

Appendix D Safety Validation Report for AVOID Dataset using the CuneiForm method

Safety Validation Report for AVOID Dataset using the CuneiForm method



Dataset Safety Report
By
Haider Al-Shareefy
haideralshareefy@outlook.com
The output of AVOIDDS Case Study

Part of PhD project Supervised by
Prof Michael Butler, Dr Thai Son Hoang,
University of Southampton

Southampton, UK
Prof Hamid Asgari
Thales UK

Definitions

Concept	Definition
ALARP	As Low As Reasonably Practicable
ArcUC	Architect Epistemic Uncertainty Curve for a given dataset
PHI	Pictorial Visible Horizon Attitude Indicator
TOI	Target Object of Interest

Introduction

- **Objective:** Assess the **trustworthiness** of AVOIDDS for **AI-based mid-air collision avoidance systems**.
- **Validation Methodology:** Applied **CuneiForm analysis** to evaluate dataset completeness, bias, and epistemic uncertainty. Access the paper [here](#).
- **Key Dimensions Analyzed:**
 - **Time-of-day coverage** (bias in night/midday instances).
 - **Cloud coverage distribution** (imbalanced across scenarios).
 - **Pictorial distance & object positioning** (lack of dangerously close TOIs).
 - **Horizon attitude coverage** (limited diversity in aircraft perspectives).

Purpose of the Report

The **purpose of this report** is to assess the AVOID dataset's **suitability for training AI-based mid-air collision avoidance perception models** by evaluating its **epistemic uncertainty and dataset bias** across CuneiForm epistemic training classes. Specifically, this report aims to:

- **Validate dataset completeness** using the **CuneiForm method**, ensuring that training samples cover diverse operational conditions.
- **Identify dataset biases** that may introduce epistemic uncertainty, leading to unreliable model performance in critical scenarios.
- **Evaluate dataset suitability** for **Black Swan** scenarios, determining whether the dataset supports robust AI decision-making in unpredictable or rare events.
- **Assess the trustworthiness** of AVOIDDS for **real-world safety-critical applications**, particularly for aviation-based detect-and-avoid systems.
- **Provide mitigation strategies** to improve dataset robustness, ensuring compliance with ALARP uncertainty coverage standards.

Findings

Dataset lacks coverage for **critical Black Swan scenarios**.

High uncertainty in detecting close, and atypically oriented aircraft.

Potential risks in real-world applications for mid-air collision avoidance.

AVOIDDS Training Syllabus

The following is the training Syllabus that AVOIDDS appears to be designed to train perception models on. It includes the following Training Classes:



Satisfying ALARP Requirements

AVOIDDS does not satisfactorily fulfil the coverage of the times of day training classes.

AVOIDDS does not satisfactorily fulfil the ALARP requirement for pictorial distance training classes coverage.

AVOIDDS does not satisfactorily fulfil the ALARP requirement for TOI's positioning training classes coverage.

AVOIDDS does not satisfactorily fulfil the ALARP requirement for pictorial horizon attitudes training classes coverage.

Recommendations

Improve

Improve dataset balance across CuneiForm Training Classes to meet the ALARP Requirement to reduce uncertainty.

Expand

Expand training instances to cover Black Swan Scenarios to meet the ALARP Requirement to reduce uncertainty.

Enhance

Enhance operational domain epistemic coverage to meet the ALARP Requirement to reduce uncertainty (Traceability to clearly articulated Safety Concept).

Conclusion

AVOIDDS is **useful as a benchmark** but requires **further improvements** to support real-world **safety-critical aviation AI models**.





05/02/2025

AVOID Dataset description

This repository contains datasets, models, and simulators for the AVOIDDS (Aircraft Vision-based Intruder Detection Dataset and Simulator) benchmark, which centres around the vision-based aircraft detect-and-avoid (DAA) problem. The full AVOIDDS dataset, which includes 72,000 labelled images, is available here: purl.stanford.edu/hj293cv5980.



Assumptions

- The sample_small folder of training and validation datasets is statistically representative of AVOIDDS dataset.
 - 30 images, training sample.
 - 30 images validation sample.
- Time of day, Clouds types, file names all taken directly from the provided state_data.xlsx in the repository.
- The CuneiForm coverage results on the representative sample are accepted as a quality assessment of the entire AVOIDDS dataset.

Definition of ALARP

Our ODD classification for time of day

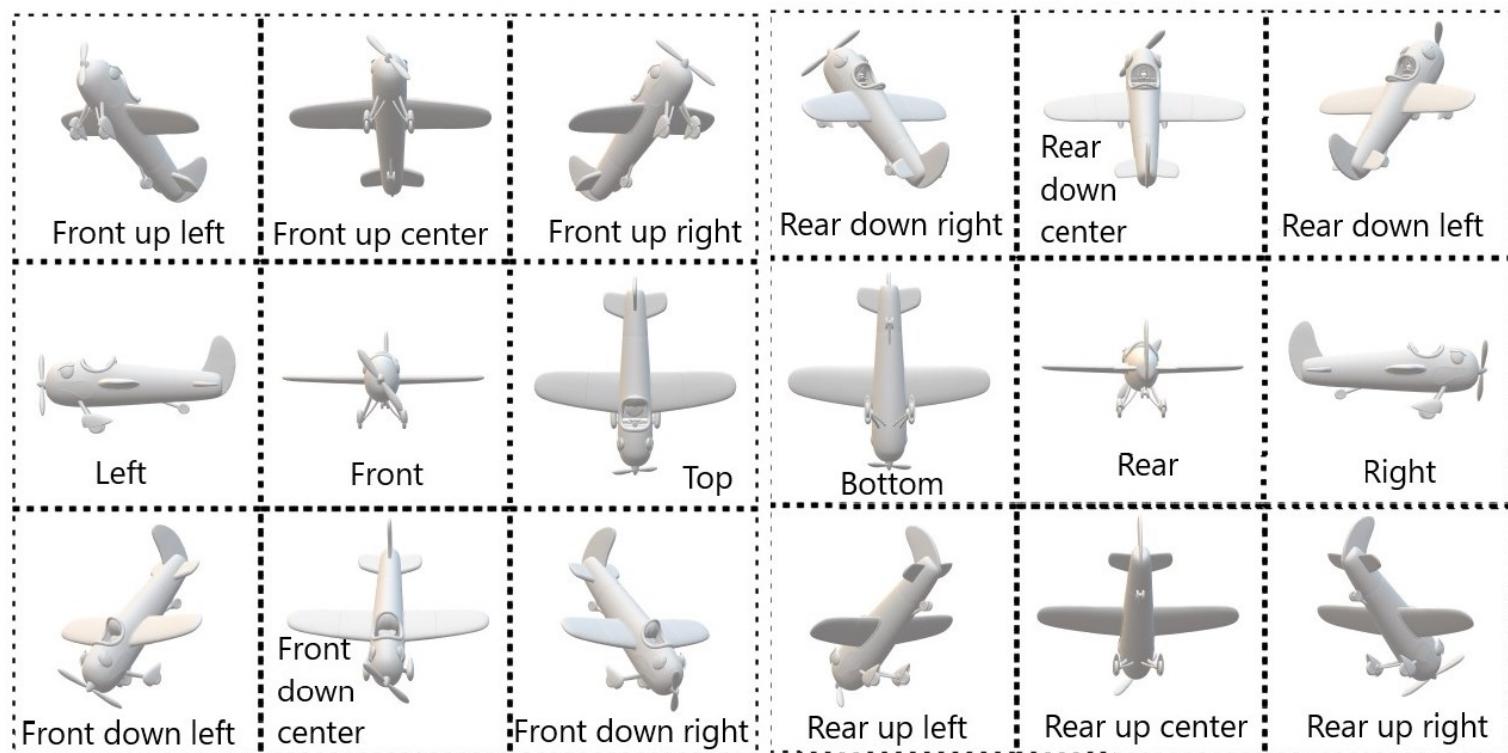
Category	Time Range
Early Morning (Dawn)	4:00 AM - 6:00 AM
Morning	6:00 AM - 9:00 AM
Mid-Morning	9:00 AM - 11:00 AM
Midday (Noon)	11:00 AM - 1:00 PM
Afternoon	1:00 PM - 4:00 PM
Evening	4:00 PM - 6:00 PM
Evening (Dusk)	6:00 PM - 8:00 PM
Night	8:00 PM - 4:00 AM

- To reduce the risk of perception failure due to insufficient development dataset coverage, statistically sound samples should demonstrate the following coverage criteria:
 - Note: the following criteria in the blue table are directly taken from AVOIDDS documentation associated with their datasets.
 - Their classification of timing did not make sense, so we used our time of day classification.

ODD Dimension	Training class spec
Weather Conditions	clear, high cirrus, scattered clouds, broken clouds, overcast, stratus
Time of Day	morning, midday, afternoon, and late afternoon.

Definition of ALARP: TOI's 3D orientation coverage to achieve ALARP requirement

To reduce the risk of epistemic uncertainty that can lead to perception failure due to insufficient development dataset coverage, statistically sound samples should demonstrate the following training classes coverage criteria:



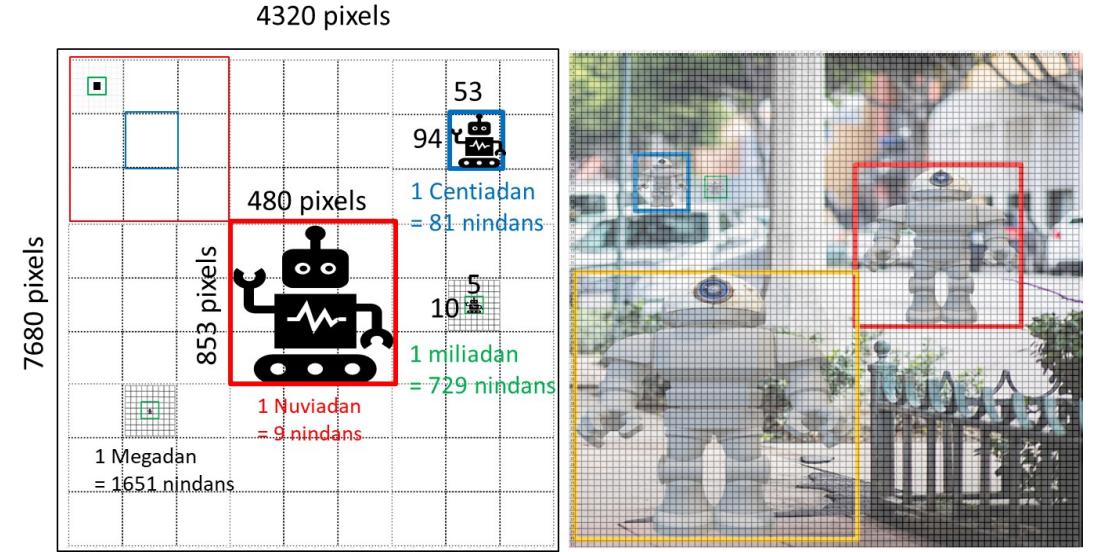
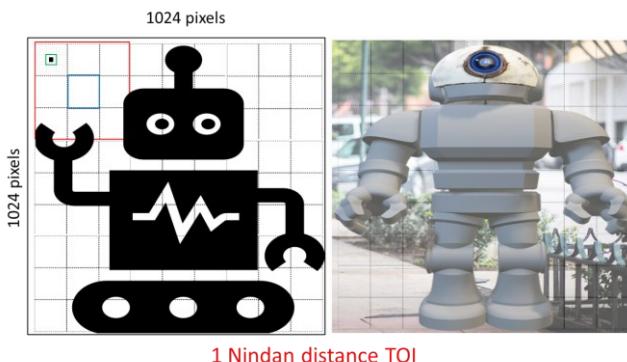
Definition of ALARP: Pictorial distance categories

To reduce the risk of perception failure due to insufficient development dataset coverage, statistically sound samples should demonstrate the following coverage criteria:

To define the pictorial distance units, we define the following system:

1 Nindan = the TOI pictorial size, covers the size of the picture frame.

- 1 Nuviadan = 9 Nindans further away = $1/9$ frame area
- 1 Centiadan = 81 Nindans further away = $1/81$ frame area
- 1 Miliadan = $81 \times 9 = 729$ Nindans further away = $1/729$ frame area



Category (wrt human verifier)	Pictorial Distance (Dx) Range	Example
Extremely Unrecognisable TOI Distance	$Dx > 1600$ nindans	
Moderately Recognisable TOI Distance	$729 > Dx \leq 1600$ nindans	
Recognisable TOI Distance	$300 > Dx \leq 729$ nindans	
Clear Close TOI Distance	$40 > Dx \leq 300$ nindans	
Dangerously Close TOI Distance	$Dx \leq 40$ nindans	

Definition of ALARP: Pictorial distance categories

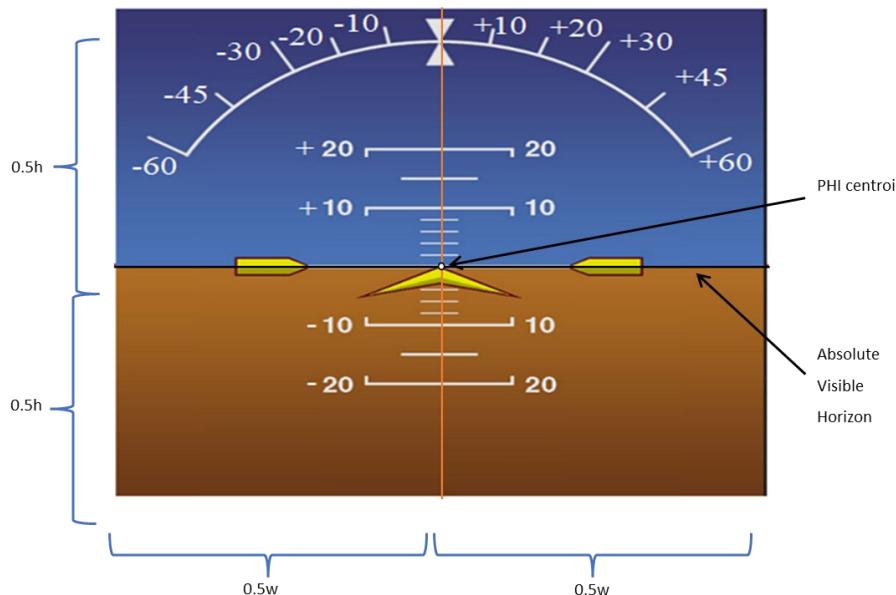
To compute the pictorial distance, we used a Python script that calculated the bounding box number of pixels (as specified by the training dataset sample) and the total number of pixels for the whole image area. Then we matched a particular categorical system to define whether a TOI is within a specific range. Below is a sample of the Python script output

Category (wrt human verifier)	Pictorial Distance (Dx) Range	Example
Extremely Unrecognisable TOI Distance	$Dx > 1600$	
Moderately Recognisable TOI Distance	$729 > Dx \leq 1600$	
Recognisable TOI Distance	$300 > Dx \leq 729$	
Clear Close TOI Distance	$40 > Dx \leq 300$	
Dangerously Close TOI Distance	$Dx \leq 40$	

Image	X1	Y1	X2	Y2	Bounding B	Total Pixels	Pictorial Distar	Training Class
0.jpg	2518	1851	2584	1876	1627	5621280	3454.996927	Extremely Unrecognisable TOI Distance
1.jpg	2245	1541	2398	1599	8801	5621280	638.7092376	Recognisable TOI Distance
2.jpg	1958	879	2073	922	4969	5621280	1131.269873	Moderately Recognisable TOI Distance
3.jpg	2610	1279	2657	1296	815	5621280	6897.276074	Extremely Unrecognisable TOI Distance

Definition of ALARP: Horizon attitude categories to achieve ALARP requirements

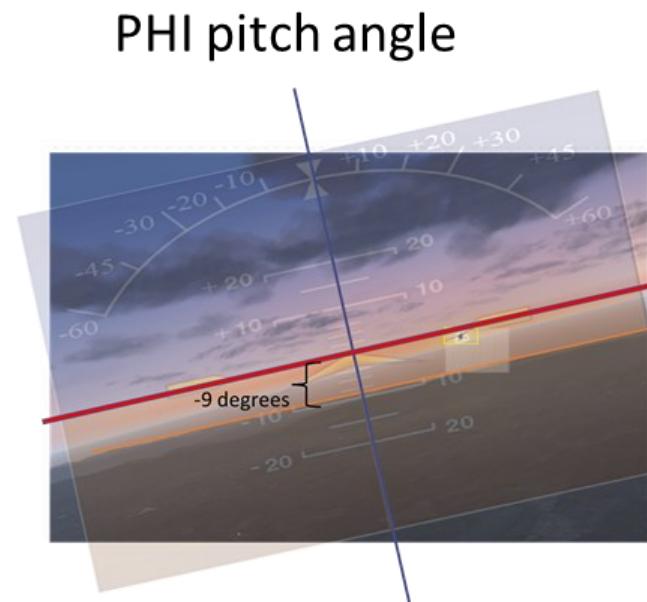
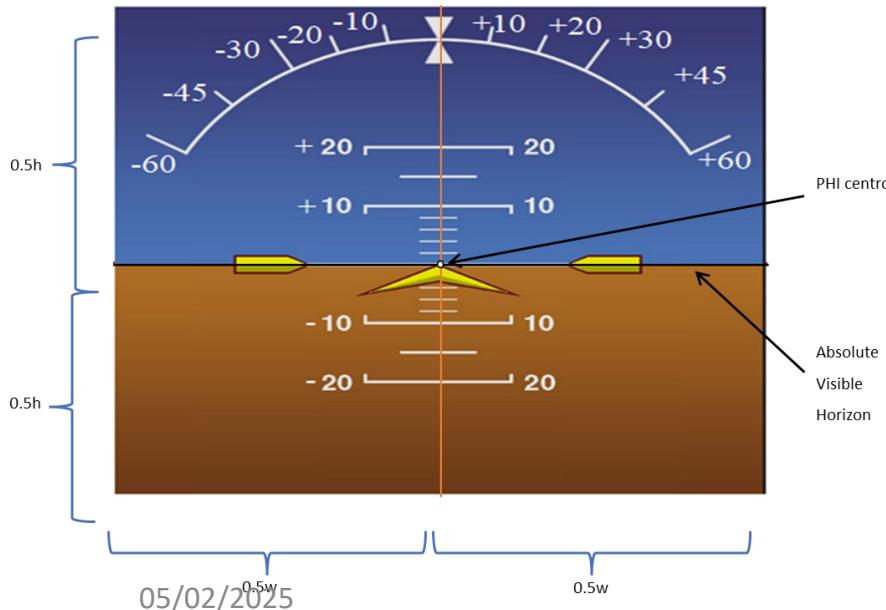
To reduce the risk of perception failure due to insufficient development dataset coverage, statistically sound samples should demonstrate the following coverage criteria:



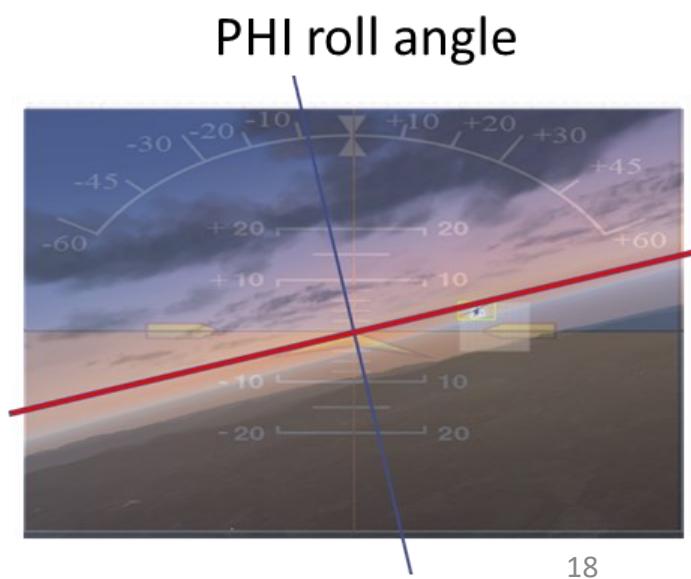
Horizon attitude category	Roll Range	Pitch Range
Level Horizon	$-1 \leq \text{ROLL} \leq 1$	$-1 \leq \text{PITCH} \leq 1$
Positively Tilted Level Horizon	$1 < \text{ROLL} \leq 90$	$-1 \leq \text{PITCH} \leq 1$
Negatively Tilted Level Horizon	$-90 \leq \text{ROLL} < -1$	$-1 \leq \text{PITCH} \leq 1$
Elevated Level Horizon	$-1 \leq \text{ROLL} \leq 1$	$1 < \text{PITCH} \leq 45$
Positively Tilted Elevated Horizon	$1 < \text{ROLL} \leq 90$	$1 < \text{PITCH} \leq 45$
Negatively Tilted Elevated Horizon	$-90 \leq \text{ROLL} < -1$	$1 < \text{PITCH} \leq 45$
Acute Angled Bird's Eye Ground View	$-90 \leq \text{ROLL} \leq 90$	$45 < \text{PITCH} \leq 80$
Bird's Eye Ground View	$-90 \leq \text{ROLL} \leq 90$	$80 < \text{PITCH} \leq 90$
Lowered Level Horizon	$-1 \leq \text{ROLL} \leq 1$	$-45 \leq \text{PITCH} \leq -1$
Positively Tilted Lowered Horizon	$1 < \text{ROLL} \leq 90$	$-45 \leq \text{PITCH} \leq -1$
Negatively Tilted Lowered Horizon	$-90 \leq \text{ROLL} < -1$	$-45 \leq \text{PITCH} \leq -1$
Acute Angled Rocket Sky View	$-90 \leq \text{ROLL} \leq 90$	$-80 \leq \text{PITCH} \leq -45$
Ascending Rocket Sky View	$-90 \leq \text{ROLL} \leq 90$	$-90 \leq \text{PITCH} \leq -80$

Definition of ALARP: Horizon attitude categories to achieve ALARP requirements

To reduce the risk of perception failure due to insufficient development dataset coverage, statistically sound samples should demonstrate the following coverage criteria:



