**Task Stage 2 (*CLIMB TO 150 FL*)**
1. Apply Throttle from a standing Start 2. Simultaneously apply right rudder to maintain centerline integrity during run out to T/O. 3. Watch speed progression for 55 Kts (Approx.) - Max 60 allowed. 4. Rotate nose up gently to takeoff – Using the Yoke Control 5. Maintain an angle of attack <= 10 deg.	1. Following Initial Climb, momentarily reduce pitch angle or Angle of Attack (AoA) to increase climb speed < 10deg, maintaining a climb speed of 75kts 2. Maintain steady climb profile using Altitude indicator and Vertical Speed for information on climb progress 3. Identify vocally when 140 FL is reached 4. Apply pitch/nose down activity on yoke to force a drop in Vertical Speed. 5. Maintain 145 FL - 155 FL – (hold vertical speed indicator at 0) 6. Hold Altitude until simulation stops

Sample Preliminary Results
Vision Performance Vs Aggregate Test Score



Potential for Diversification

Automotive Applications: Understanding driver gaze patterns could have implications for driverless cars AI.

Cognitive Science: Potential to interface with Psychology department in order to extend studies into cognitive aspects of human performance

(incorporating EEG and eye tracking for instance)

Other transport based applications (Train driving studies)

Human-Technology/Machine Interaction Studies

Virtual Reality Developments (Foveated rendering for instance)

Etc..

Thank You