PHI pitch angle

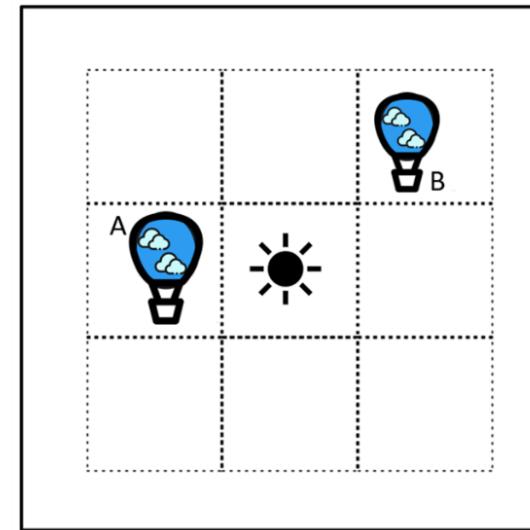
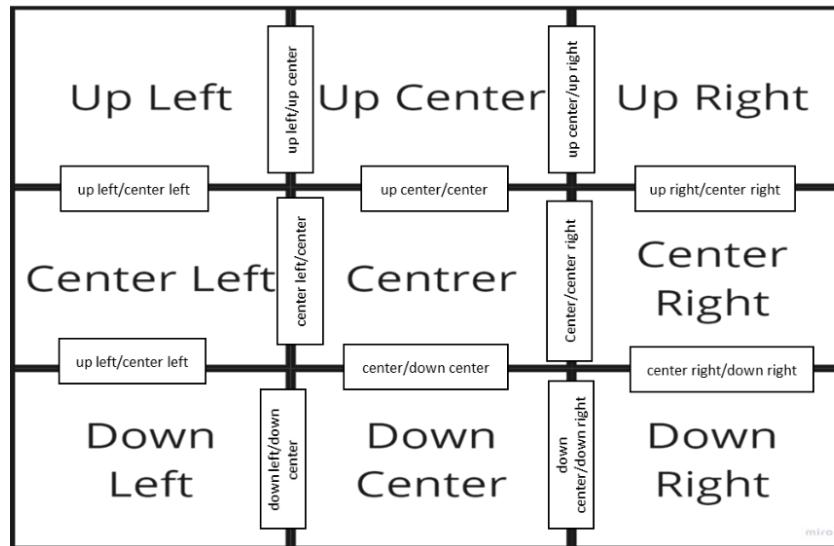


PHI roll angle

Horizon attitude category	Roll Range	Pitch Range
Level Horizon	$-1 \leq \text{ROLL} \leq 1$	$-1 \leq \text{PITCH} \leq 1$
Positively Tilted Level Horizon	$1 < \text{ROLL} \leq 90$	$-1 \leq \text{PITCH} \leq 1$
Negatively Tilted Level Horizon	$-90 \leq \text{ROLL} < -1$	$-1 \leq \text{PITCH} \leq 1$
Elevated Level Horizon	$-1 \leq \text{ROLL} \leq 1$	$1 < \text{PITCH} \leq 45$
Positively Tilted Elevated Horizon	$1 < \text{ROLL} \leq 90$	$1 < \text{PITCH} \leq 45$
Negatively Tilted Elevated Horizon	$-90 \leq \text{ROLL} < -1$	$1 < \text{PITCH} \leq 45$
Acute Angled Bird's Eye Ground View	$-90 \leq \text{ROLL} \leq 90$	$45 < \text{PITCH} \leq 80$
Bird's Eye Ground View	$-90 \leq \text{ROLL} \leq 90$	$80 < \text{PITCH} \leq 90$
Lowered Level Horizon	$-1 \leq \text{ROLL} \leq 1$	$-45 \leq \text{PITCH} < -1$
Positively Tilted Lowered Horizon	$1 < \text{ROLL} \leq 90$	$-45 \leq \text{PITCH} < -1$
Negatively Tilted Lowered Horizon	$-90 \leq \text{ROLL} < -1$	$-45 \leq \text{PITCH} < -1$
Acute Angled Rocket Sky View	$-90 \leq \text{ROLL} \leq 90$	$-80 \leq \text{PITCH} \leq -45$
Ascending Rocket Sky View	$-90 \leq \text{ROLL} \leq 90$	$-90 \leq \text{PITCH} \leq -80$

To reduce the risk of perception failure due to insufficient development dataset coverage, statistically sound samples should demonstrate the following training class coverage criteria:

down right	center right	up right
down center	center	up center
down left	center left	up left
up left/center left	center left/center	center/down center
up left/center left	down left/down center	up center/up right
up left/up center	up center/center	Center/center right
down center/down right	up right/center right	center right/down right



Definition of ALARP: TOI's positioning
Training classes to achieve ALARP
requirements

05/02/2025

AVOIDDS Training Sample Validation Process



4.jpg



10.jpg



21.jpg



22.jpg



33.jpg



34.jpg

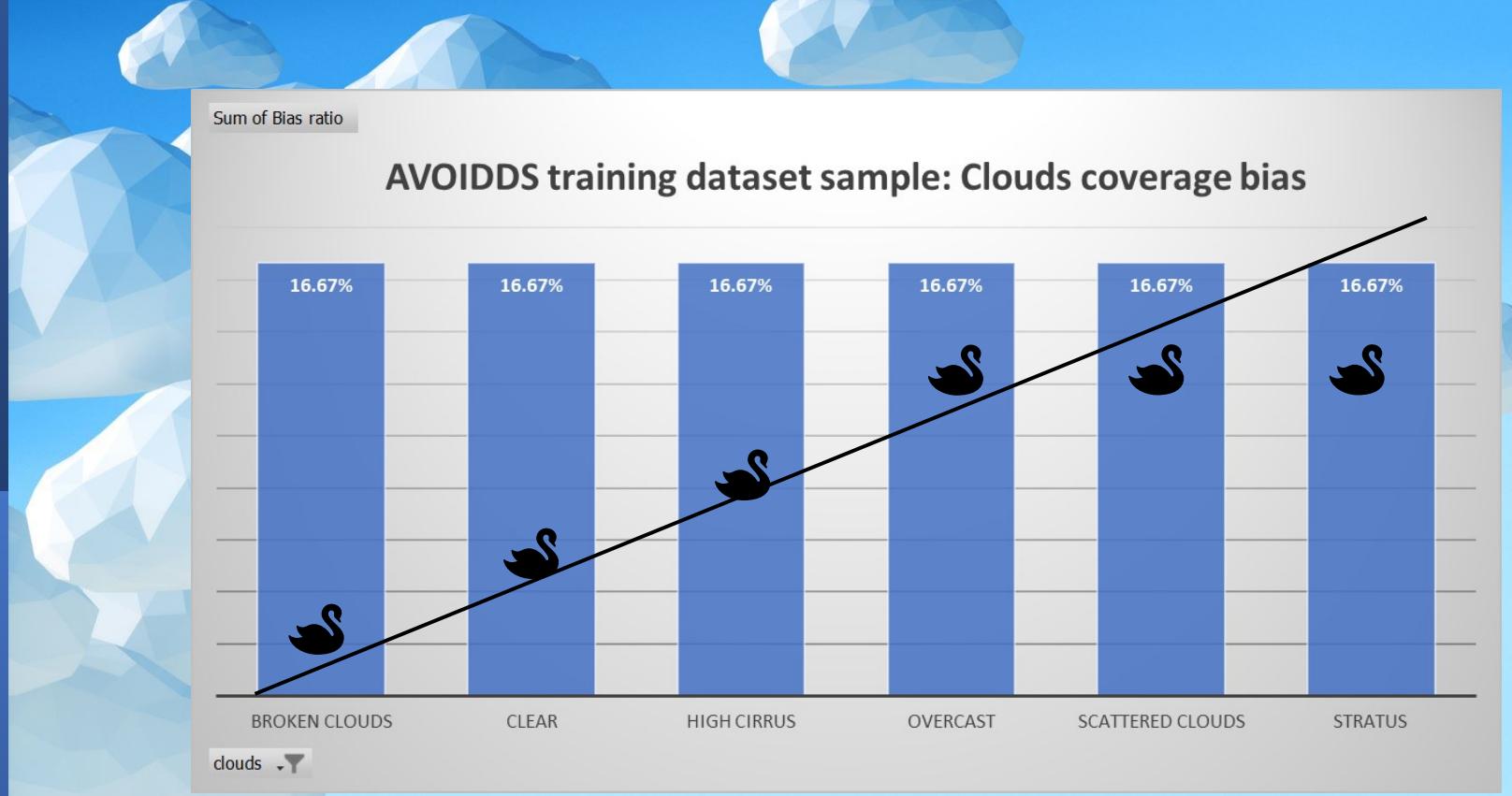


50.jpg



51.jpg

Examining AVOIDDS Training Strategy in Covering Clouds type

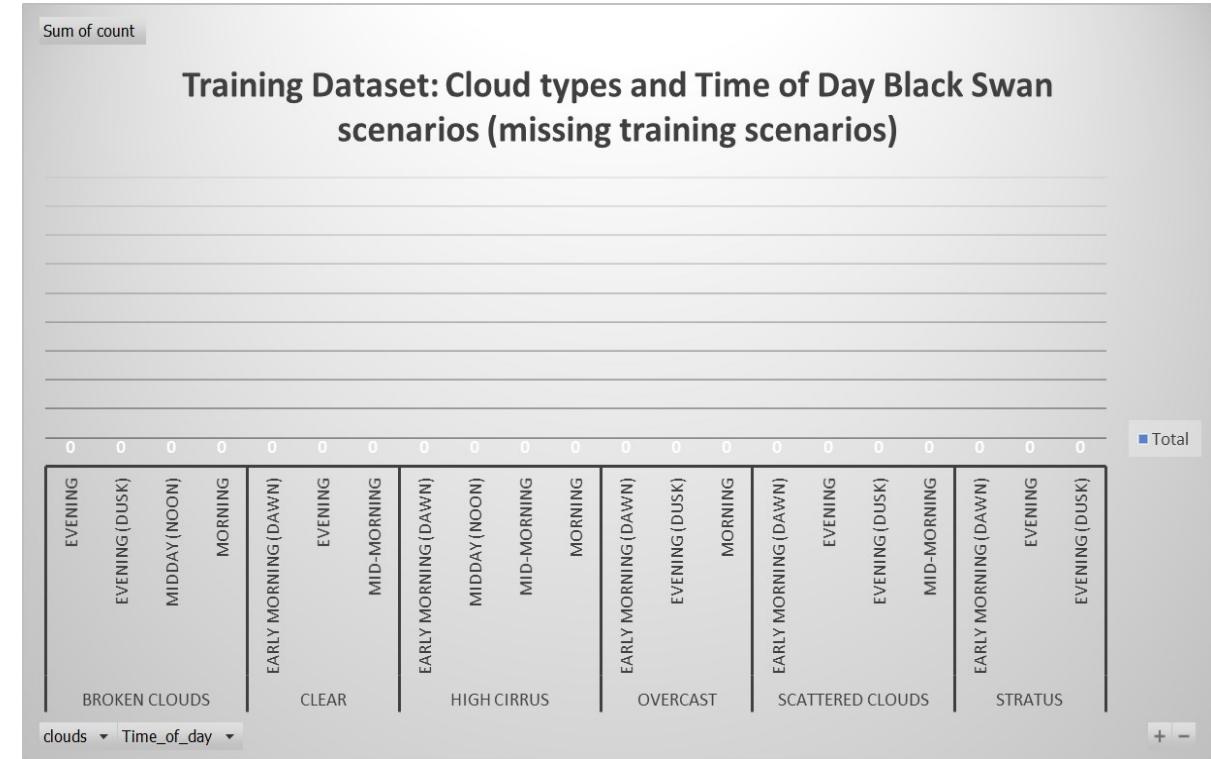
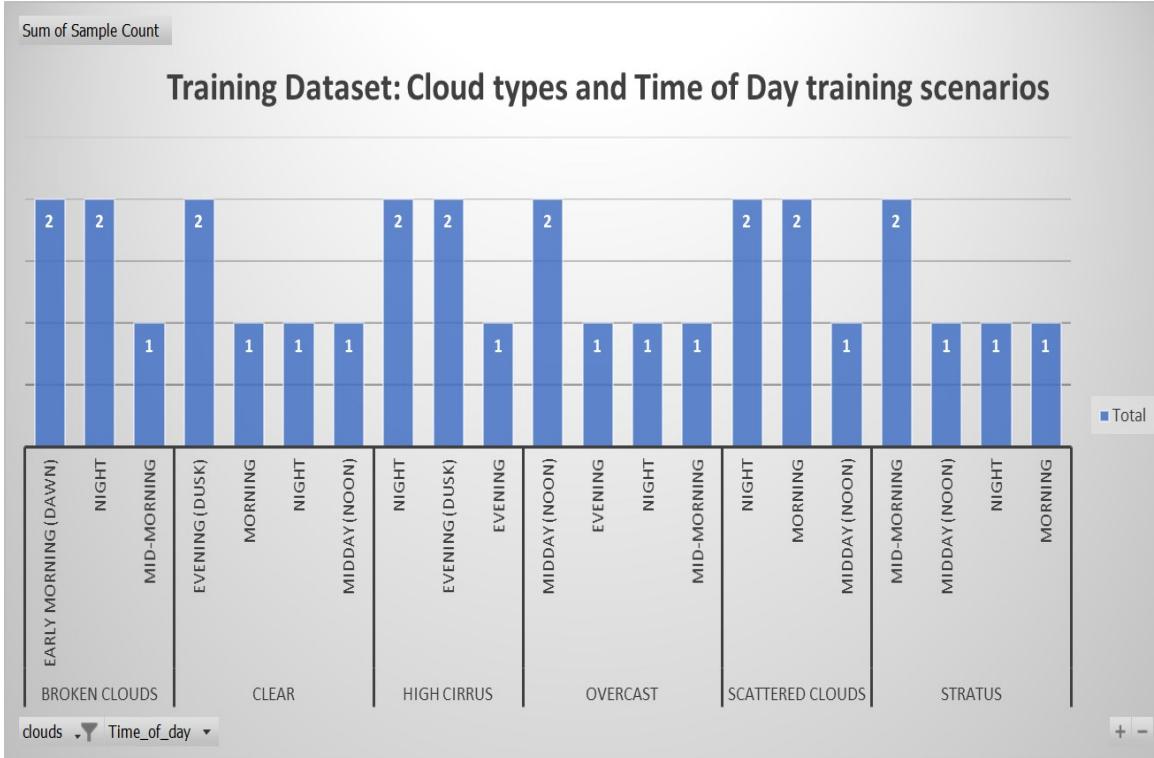


The cloud coverage appears to be balanced, suggesting that the perception system is exposed to equal experiences in each category of cloud type. The dataset satisfactorily meets the ALARP (As Low As Reasonably Practicable) requirement within cloud types coverage.

However, some instances in the training dataset do not represent the types of clouds specified; for example, high cirrus clouds need to be captured adequately, as the clouds in the sample images represent broken or scattered clouds. Furthermore, there is no evidence of bias in the analysis.

The balanced coverage suggests a uniform (equal) chance of handling emergent black swan events in each category. The datasets pass the ALARP requirement for dealing with black swan events.

Missing Training and Black Swan Scenarios

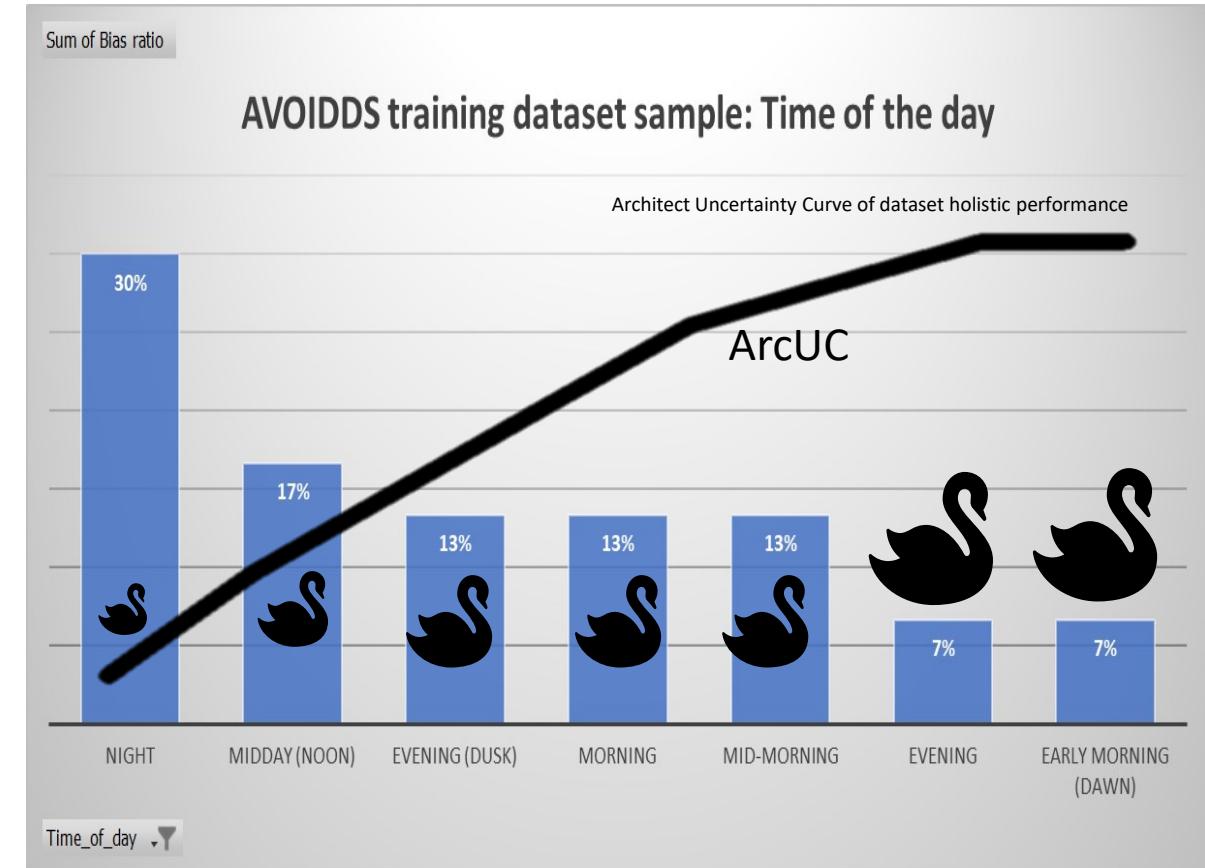


Examining AVOIDDS Training Strategy in Covering Time-of-Day Training Classes

There exists an imbalance in coverage, with 47% of instances recorded at night or at midday (noon), demonstrating strong bias.

The lack of balanced exposure constitutes a potential for an exponentially unpredictable high-risk emergent black swan behaviour the perception performs. The dataset does not satisfactorily meet the ALARP requirement.

This dataset does not pass the ALARP criteria for the coverage of times of day categories. The unbalanced coverage leads to hazardous uncertainty in the intelligent system's behaviour during Black Swan scenarios in a respective category.



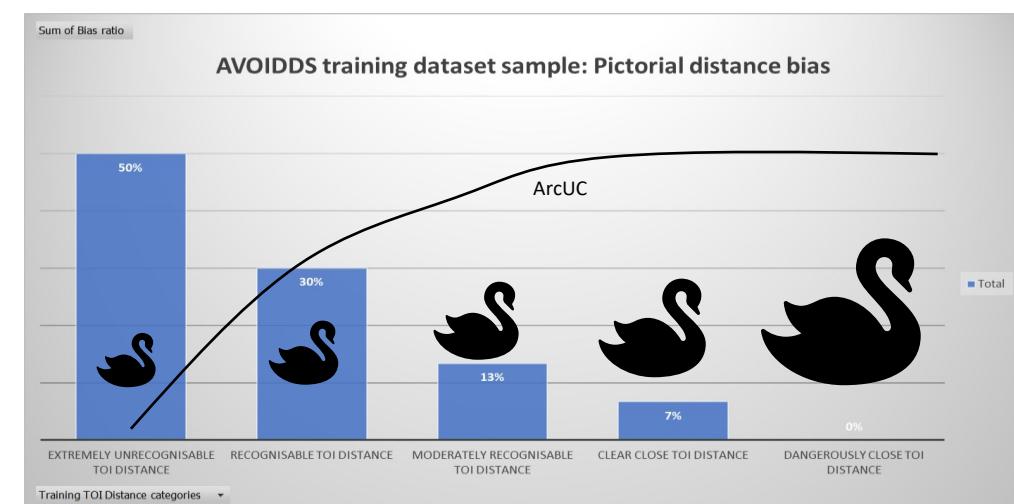
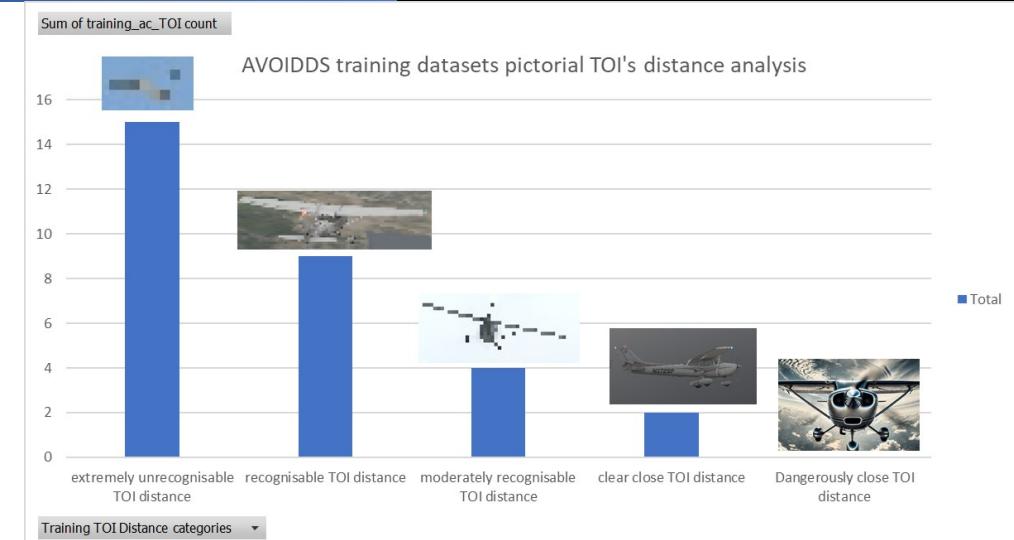
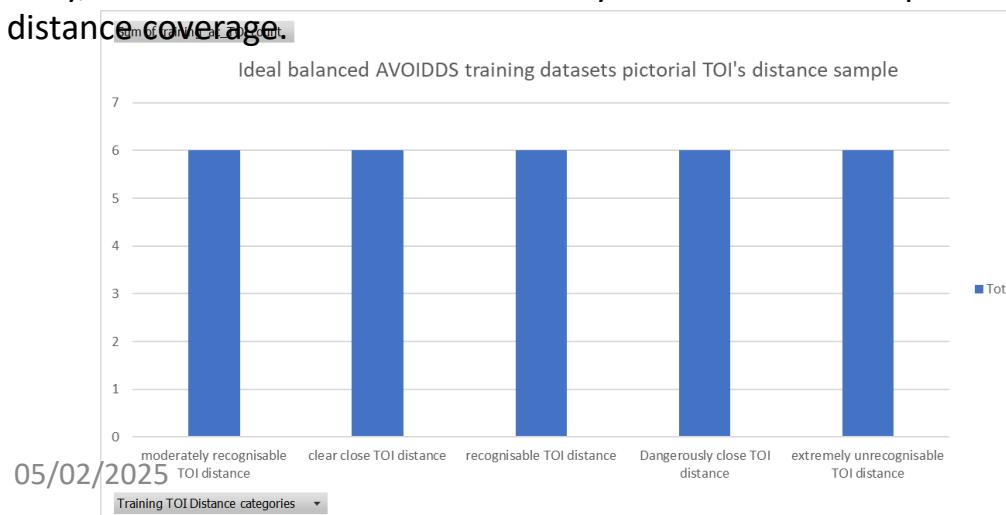
Examining AVOIDDS Training Strategy in Covering Pictorial Distance Training Classes:

The dataset exhibits significant imbalance, with 50% of instances in 20% of required coverage. Categorized as occurring at “extremely unrecognizable distance”. Notably, there is a complete absence of instances classified as :

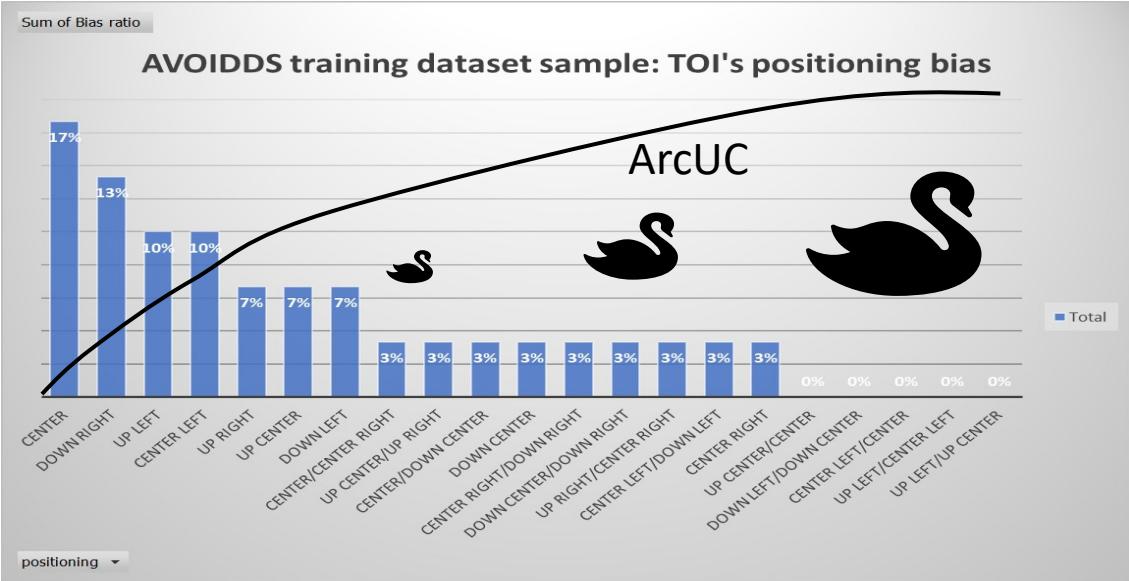
1. dangerously close distances

The lack of exposure constitutes a potential for an exponentially unpredictable high-risk emergent black swan behaviour performed by the perception. Unbalanced coverage leads to a hyperbolic uncertainty profile in the intelligent system's behaviour. [An example incident of a Mid-air collision due to a close but unnoticed approach.](#)

Consequently, the dataset does not satisfactorily fulfil the ALARP requirement for pictorial distance coverage.



Examining AVOIDDS Training Strategy in Covering TOI's Positioning Training Classes:

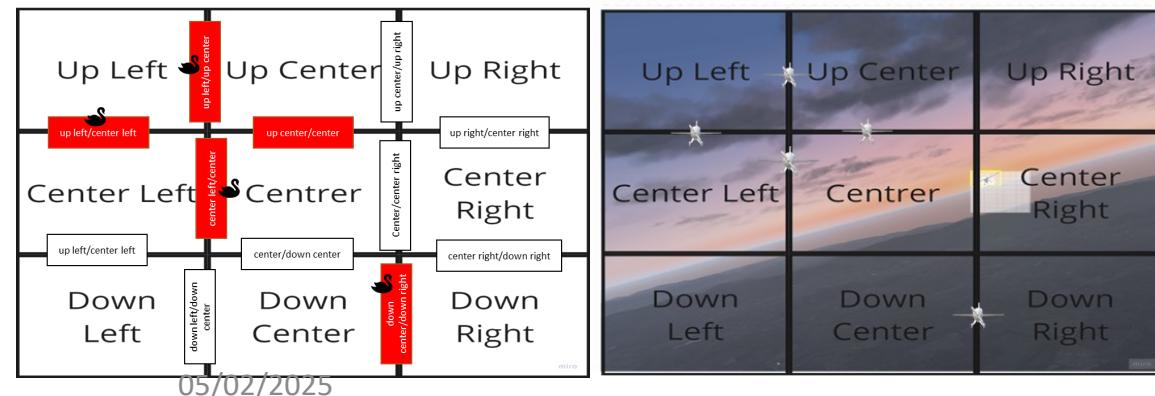


The dataset exhibits significant imbalance, with 60% of perception experiencing TOIs only 20% of the possible positioning quadrants. Notably, there is a complete absence experience in the following possible positions:

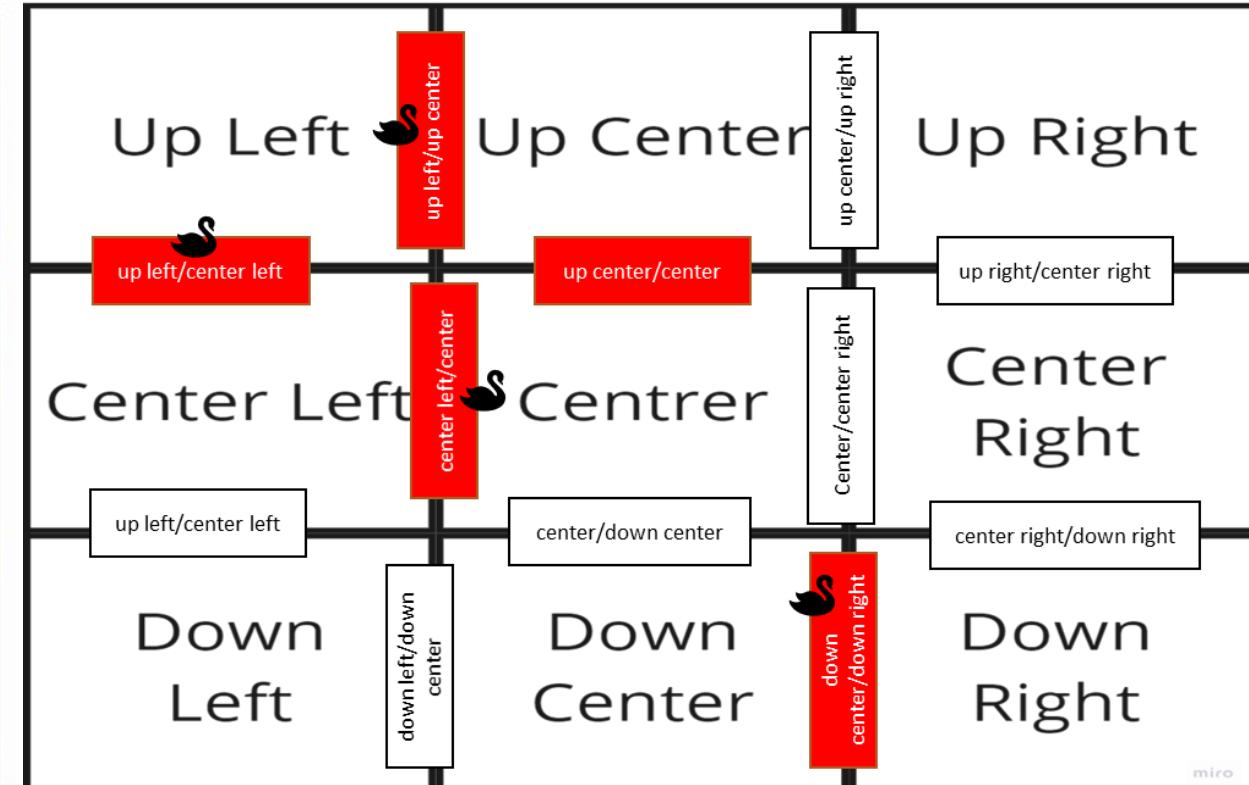
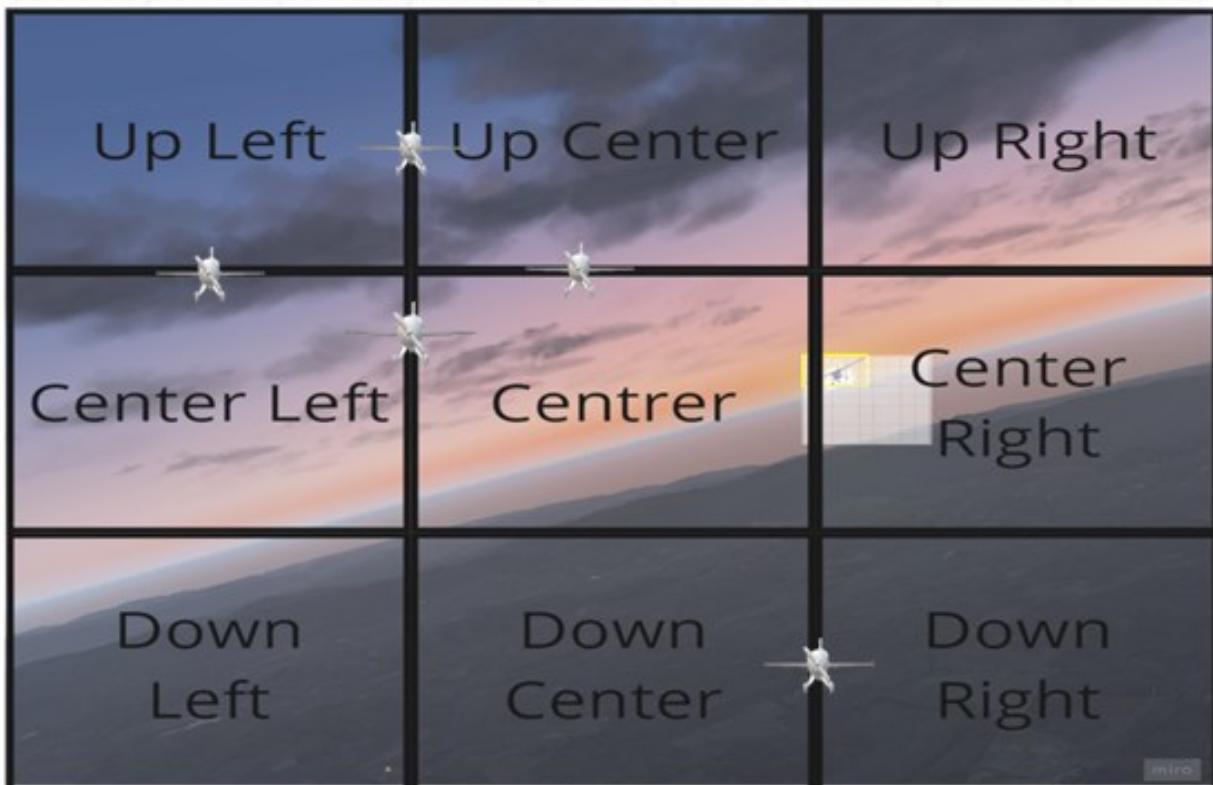
1. up center/center
2. up left/center left
3. center left/center
4. up left/up center
5. down left/down center

The lack of exposure constitutes a potential for an exponentially unpredictable high-risk emergent black swan behaviour performed by the perception.

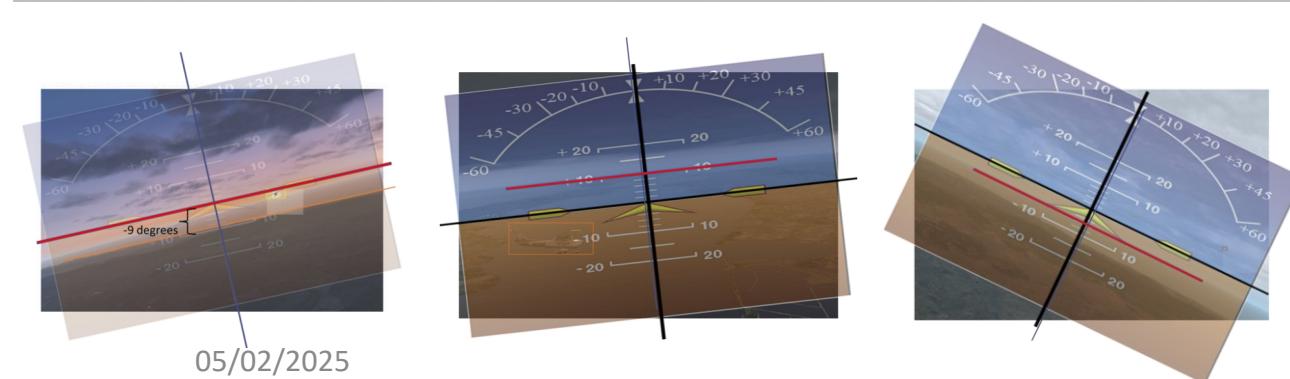
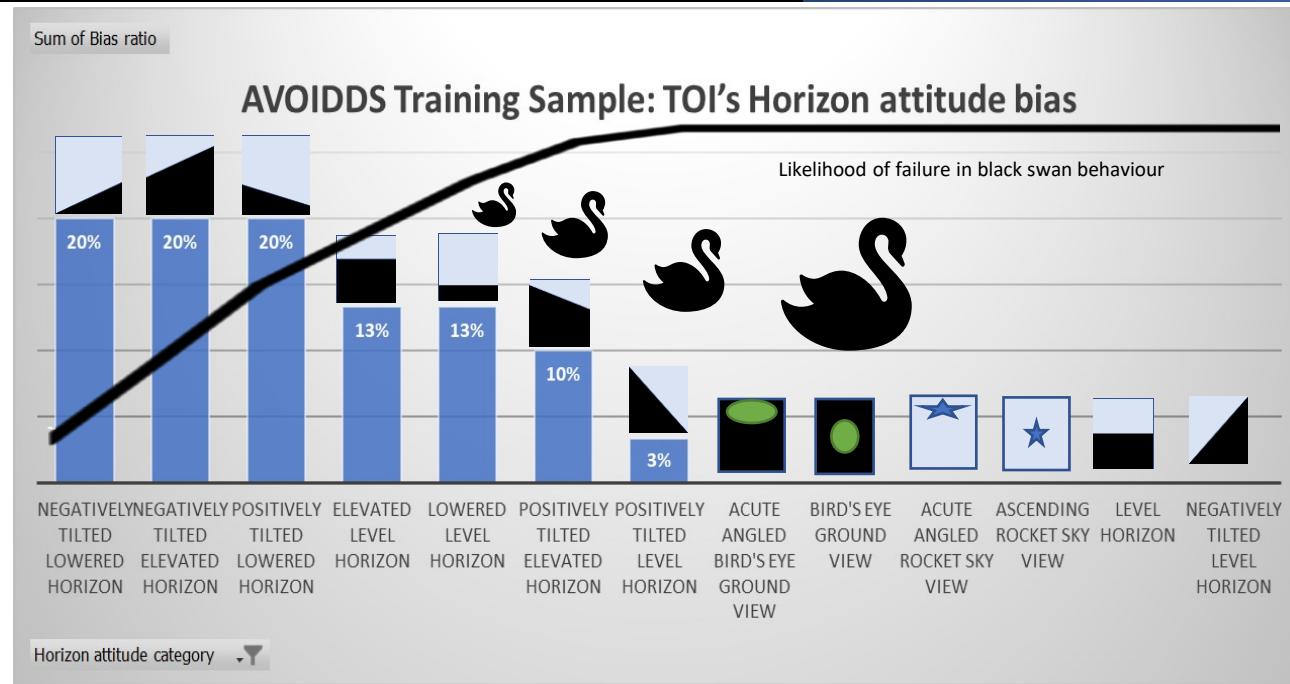
Consequently, the dataset does not satisfactorily fulfil the ALARP (As Low As Reasonably Practicable) requirement for TOI's positioning coverage.



Examining AVOIDDS Training Strategy in Covering TOI's Positioning Training Classes:



AVOIDDS Training Sample TOI's Horizon attitude analysis



The dataset exhibits significant imbalance, with 60% of perception experiencing TOIs in only 23% of the possible horizon attitudes. Notably, there is a complete absence of experience in the following possible horizon attitudes:

1. Level Horizon
2. Negatively Tilted Elevated Horizon
3. Acute Angled Bird's Eye Ground View
4. Bird's Eye Ground View
5. Ascending Rocket Sky View
6. Negatively Tilted level Horizon
7. Acute Angled Rocket Sky View

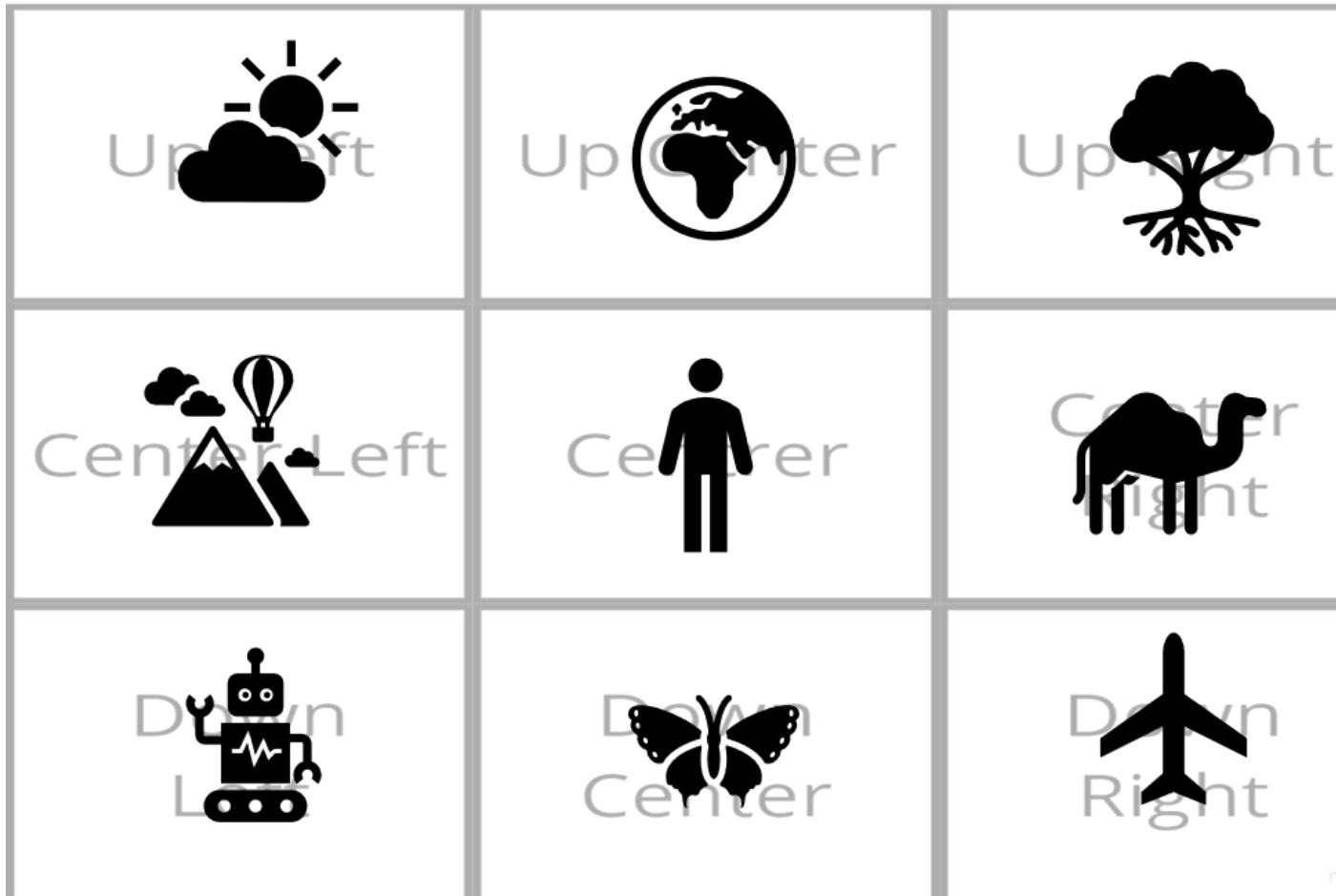
The lack of exposure constitutes a potential for an exponentially unpredictable high-risk emergent black swan behaviour performed by the perception.

Consequently, the dataset needs to satisfactorily fulfil the ALARP (As Low As Reasonably Practicable) requirement in terms of horizon attitude coverage.

CuneiForm Training Syllabus for AVOIDDS



CuneiForm Training Syllabus for AVOIDDS



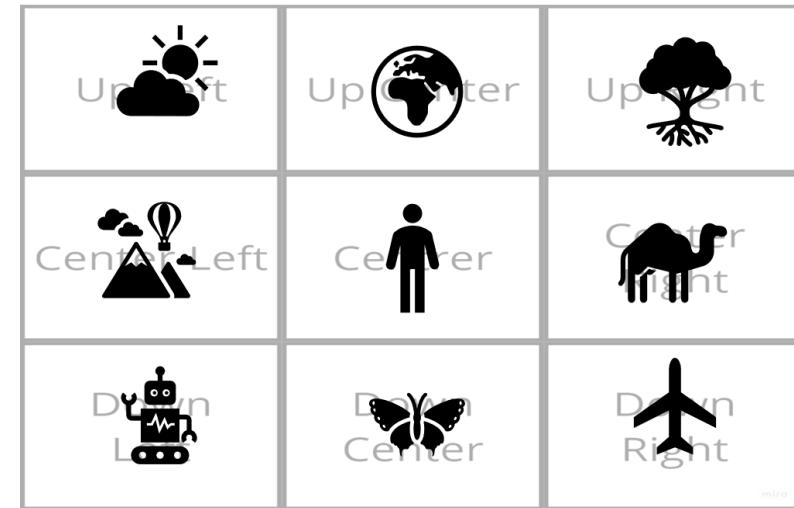
We retrospectively produced CuneiForms for the training to illustrate how the CuneiForm can be designed.

We grouped the training images according to Clouds type.

For determining the pictorial distances of TOIs, we used a Python script to compute the area of the bounding boxes relative to the area of an image.

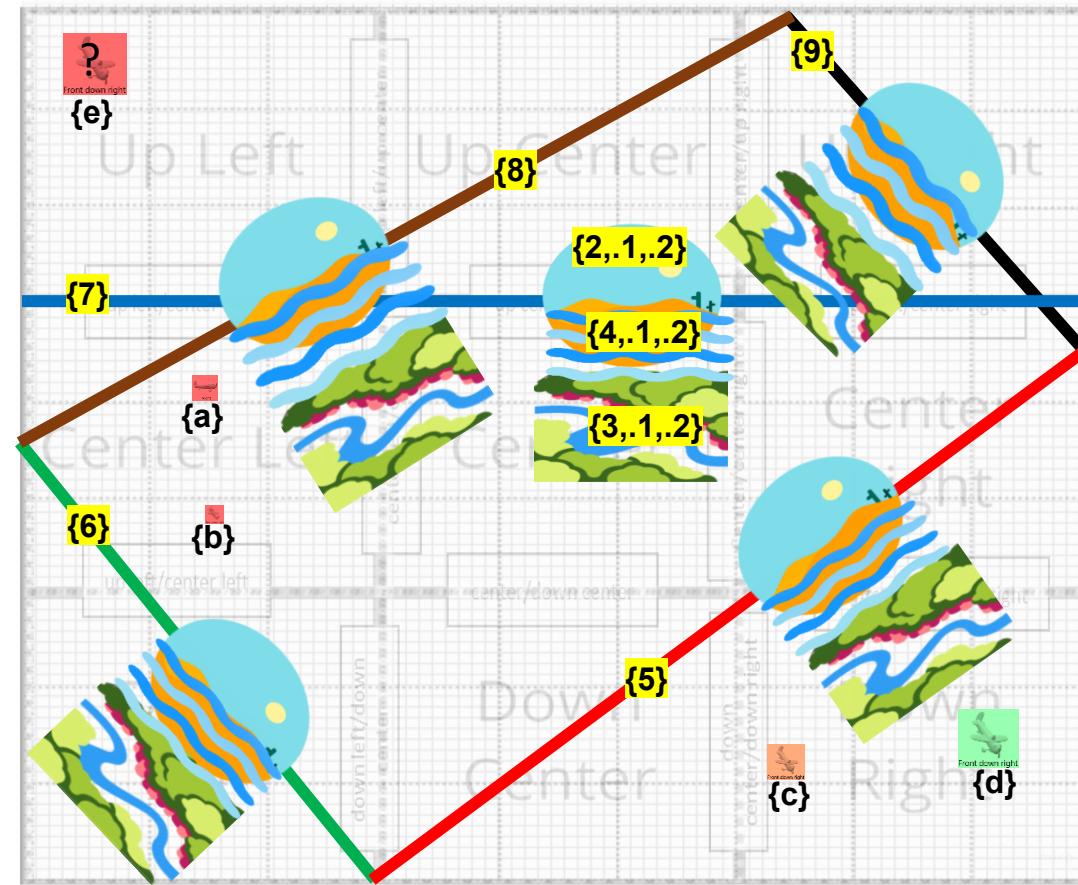
CuneiForm

Training Class 0



Abstract CuneiForm Characteristics (dimensions)	Abstract CuneiForm Characteristics definitions
TOIs definition and their aesthetic complexity	Single-engine propeller aeroplane {1}
TOI Motion and Dynamic optical states	Motion trajectory: Linear motion captured in consecutive images where the aeroplane appears to move in a straight line at a constant speed (no acceleration) {1.2}. Dynamic optical state: captured without optical blur {1.3}.
Background Objects associated with TOIs	Clear sky{2} green-terrain {3} water surface{4}
Background Objects Motion and Dynamic optical states	Motion trajectory: is static {2.1,3.1,4.1} Dynamic optical state: no motion blur{2.2,3.2,4.2}
Visible horizon attitude	Negatively Tilted Lowered Horizon{5} Positively Tilted Lowered Horizon{6} Elevated Level Horizon{7} Negatively Tilted Elevated Horizon{8} Positively Tilted Elevated Horizon{9}
TOI's Pictorial Positioning	up center{1.4} Down right{1.5} center left{1.6}
TOI's Pictorial Distance	recognisable TOI distance{1.8}, moderately recognisable TOI distance{1.9}, extremely unrecognisable TOI distance{1.10},
TOI's 3D Orientation	front down right{1.11} rear down right{1.12} right{1.13} Unknown{??}
05/02/2025	

CuneiForm Training Class 0



Instantiated Image
cessna_ac_training0
cessna_ac_training1
cessna_ac_training2
cessna_ac_training3
cessna_ac_training4

Time of Day
Evening (Dusk)
Midday (Noon)
Morning
Night

Training TOIs

{1,2,.3,.6,.10,.13}

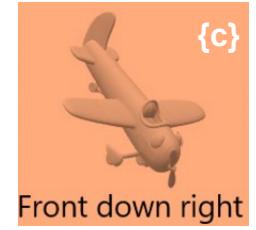


Right

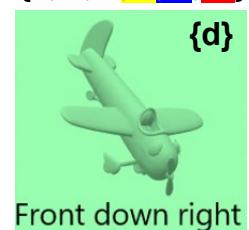


Rear down right

{1,2,.3,.5,.9,11}

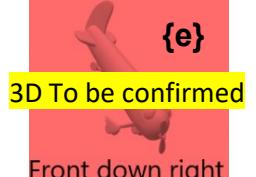


Front down right



Front down right

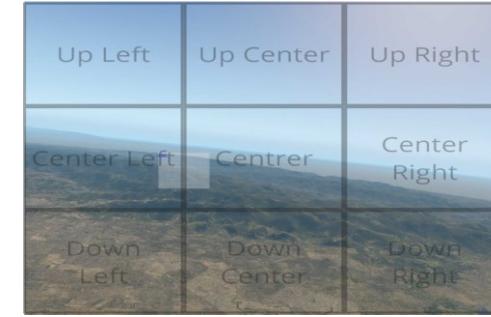
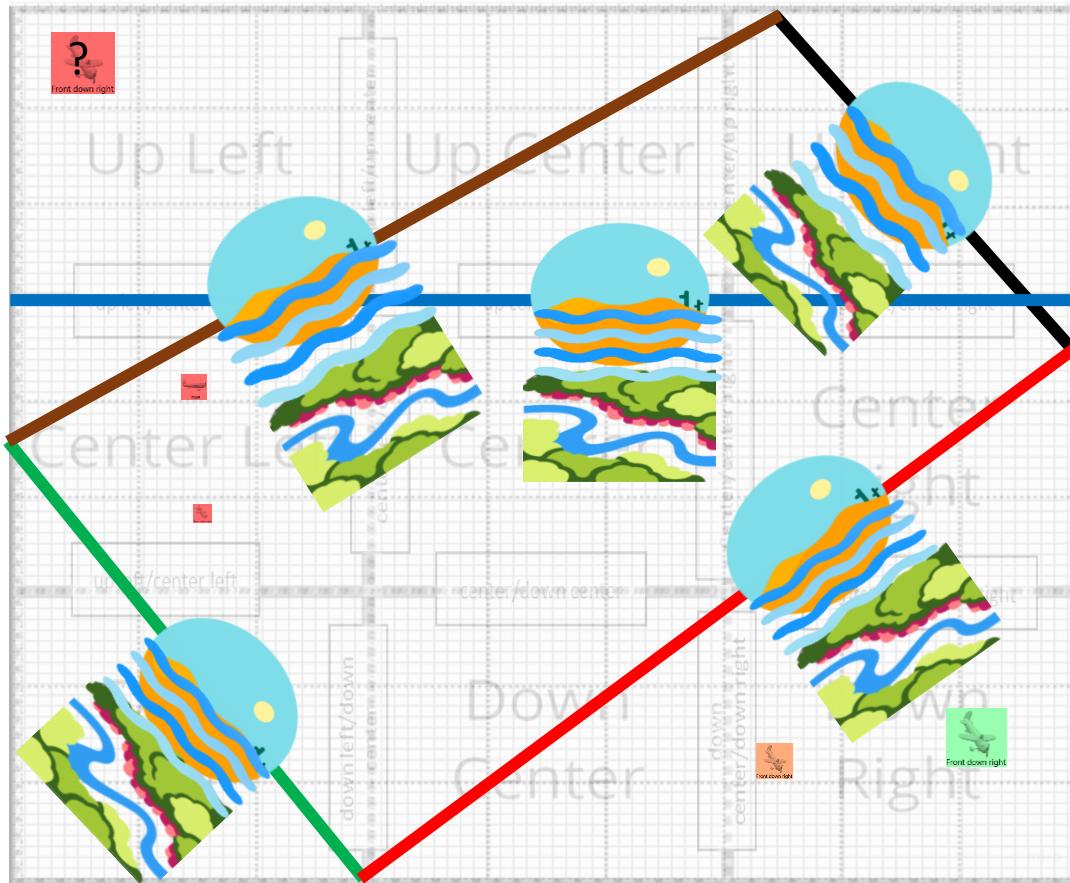
{1,2,.3,.5,10,?}



3D To be confirmed
Front down right

Note: yellow
Highlight on the cuneiForm
Only to help the number stand out

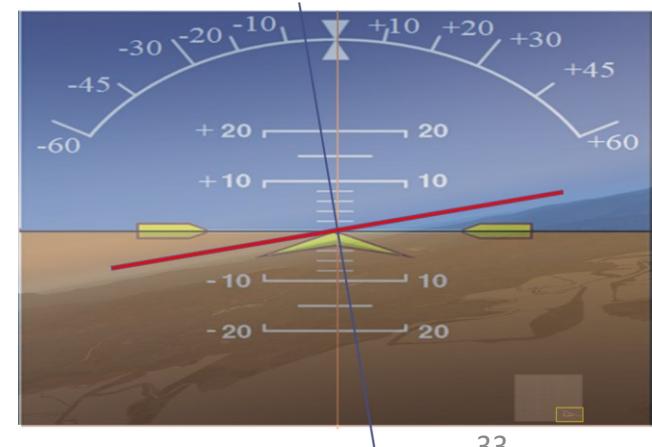
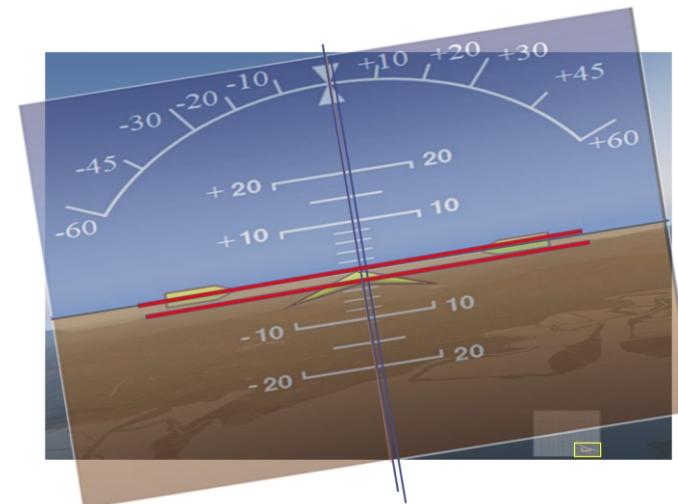
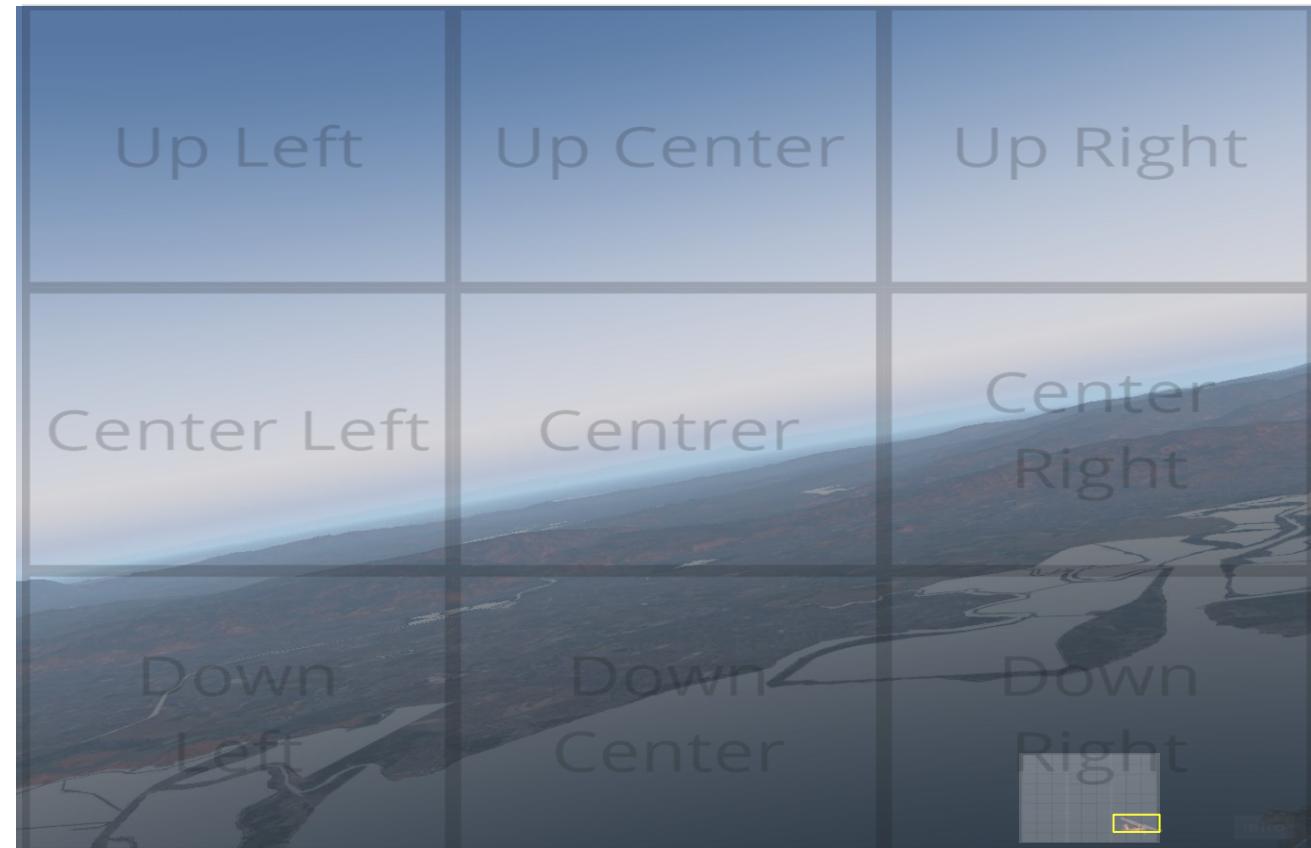
Cuneiform Training Class 0



0.jpg

ODD Dimension	Training class spec
Weather Conditions	clear
Time of Day	Evening (Dusk). 18:15:31

CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Extremely Unrecognisable TOI Distance (3455)
TOI's Pictorial positioning	Down right
TOI's 3D orientation	front down right
Horizon attitude	Roll: -5, Pitch: -2

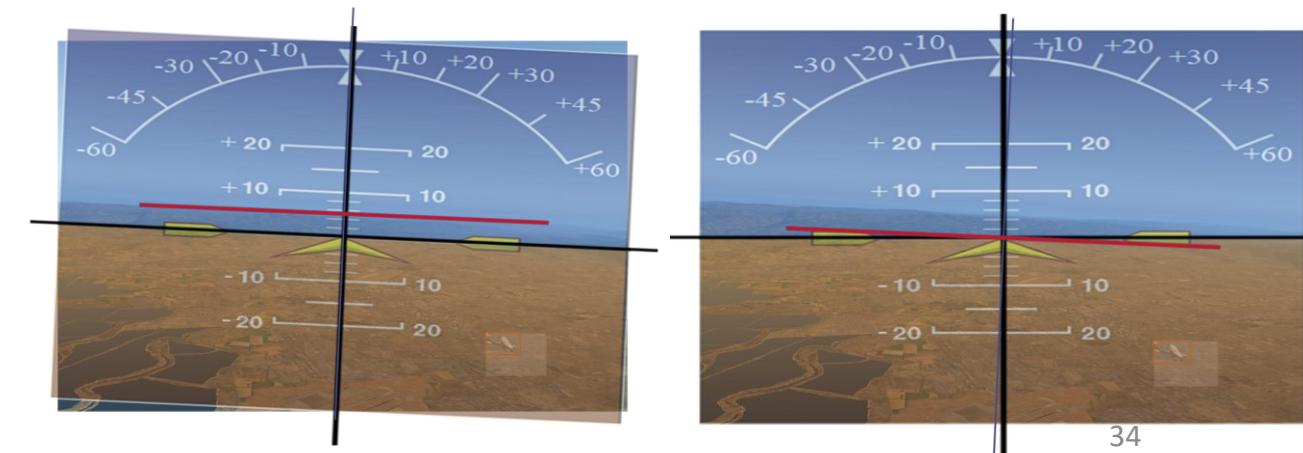


1.jpg

ODD Dimension	Training class spec
Weather Conditions	clear
Time of Day	late afternoon, 19:20:53
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Recognisable TOI Distance (639)
TOI's Pictorial positioning	down right
TOI's 3D orientation	front down right
Horizon attitude	Roll: 1, Pitch: 7



05/02/2025



2.jpg

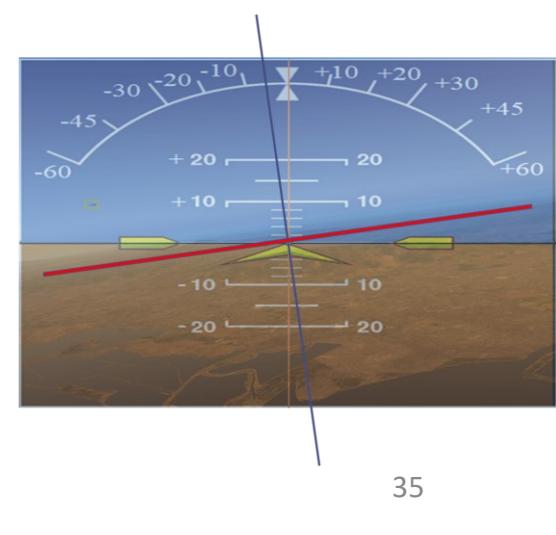
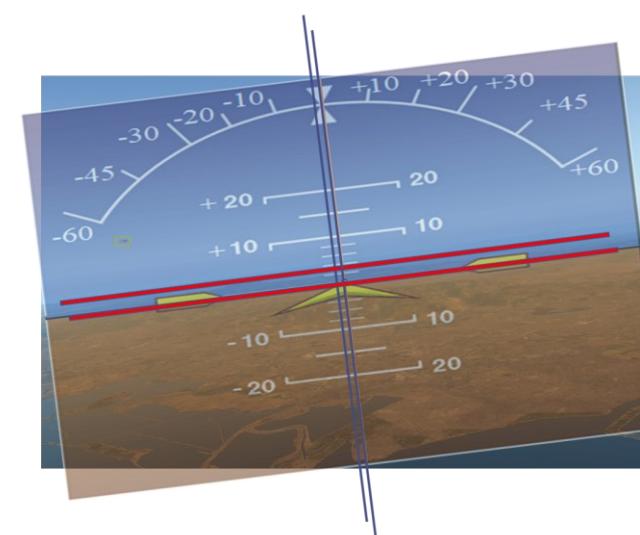
ODD Dimension	Training class spec
Weather Conditions	clear
Time of Day	Midday (Noon), 11:16:17
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Moderately Recognisable TOI Distance (1131)
TOI's Pictorial positioning	center left
TOI's 3D orientation	right
Horizon attitude	Roll: -5, Pitch: 3



Right



05/02/2025



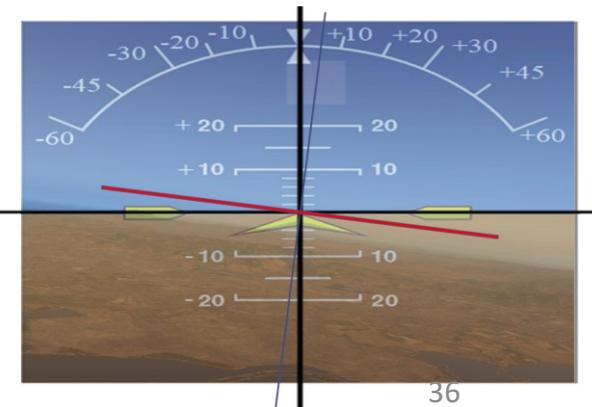
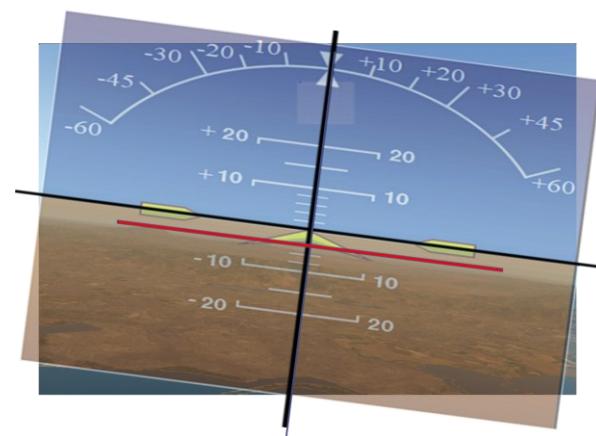
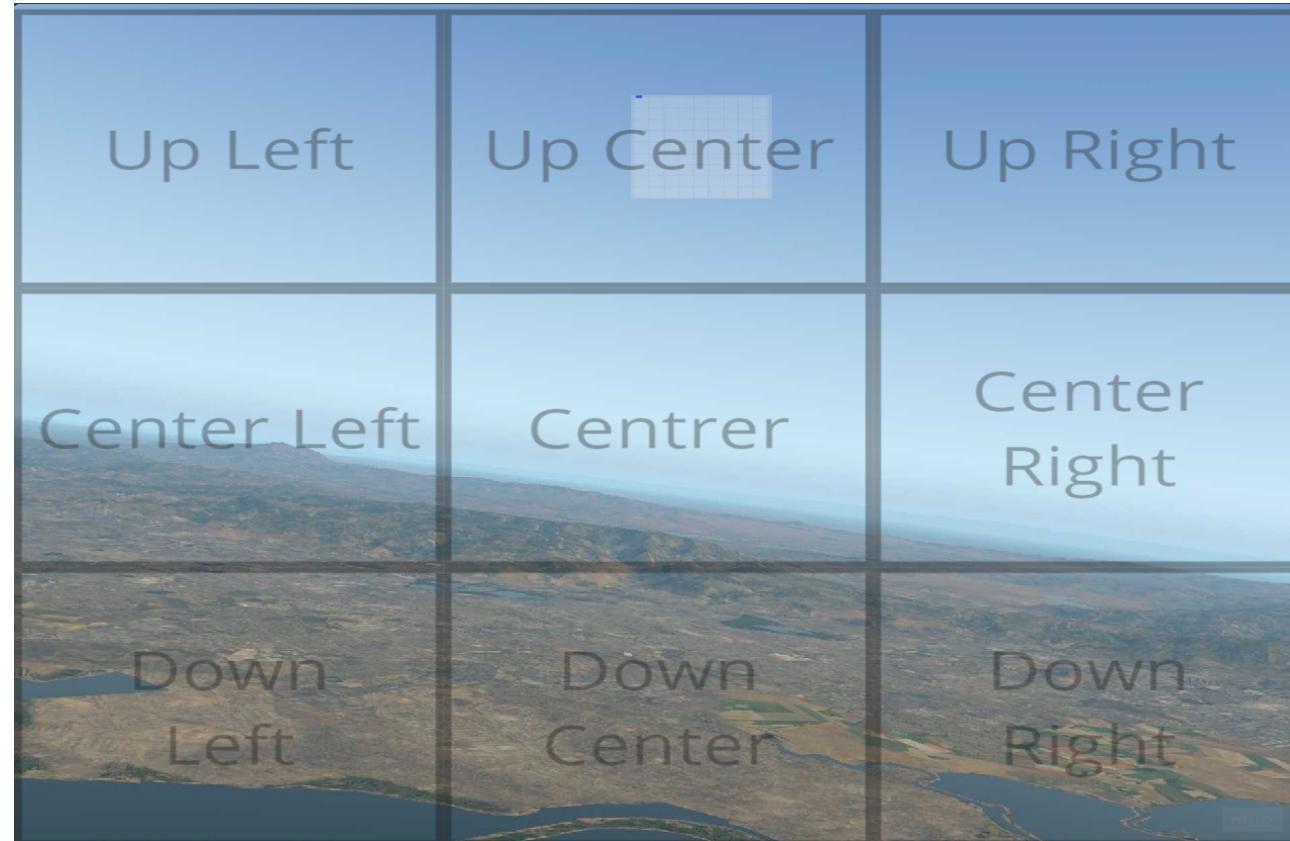
3.jpg

ODD Dimension	Training class spec
Weather Conditions	clear
Time of Day	morning, 08:29:51
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Extremely Unrecognisable TOI Distance (6897)
TOI's Pictorial positioning	up center
TOI's 3D orientation	Unknown
Horizon attitude	Roll: 5, Pitch: -4

?



05/02/2025



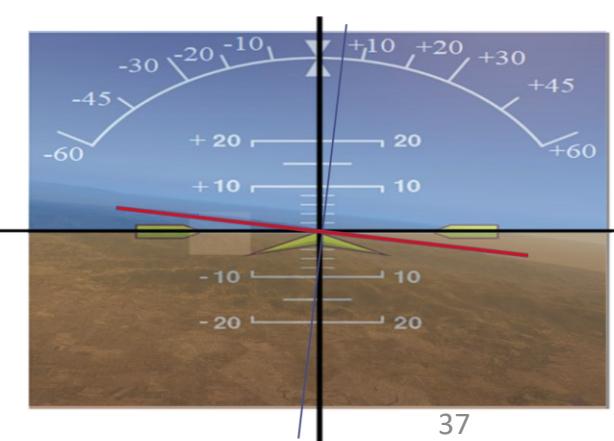
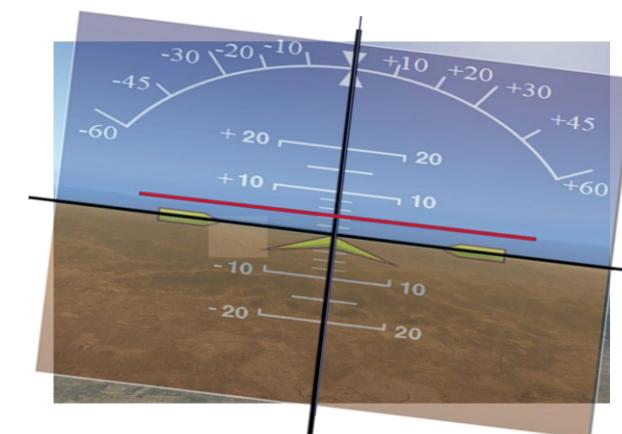
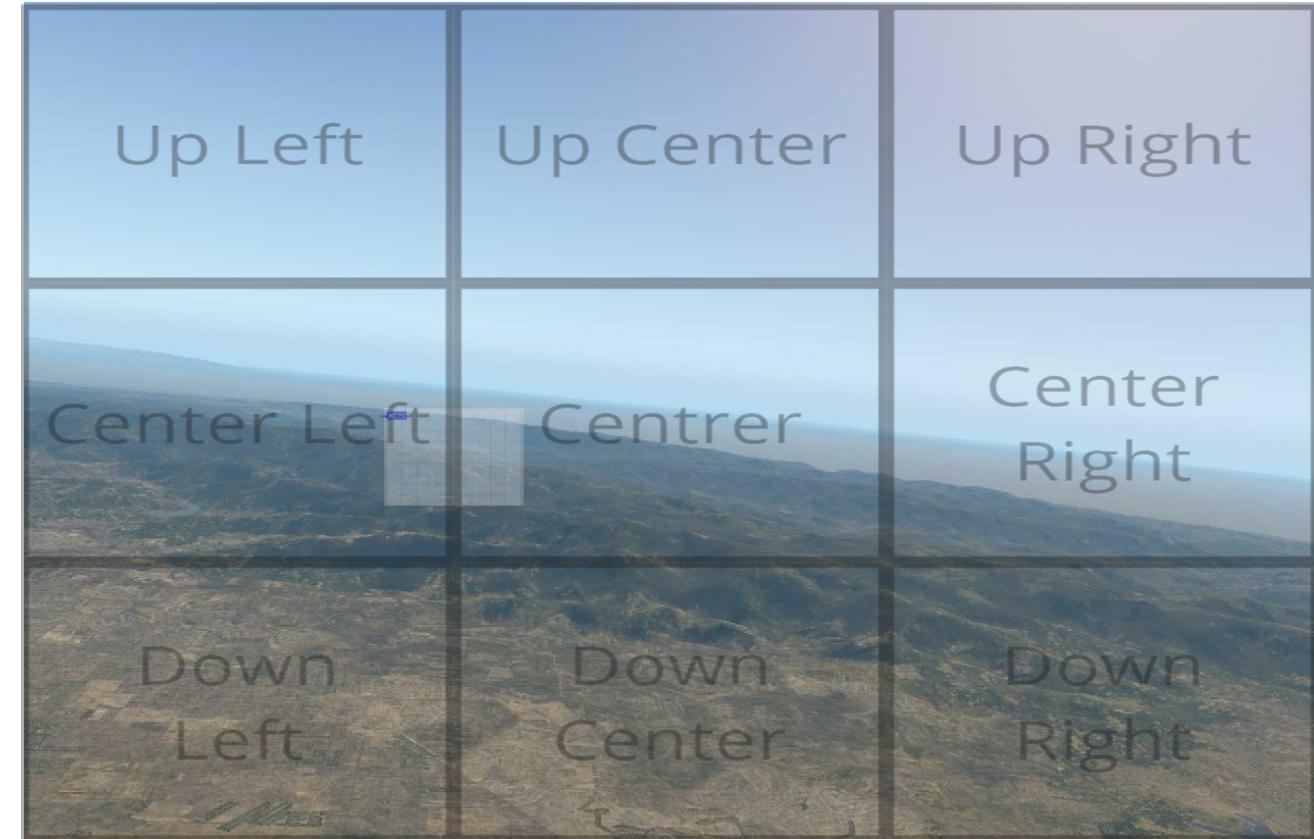
36

4.jpg

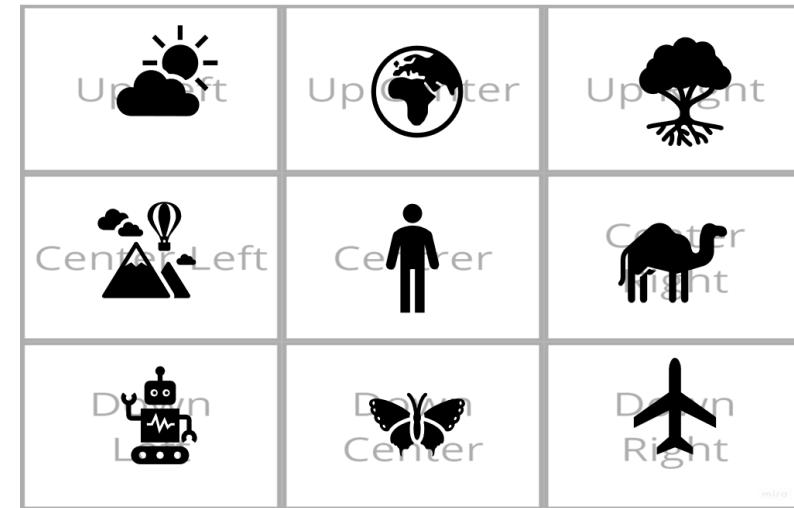
ODD Dimension	Training class spec
Weather Conditions	clear
Time of Day	Morning, 01:44:03
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Moderately Recognisable TOI Distance (868)
TOI's Pictorial positioning	center left
TOI's 3D orientation	rear down right
Horizon attitude	Roll: 5, Pitch: 4



05/02/2025

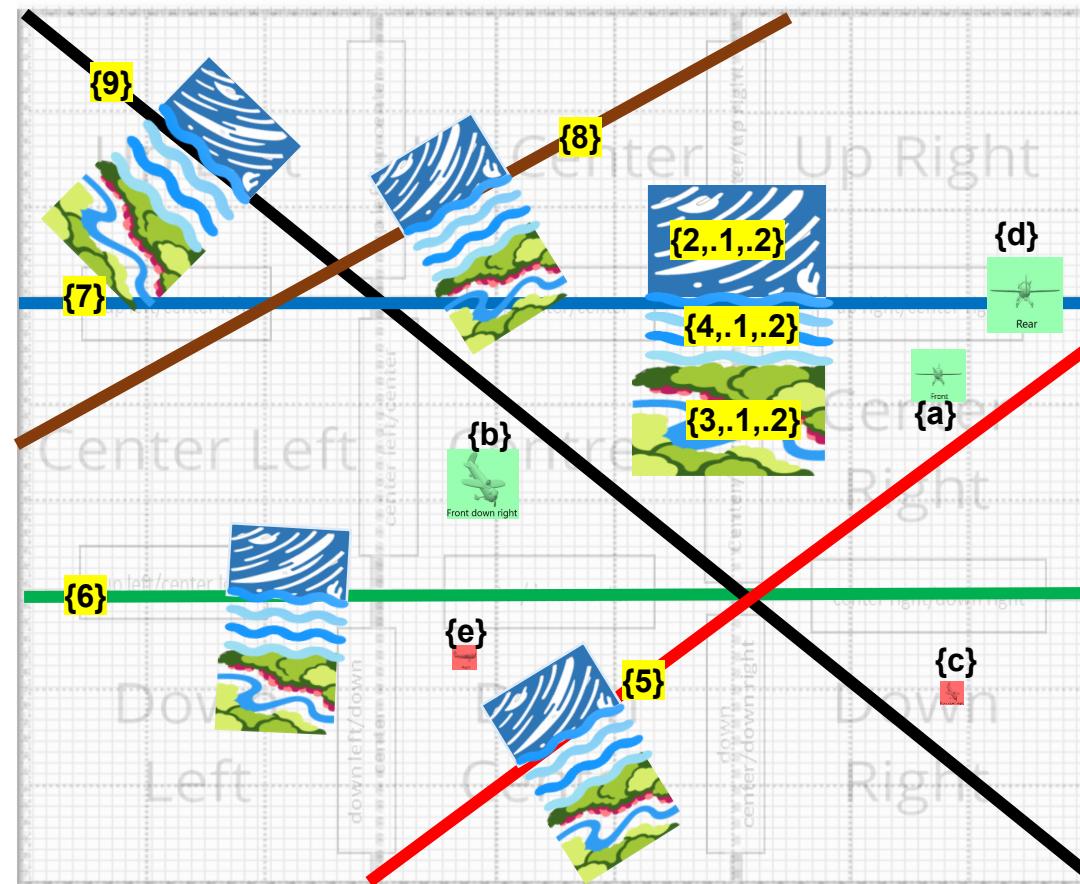


CuneiForm Training Class 1



Abstract CuneiForm Characteristics (dimensions)	Abstract CuneiForm Characteristics definitions
TOIs definition and their aesthetic complexity	Single-engine propeller aeroplane {1}
TOI Motion and Dynamic optical states	Motion trajectory: Linear motion captured in consecutive images where the aeroplane appears to move in a straight line at a constant speed (no acceleration) {1.2}. Dynamic optical state: captured without optical blur {1.3}.
Background Objects associated with TOIs	high cirrus clouds{2} green-terrain {3} water surface{4}
Background Objects Motion and Dynamic optical states	Motion trajectory: is static {2.1,3.1,4.1} Dynamic optical state: no motion blur{2.2,3.2,4.2}
Visible horizon attitude	Negatively Tilted Lowered Horizon{5} Lowered Level Horizon{6} Elevated Level Horizon{7} Negatively Tilted Elevated Horizon{8} Positively Tilted Level Horizon{9}
TOI's Pictorial Positioning	Center{1.4} center right{1.5} center right/down right{1.6} down center{1.7} up right/center right{1.8}
TOI's Pictorial Distance	recognisable TOI distance{1.9}, extremely unrecognisable TOI distance{1.10},
TOI's 3D Orientation	Front{1.11} front down right{1.12} rear{1.13} right{1.14}
05/02/2015	

CuneiForm Training Class 1



Instantiated Image
cessna_ac_training10
cessna_ac_training11
cessna_ac_training12
cessna_ac_training13
cessna_ac_training14

Time of Day
Evening (Dusk)
Midday (Noon)
Morning
Night



Training TOIs

{1,2,.3,.5,.9,.11}



{1,.2,.3,.4,.9,.12}



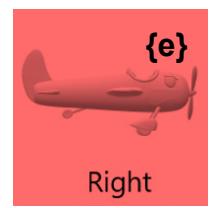
{1,2,.3,.6,.10,.12}



{1,.2,.3,.8,.9,.13}

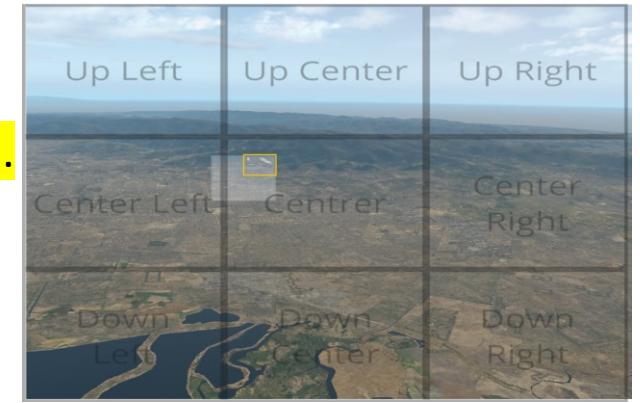
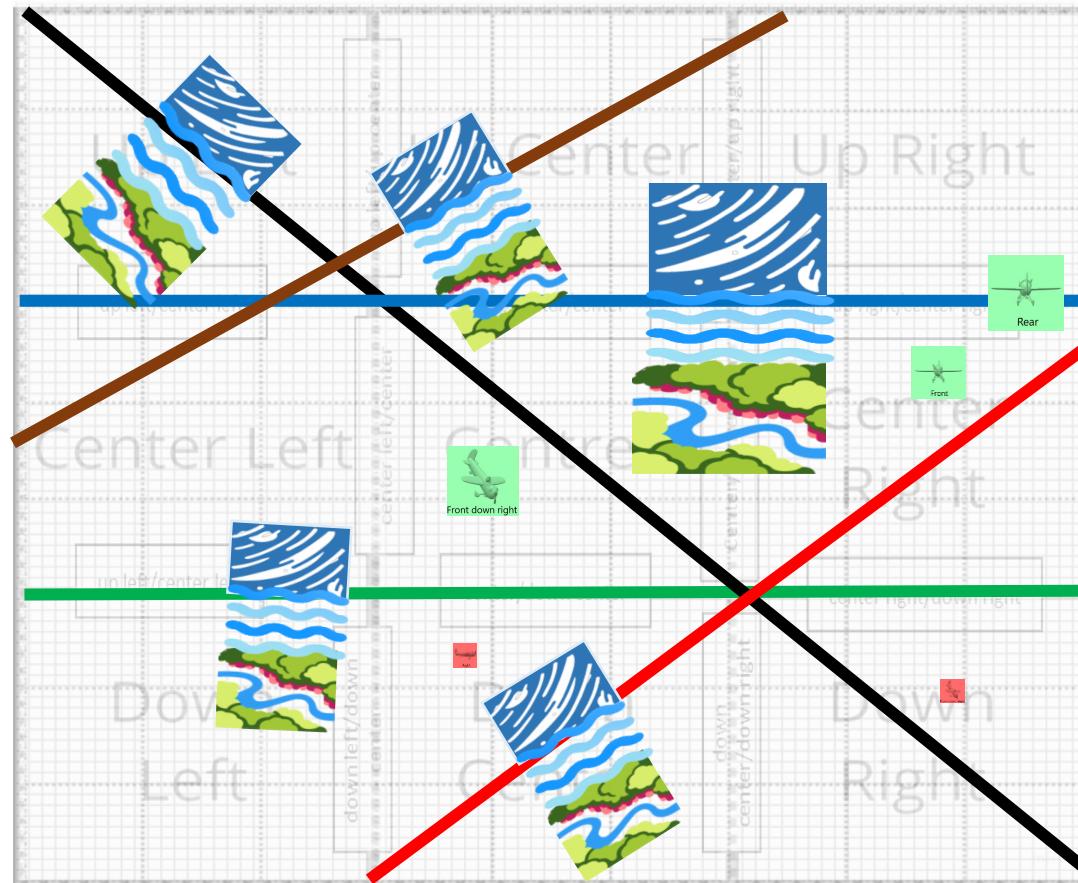


{1,2,.3,.7,.10,.14}



Cuneiform Training Class 1

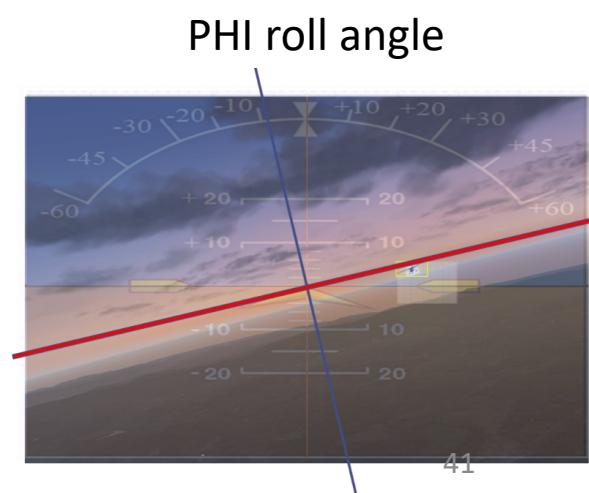
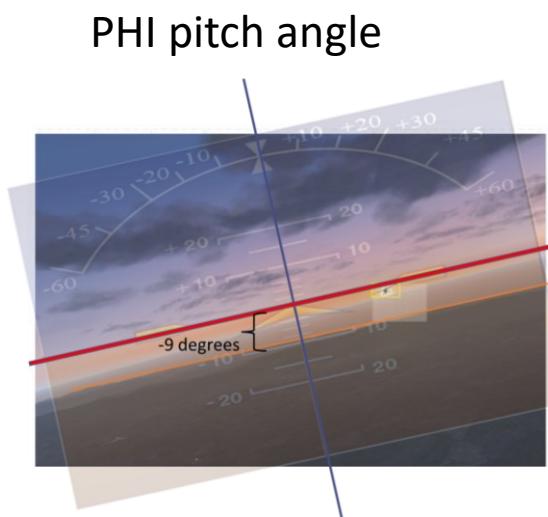
The clouds in AVOIDS training do not validate the cuneiform.



AVOIDDS Sample Training:

10.jpg

ODD Dimension	Training class spec
Weather Conditions	high cirrus
Time of Day	Evening (Dusk) 18:11:31
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Moderately Recognisable TOI Distance (1352)
TOI's Pictorial positioning	center right
TOI's 3D orientation	Front
Horizon attitude	Roll: -10, Pitch: -9

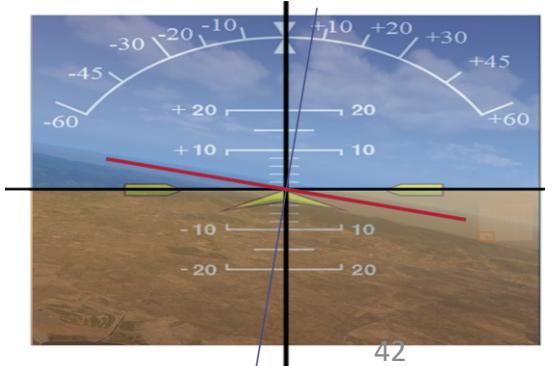
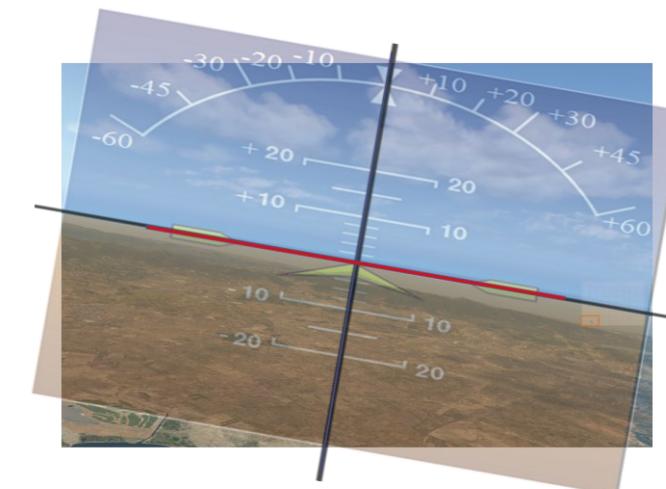
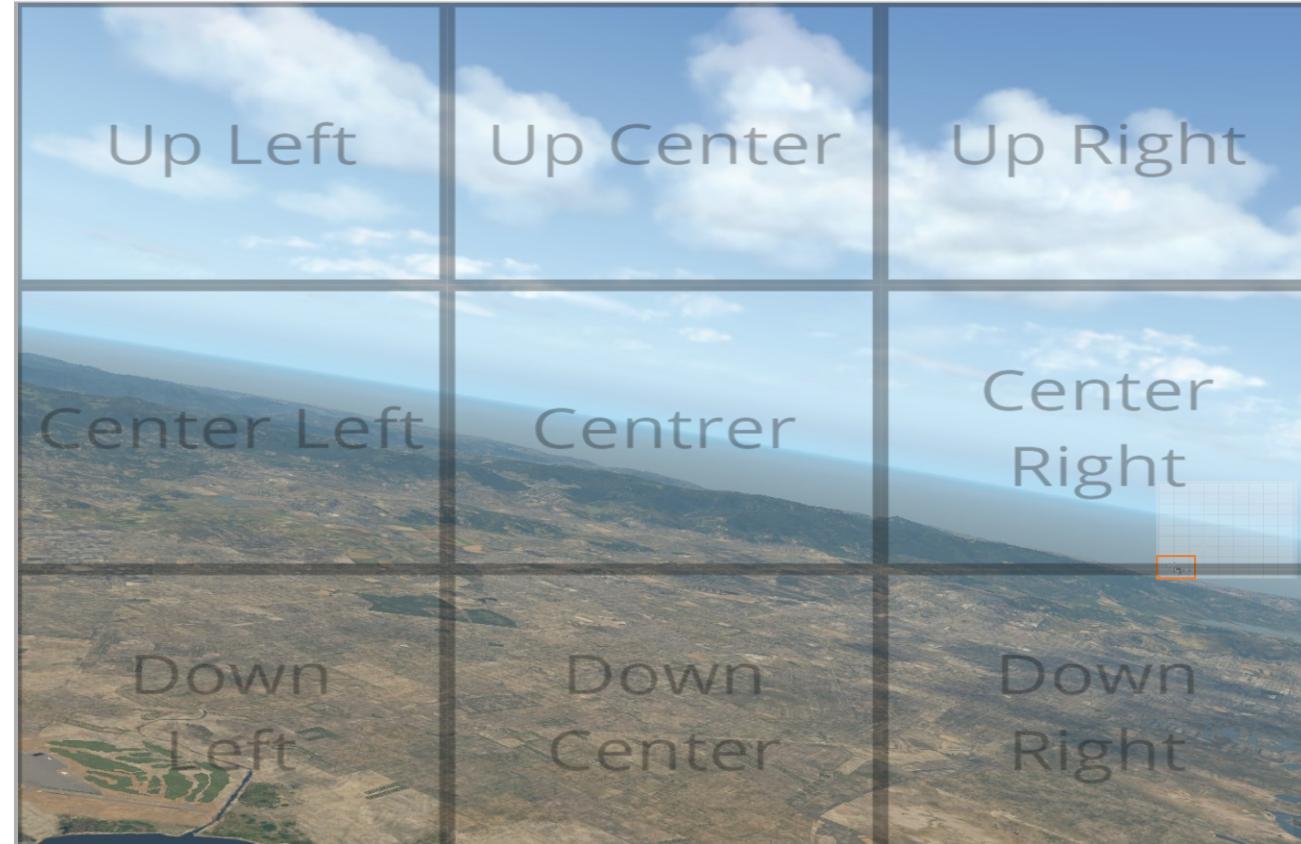


11.jpg

ODD Dimension	Training class spec
Weather Conditions	high cirrus
Time of Day	morning, 03:58:23
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Recognisable TOI Distance (694)
TOI's Pictorial positioning	center right/down right
TOI's 3D orientation	front down right
Horizon attitude	Roll: 5, Pitch: 0



Front down right
05/02/2025

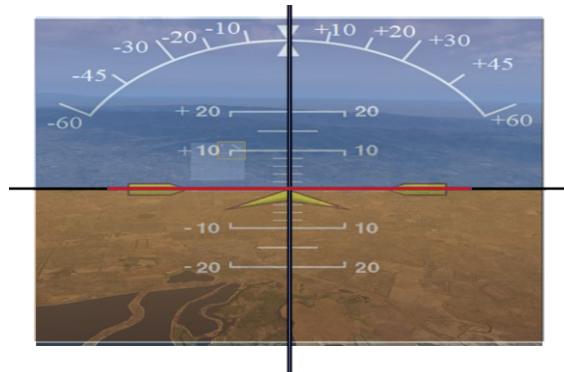
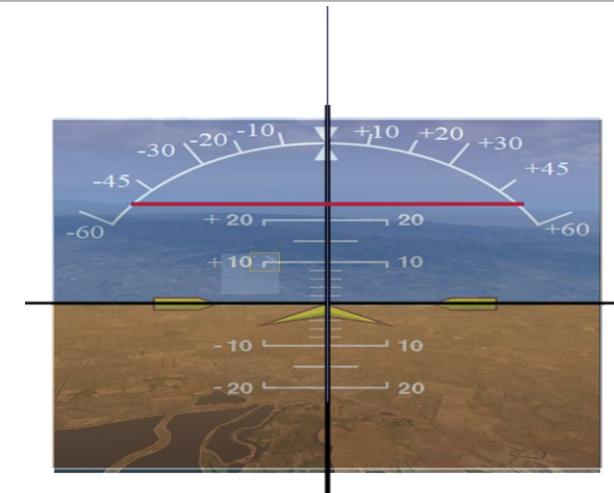


12.jpg

ODD Dimension	Training class spec
Weather Conditions	high cirrus
Time of Day	late afternoon
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Extremely Unrecognisable TOI Distance (7515)
TOI's Pictorial positioning	center
TOI's 3D orientation	front down right
Horizon attitude	Roll: 0, Pitch: 25



05/02/2025



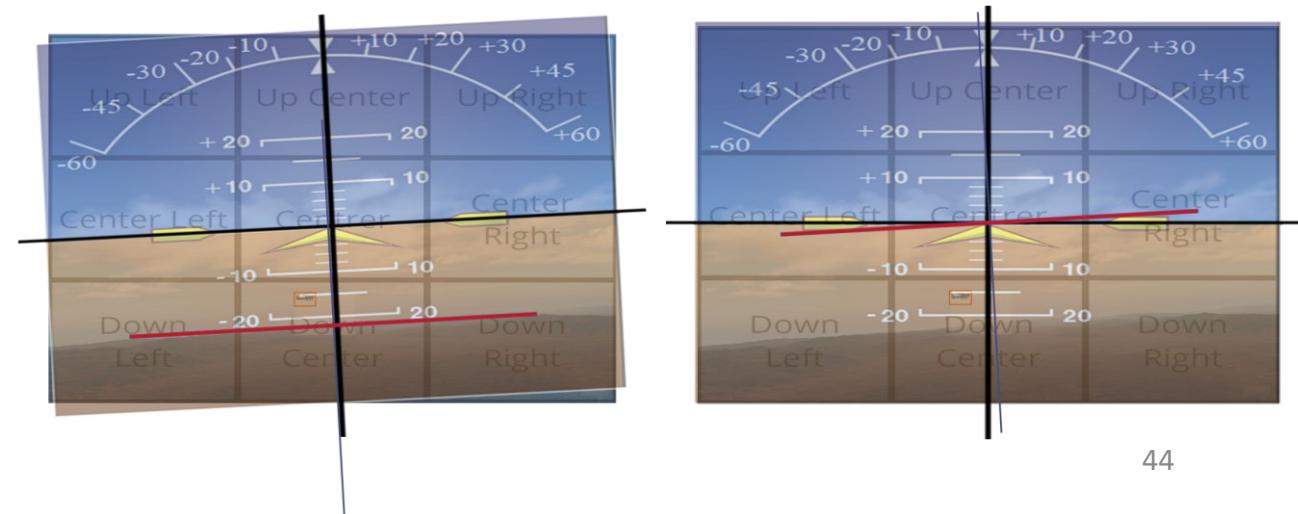
43

13.jpg

ODD Dimension	Training class spec
Weather Conditions	high cirrus
Time of Day	afternoon,
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Extremely Unrecognisable TOI Distance (13949)
TOI's Pictorial positioning	down center
TOI's 3D orientation	right
Horizon attitude	Roll: -1, Pitch: -22



Right

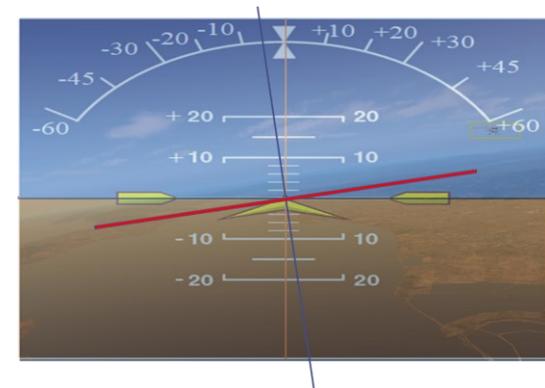
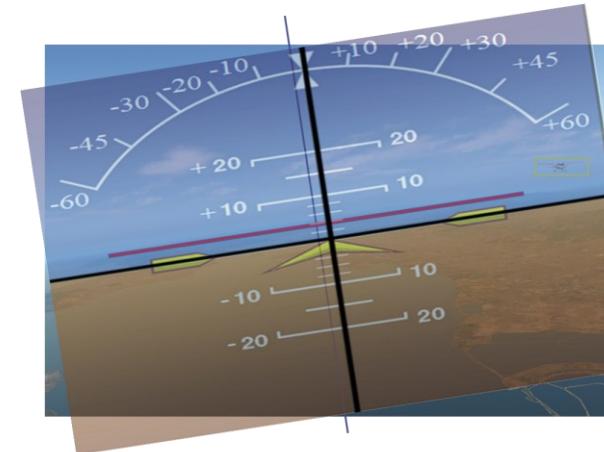


14.jpg

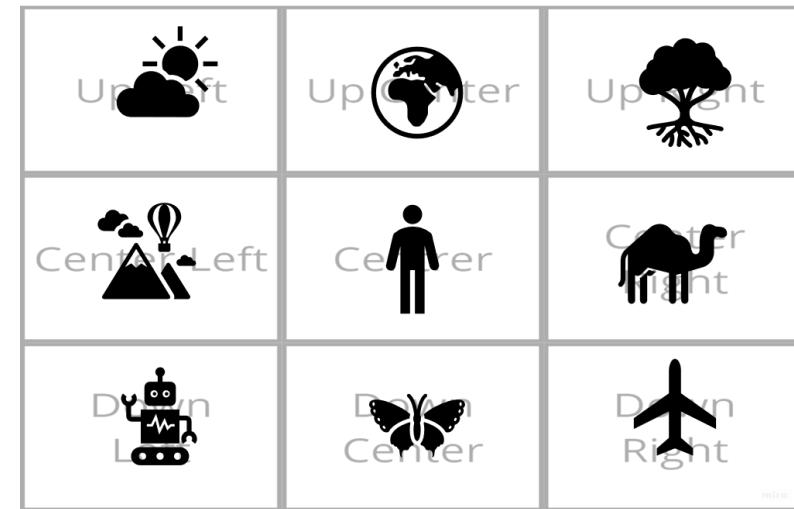
ODD Dimension	Training class spec
Weather Conditions	high cirrus
Time of Day	Evening (Dusk), 19:42:11
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Extremely Unrecognisable TOI Distance (13811)
TOI's Pictorial positioning	up right/center right
TOI's 3D orientation	rear
Horizon attitude	Roll: -5, Pitch: 4



Rear

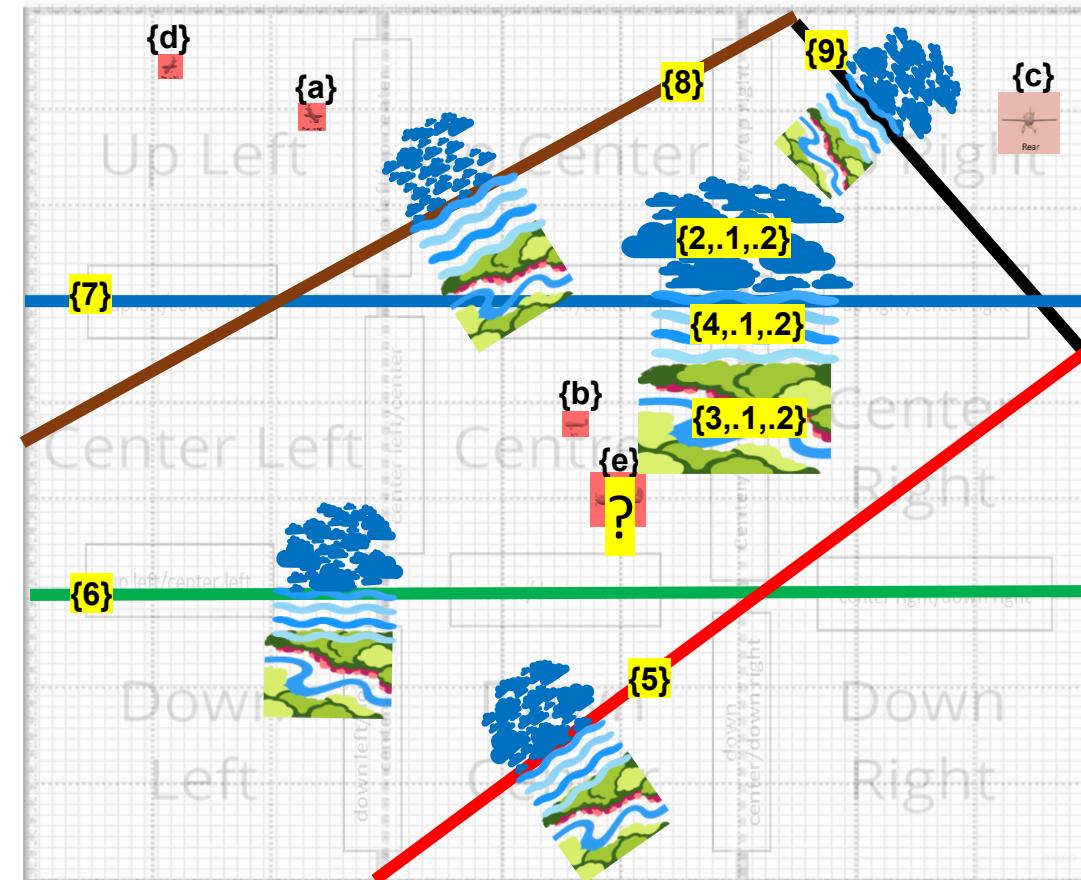


CuneiForm Training Class 2



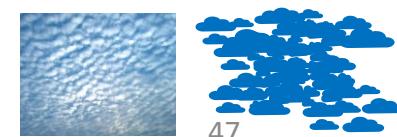
Abstract CuneiForm Characteristics (dimensions)	Abstract CuneiForm Characteristics definitions
TOIs definition and their aesthetic complexity	Single-engine propeller aeroplane {1}
TOI Motion and Dynamic optical states	Motion trajectory: Linear motion captured in consecutive images where the aeroplane appears to move in a straight line at a constant speed (no acceleration) {1.2}. Dynamic optical state: captured without optical blur {1.3}.
Background Objects associated with TOIs	Scattered Clouds{2} green-terrain {3} water surface{4}
Background Objects Motion and Dynamic optical states	Motion trajectory: is static {2.1,3.1,4.1} Dynamic optical state: no motion blur{2.2,3.2,4.2}
Visible horizon attitude	Negatively Tilted Lowered Horizon{5} Lowered Level Horizon{6} Elevated Level Horizon{7} Negatively Tilted Elevated Horizon{8} Positively Tilted Elevated Horizon{9}
TOI's Pictorial Positioning	center{1.4} Up left{1.5} up right{1.6}
TOI's Pictorial Distance	Moderately recognisable TOI distance{1.7}, extremely unrecognisable TOI distance{1.8},
TOI's 3D Orientation	Left{1.9} Rear{1.10} Rear up left{1.11} rear up right{1.12} Unknown{?}
05/02/2019	

CuneiForm Training Class 2



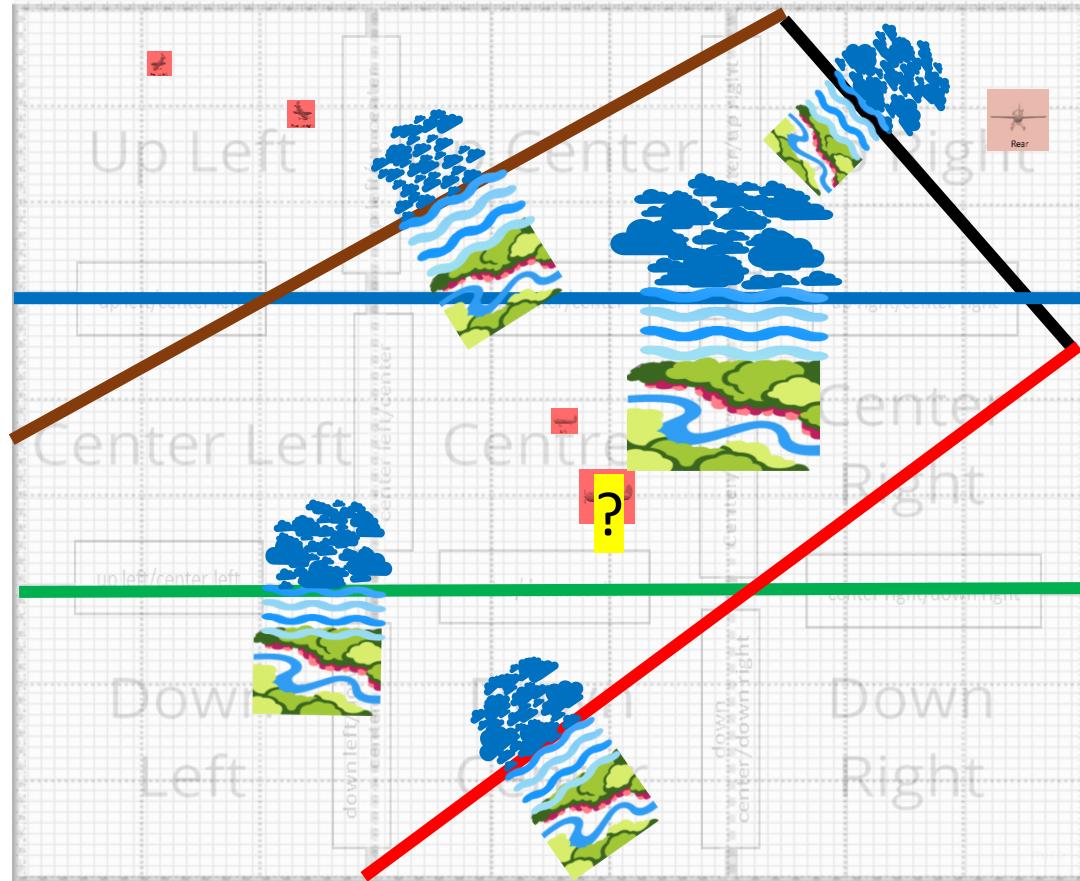
Instantiated Image
cessna_ac_training20
cessna_ac_training21
cessna_ac_training22
cessna_ac_training23
cessna_ac_training24

Time of Day
Evening (Dusk)
Midday (Noon)
Morning
Night



47
Scattered clouds

CuneiForm Training Class 2



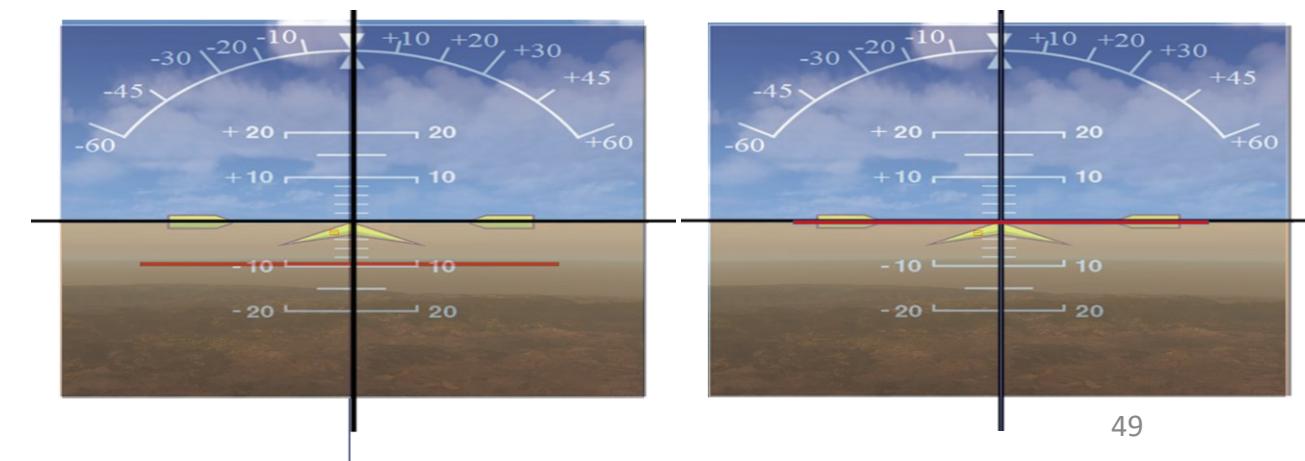
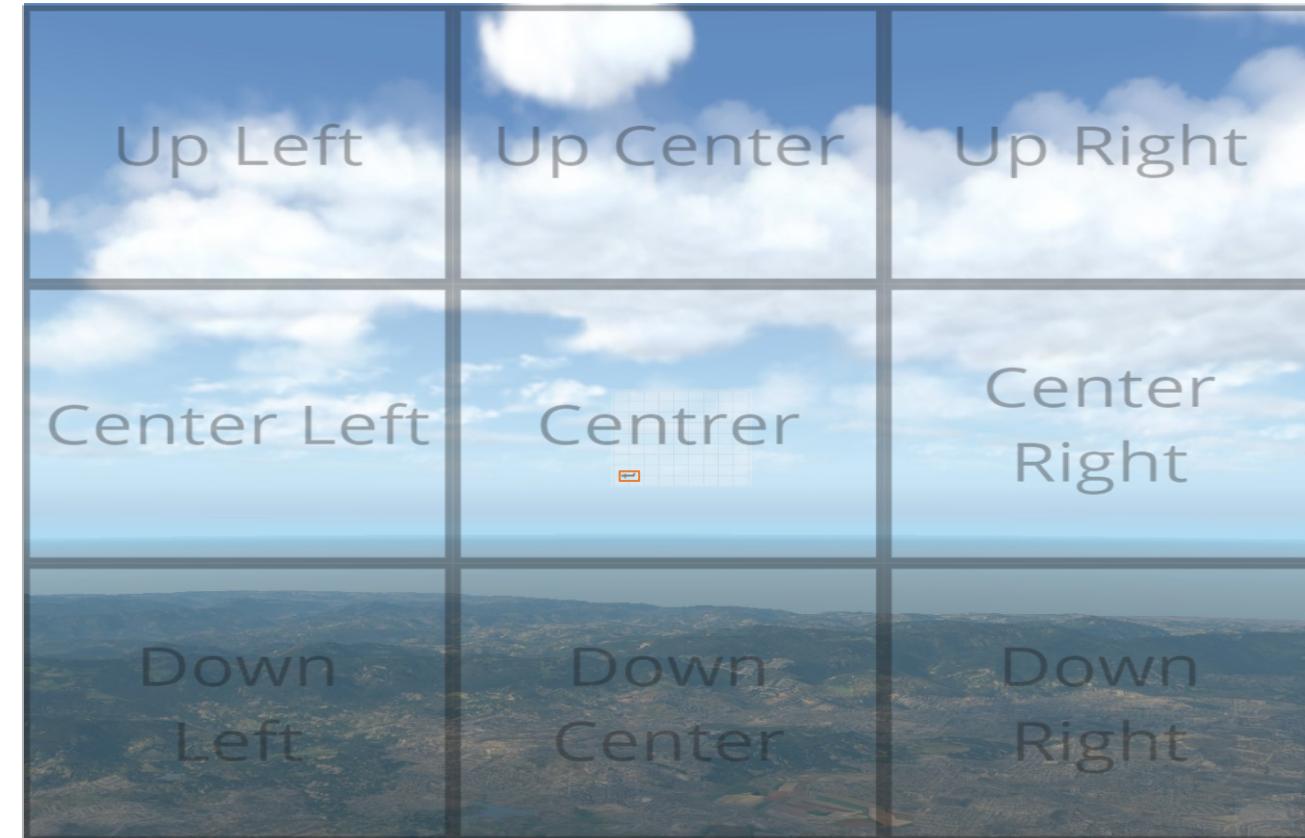
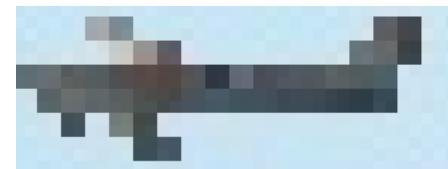
20.jpg

ODD Dimension	Training class spec
Weather Conditions	scattered clouds
Time of Day	morning, 08:12:49
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Extremely Unrecognisable TOI Distance (16436)
TOI's Pictorial positioning	center
TOI's 3D orientation	left
Horizon attitude	Roll: 0, Pitch: -10



Left

05/02/2025

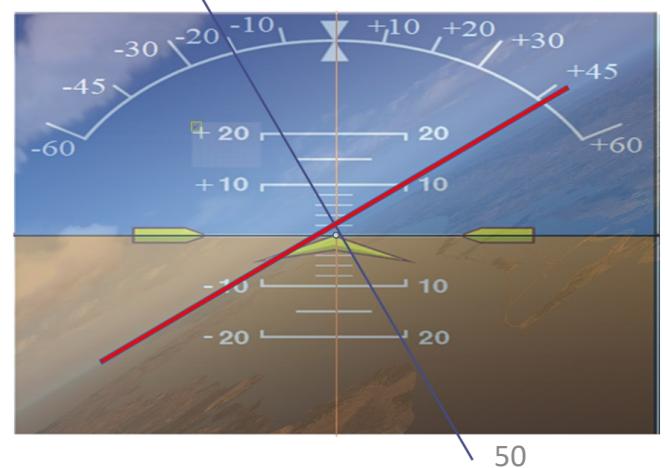
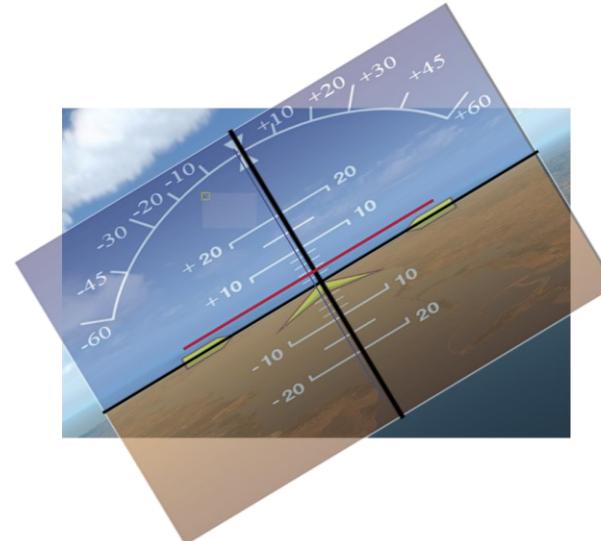


AVOIDDS Sample Training:

21.jpg

ODD Dimension	Training class spec
Weather Conditions	scattered clouds
Time of Day	Morning 06:56:32

CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Extremely Unrecognisable TOI Distance (5369)
TOI's Pictorial positioning	Up left
TOI's 3D orientation	Rear up left
Horizon attitude	Roll: -11, Pitch: +3



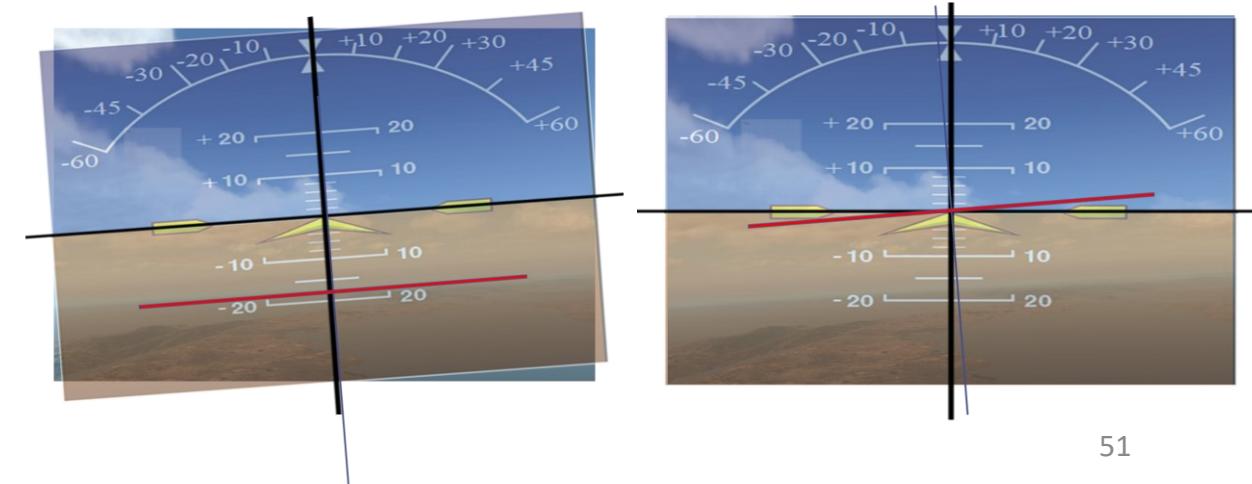
22.jpg

ODD Dimension	Training class spec
Weather Conditions	scattered clouds
Time of Day	morning, 01:14:22
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Extremely Unrecognisable TOI Distance (34486)
TOI's Pictorial positioning	Up left
TOI's 3D orientation	rear up right
Horizon attitude	Roll: -2, Pitch: -18



Rear up right

05/02/2025

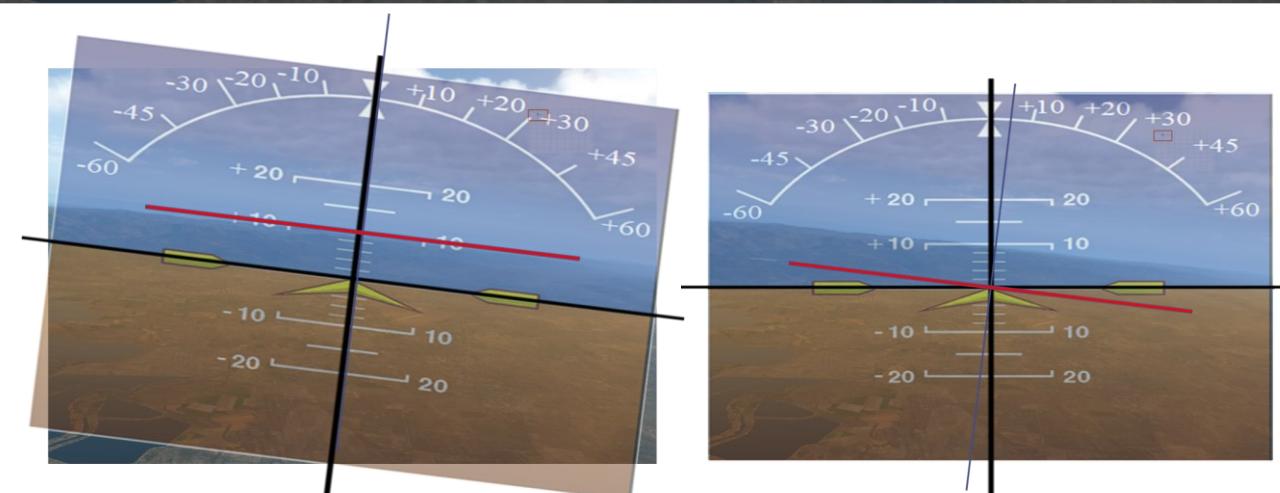


23.jpg

ODD Dimension	Training class spec
Weather Conditions	scattered clouds
Time of Day	late afternoon, 20:41:29
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Extremely Unrecognisable TOI Distance (130727)
TOI's Pictorial positioning	up right
TOI's 3D orientation	rear
Horizon attitude	Roll: 5, Pitch: 10



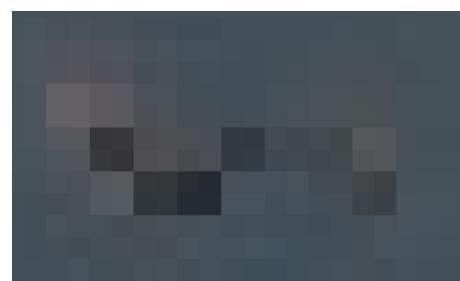
05/02/2025



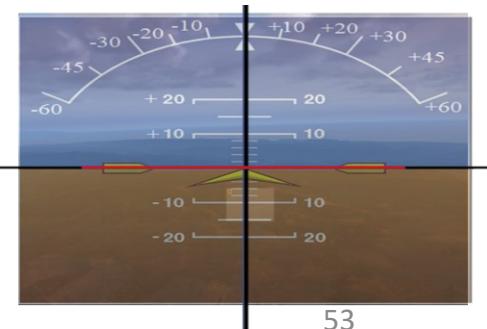
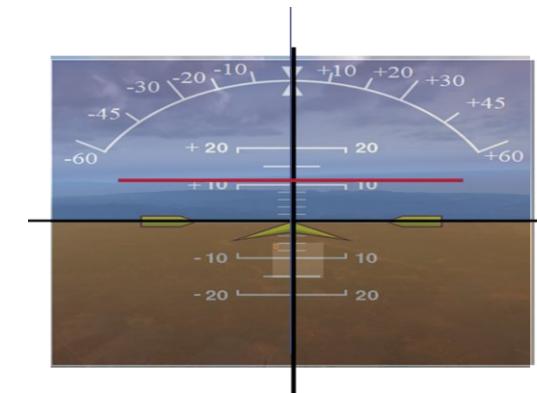
24.jpg

ODD Dimension	Training class spec
Weather Conditions	scattered clouds
Time of Day	midday, 12:14:28
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Moderately Recognisable TOI Distance (1454)
TOI's Pictorial positioning	center
TOI's 3D orientation	Unknown
Horizon attitude	Roll: 0, Pitch: 11

3D?

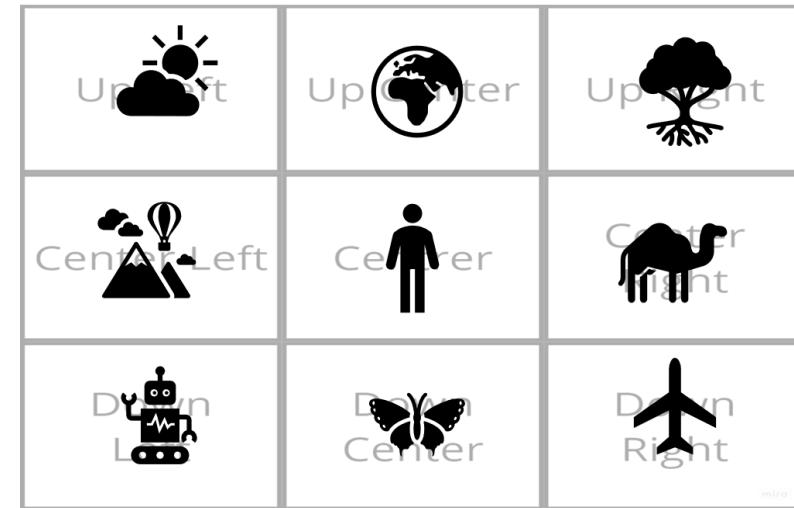


05/02/2025



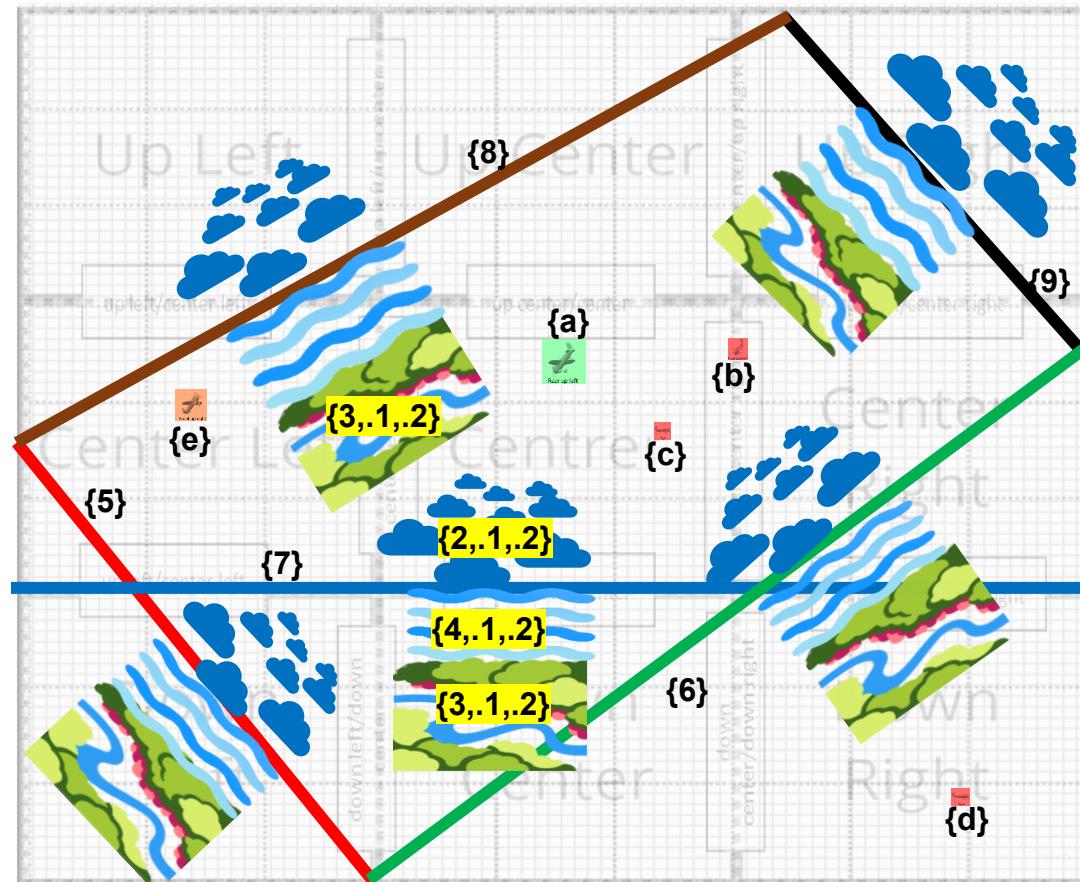
53

CuneiForm Training Class 3

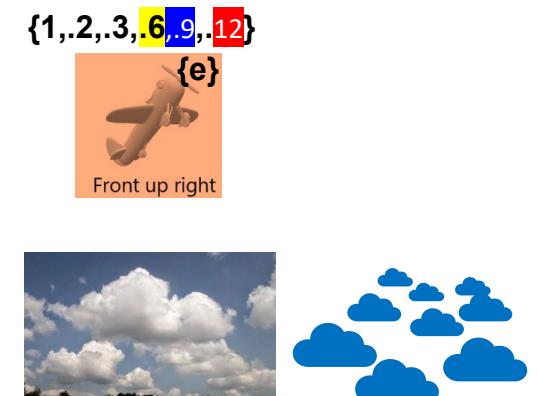
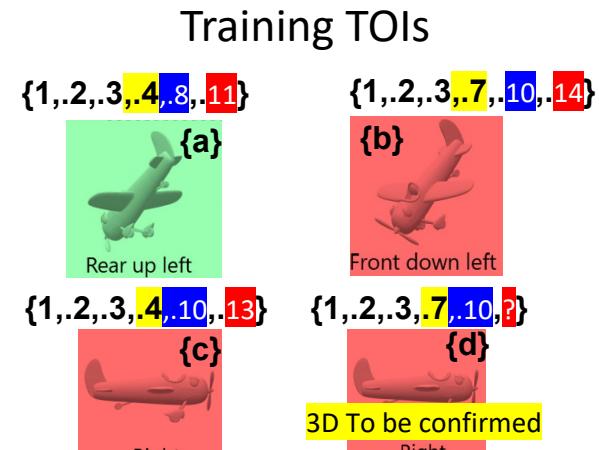


Abstract CuneiForm Characteristics (dimensions)	Abstract CuneiForm Characteristics definitions
TOIs definition and their aesthetic complexity	Single-engine propeller aeroplane {1}
TOI Motion and Dynamic optical states	Motion trajectory: Linear motion captured in consecutive images where the aeroplane appears to move in a straight line at a constant speed (no acceleration) {1.2}. Dynamic optical state: captured without optical blur {1.3}.
Background Objects associated with TOIs	Broken Clouds{2} green-terrain {3} water surface{4}
Background Objects Motion and Dynamic optical states	Background objects' motion trajectory is static {2.1,3.1,4.1} Dynamic optical state: no motion blur{2.2,3.2,4.2}
Visible horizon attitude	Negatively Tilted Lowered Horizon{5} Positively Tilted Lowered Horizon{6} Lowered Level Horizon{7} Negatively Tilted Elevated Horizon{8} Positively Tilted Elevated Horizon{9}
TOI's Pictorial Positioning	Center{1.4} Down right{1.5} center left{1.6} center/center right{1.7}
TOI's Pictorial Distance	recognisable TOI distance{1.8}, moderately recognisable TOI distance{1.9}, extremely unrecognisable TOI distance{1.10},
TOI's 3D Orientation	Rear up left{1.11} front up right{1.12} Right{1.13} front down left{1.14}
05/02/2015	

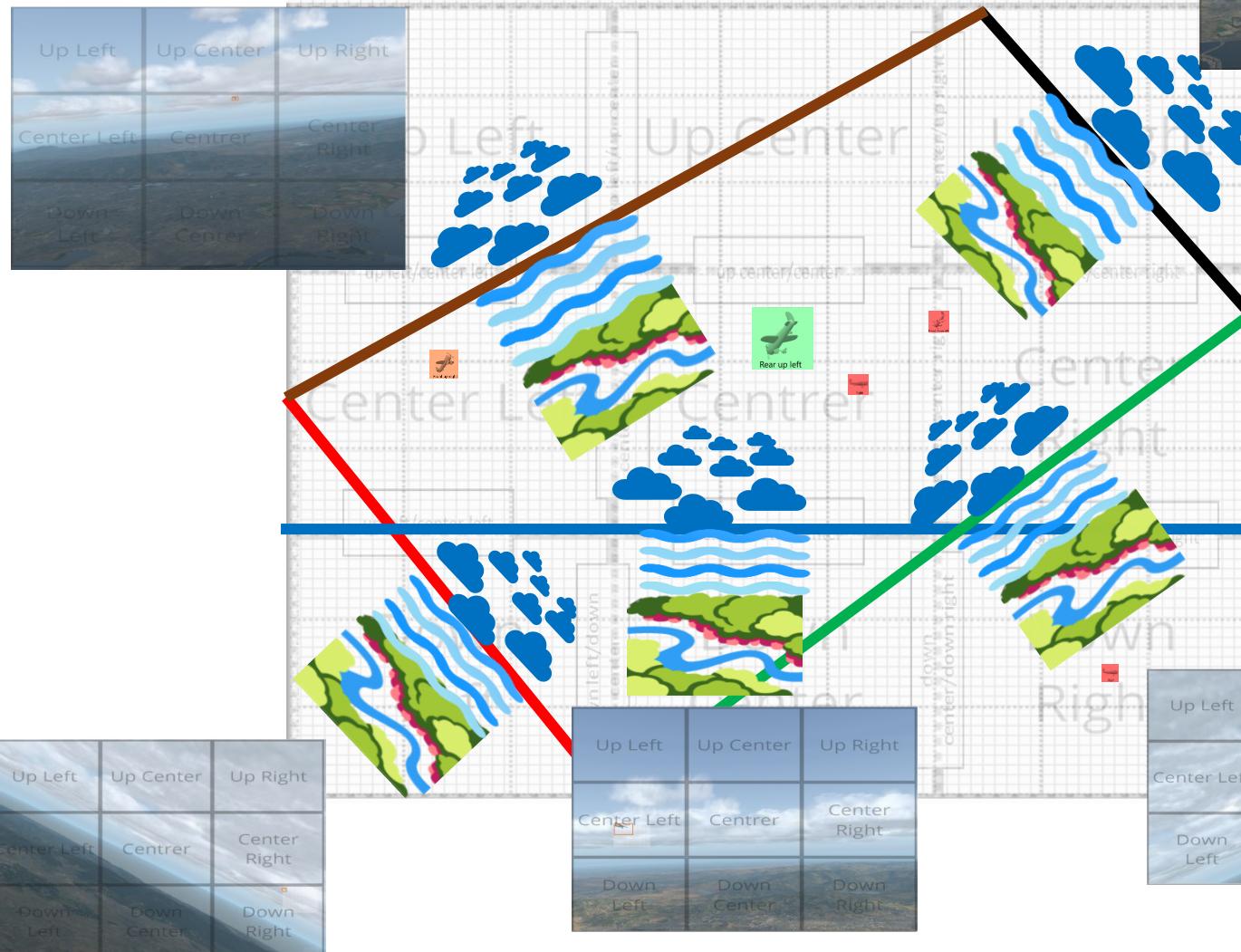
CuneiForm Training Class 3



Time of Day	Early Morning (Dawn){10}, Mid-Morning{11}, Night{12}
Instantiated Image	cessna_ac_training30 cessna_ac_training31 cessna_ac_training32 cessna_ac_training33 cessna_ac_training34



CuneiForm Training Class 3



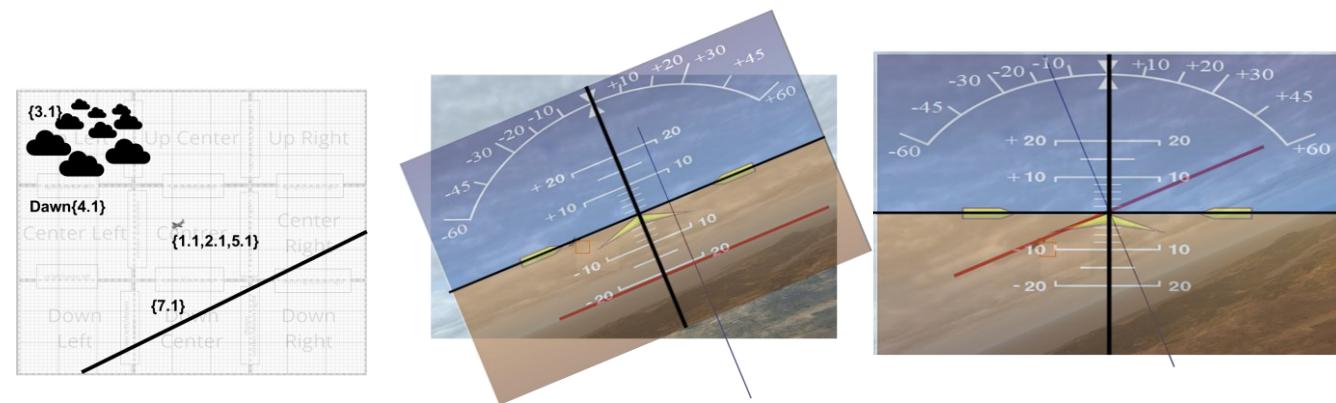
This instantiation looks more like scattered clouds than broken

30.jpg

ODD Dimension	Training class spec
Weather Conditions	broken clouds
Time of Day	Early Morning (Dawn), 05:26:23
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Moderately Recognisable TOI Distance (1555)
TOI's Pictorial positioning	center
TOI's 3D orientation	rear up left
Horizon attitude	Roll: -15, Pitch: -20



05/02/2025

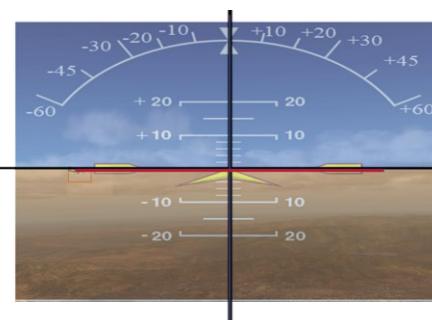
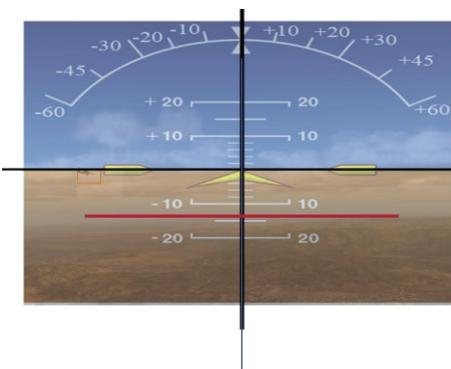
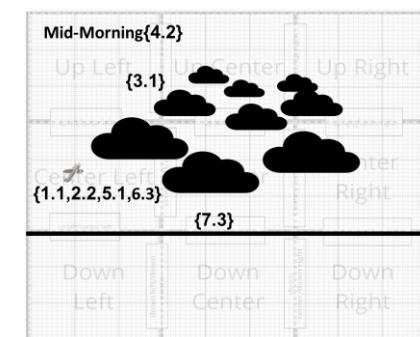
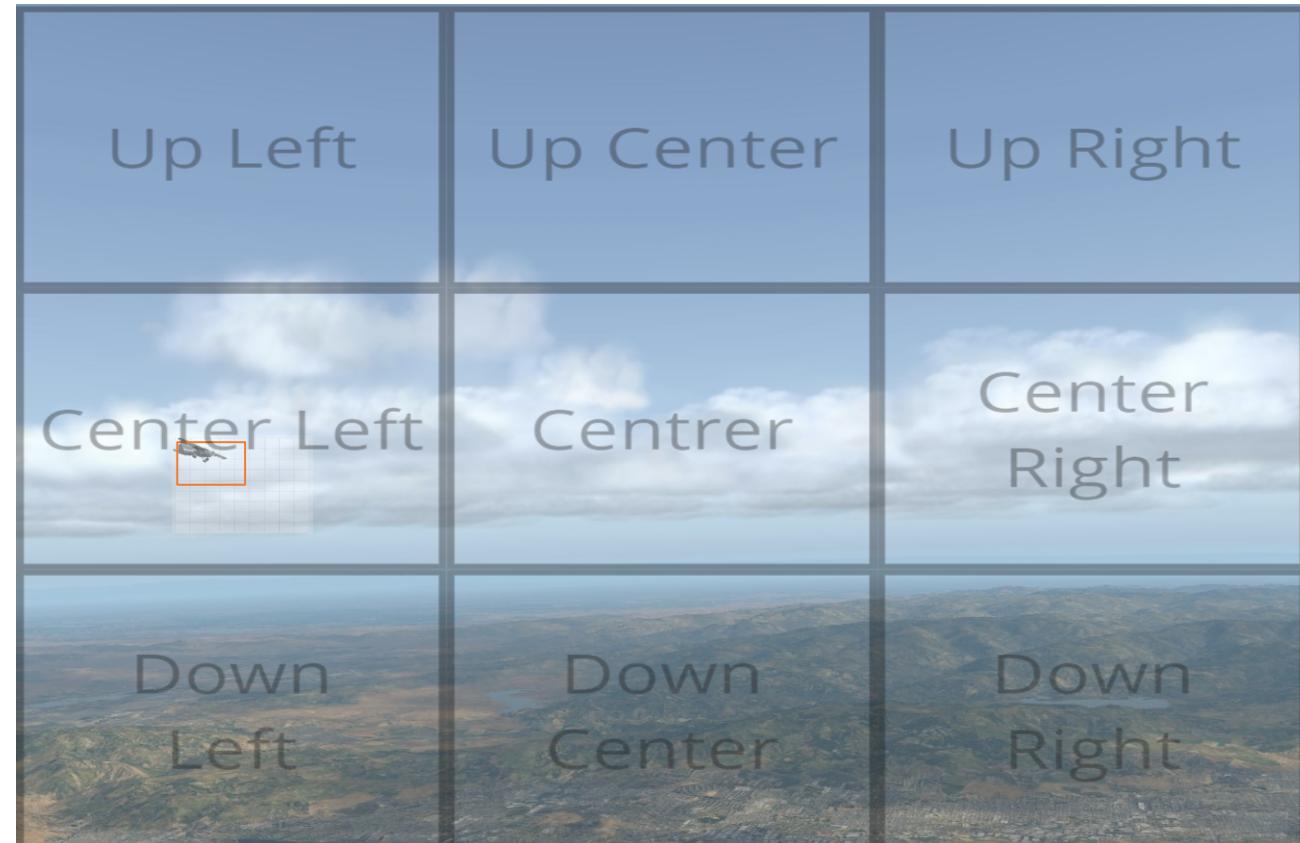


31.jpg

ODD Dimension	Training class spec
Weather Conditions	broken clouds
Time of Day	Mid-Morning, 10:20:18
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Extremely Unrecognisable TOI Distance (8353)
TOI's Pictorial positioning	center left
TOI's 3D orientation	front up right
Horizon attitude	Roll: 0, Pitch: -14



05/02/2025

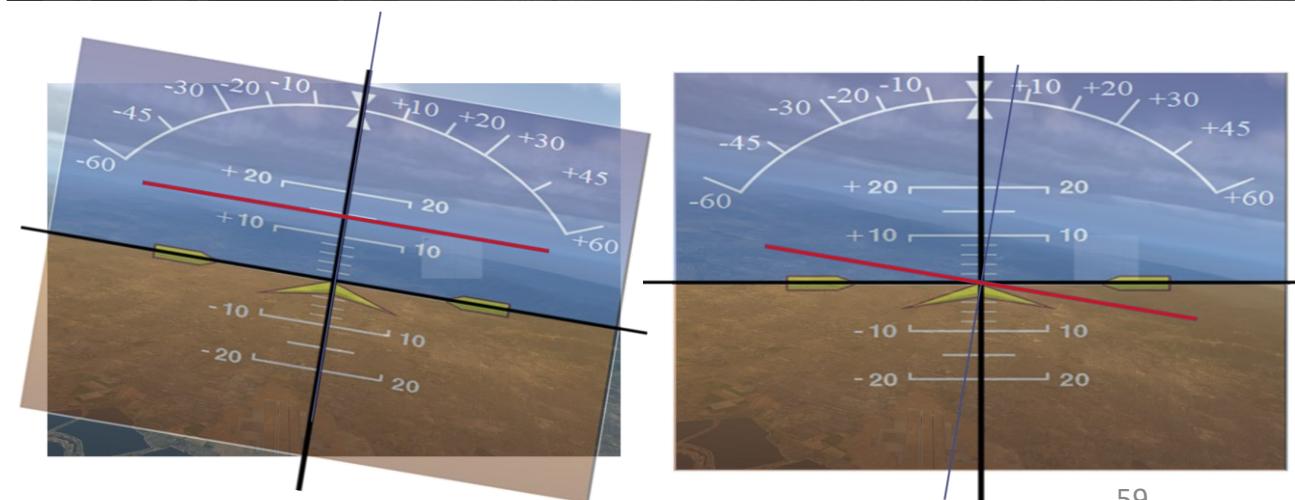


32.jpg

ODD Dimension	Training class spec
Weather Conditions	broken clouds
Time of Day	night, 03:40:13
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Extremely Unrecognisable TOI Distance (18675)
TOI's Pictorial positioning	center/center right
TOI's 3D orientation	front down left
Horizon attitude	Roll: 7, Pitch: 15



05/02/2025



33.jpg

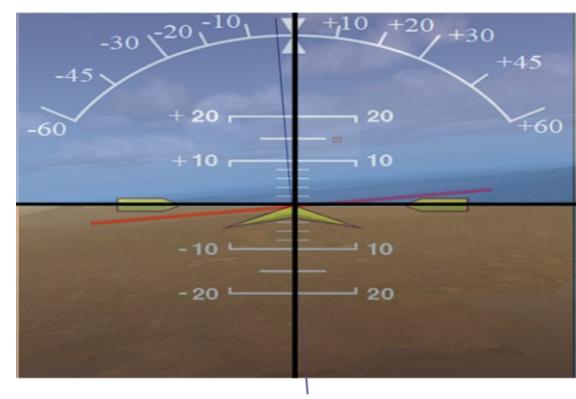
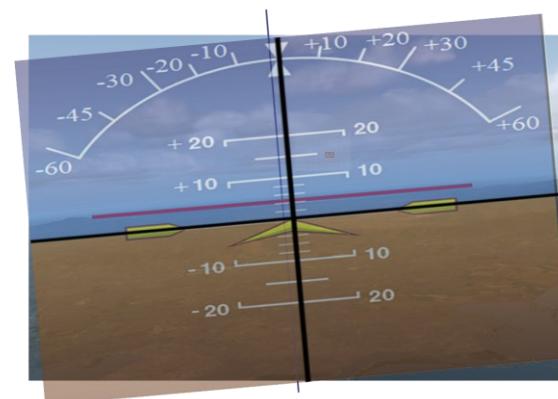
ODD Dimension	Training class spec
Weather Conditions	broken clouds
Time of Day	Night, 23:26:59
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Extremely Unrecognisable TOI Distance (43241)
TOI's Pictorial positioning	center
TOI's 3D orientation	right
Horizon attitude	Roll: -3, Pitch: 4



Right



05/02/2025



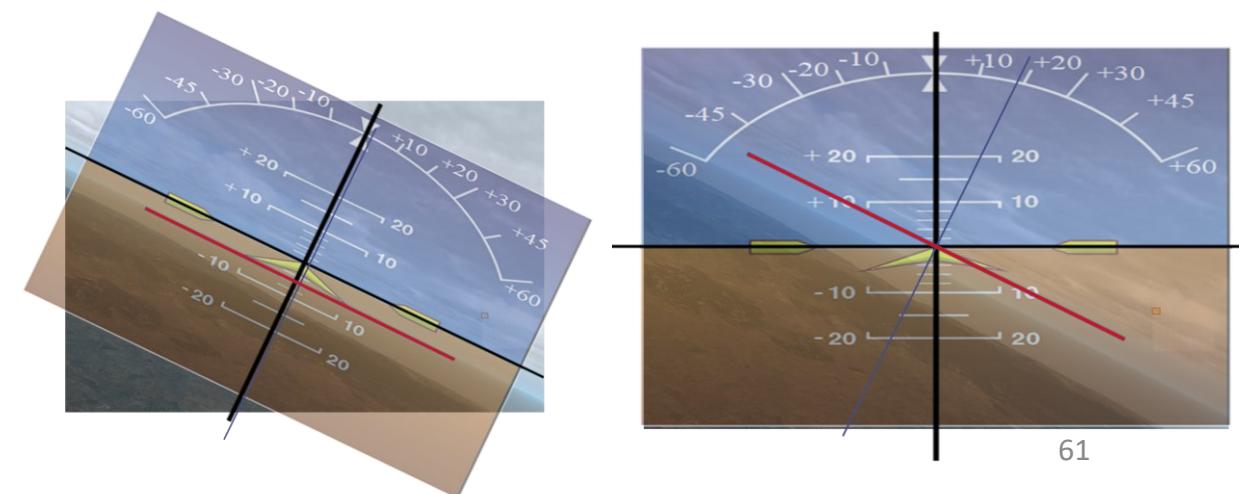
34.jpg

ODD Dimension	Training class spec
Weather Conditions	broken clouds
Time of Day	Early Morning (Dawn), 04:03:13
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Extremely Unrecognisable TOI Distance (8428)
TOI's Pictorial positioning	down right
TOI's 3D orientation	Unknown
Horizon attitude	Roll: 18, Pitch: -6

?

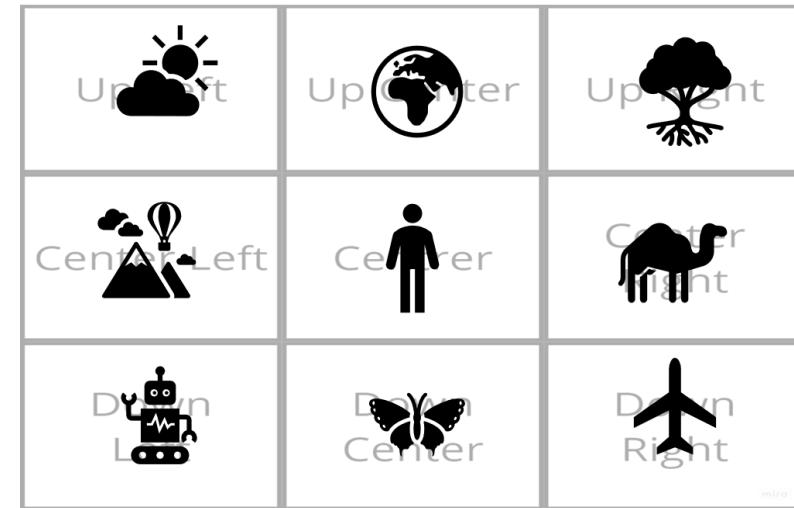


05/02/2025



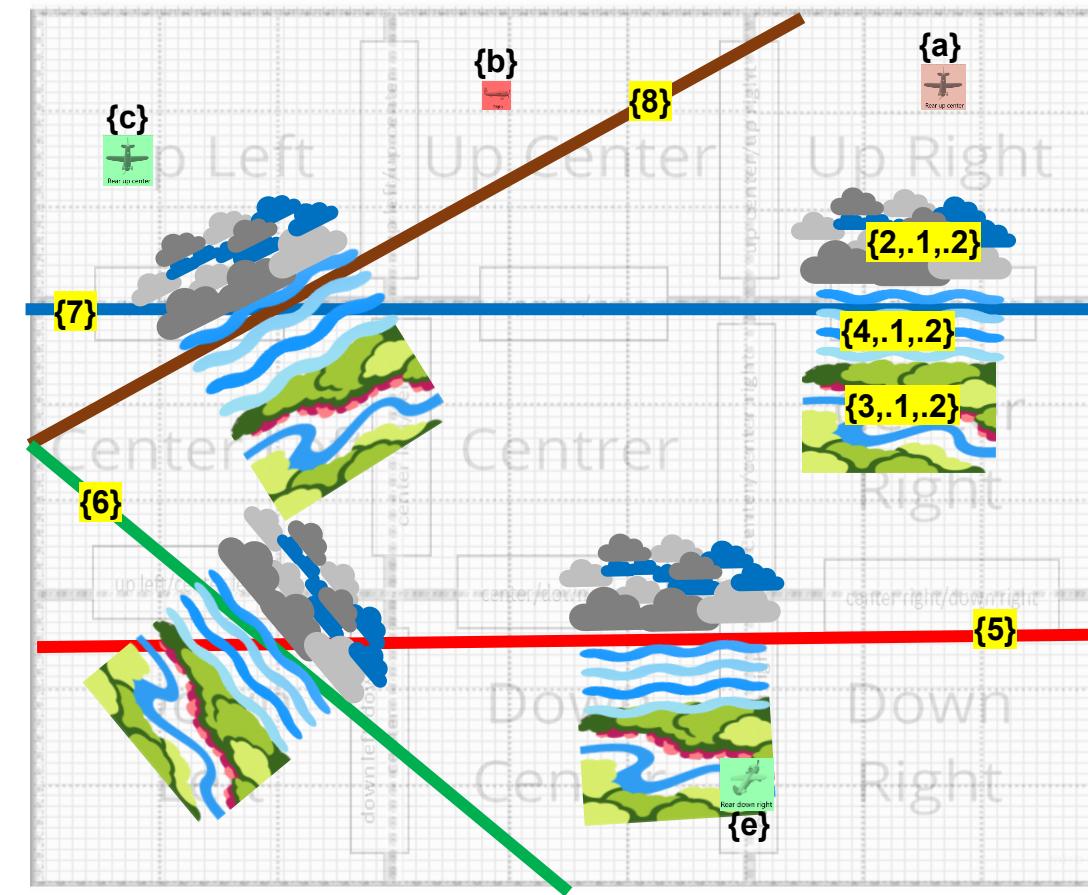
61

CuneiForm Training Class 4

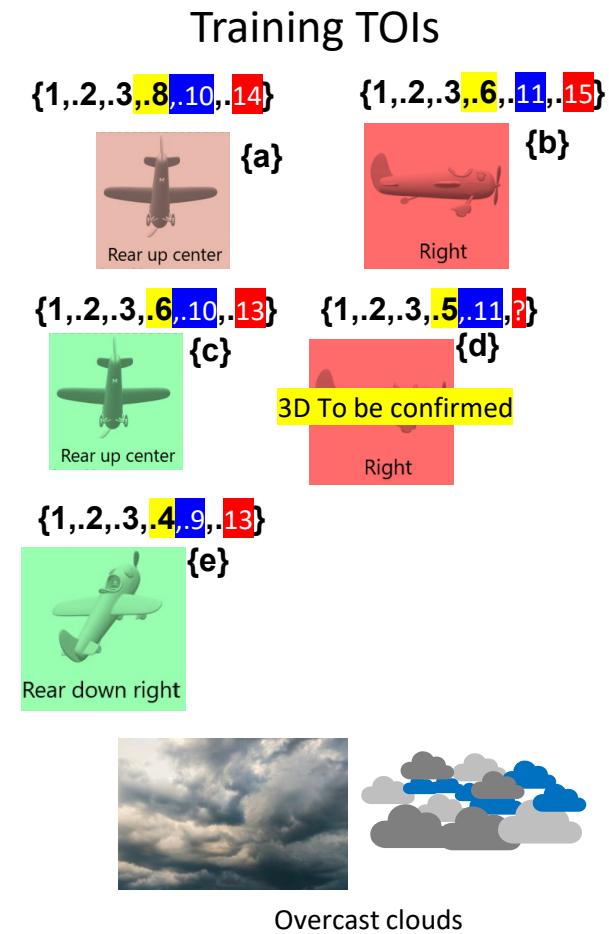


Abstract CuneiForm Characteristics (dimensions)	Abstract CuneiForm Characteristics definitions
TOIs definition and their aesthetic complexity	Single-engine propeller aeroplane {1}
TOI Motion and Dynamic optical states	Motion trajectory: Linear motion captured in consecutive images where the aeroplane appears to move in a straight line at a constant speed (no acceleration) {1.2}. Dynamic optical state: captured without optical blur {1.3}.
Background Objects associated with TOIs	Overcast Clouds{2} green-terrain {3} water surface{4}
Background Objects Motion and Dynamic optical states	Background objects' motion trajectory is static {2.1,3.1,4.1} Dynamic optical state: no motion blur{2.2,3.2,4.2}
Visible horizon attitude	Lowered Level Horizon{5} Positively Tilted Lowered Horizon{6} Elevated Level Horizon{7} Negatively Tilted Elevated Horizon{8}
TOI's Pictorial Positioning	down center/down right{1.4} Down right{1.5} up center{1.6} Up left{1.7} up right{1.8}
TOI's Pictorial Distance	recognisable TOI distance{1.9}, moderately recognisable TOI distance{1.10}, extremely unrecognisable TOI distance{1.11},
TOI's 3D Orientation	Unknown{1.12} rear down right{1.13} rear up center{1.14} right{1.15}
05/02/2015	

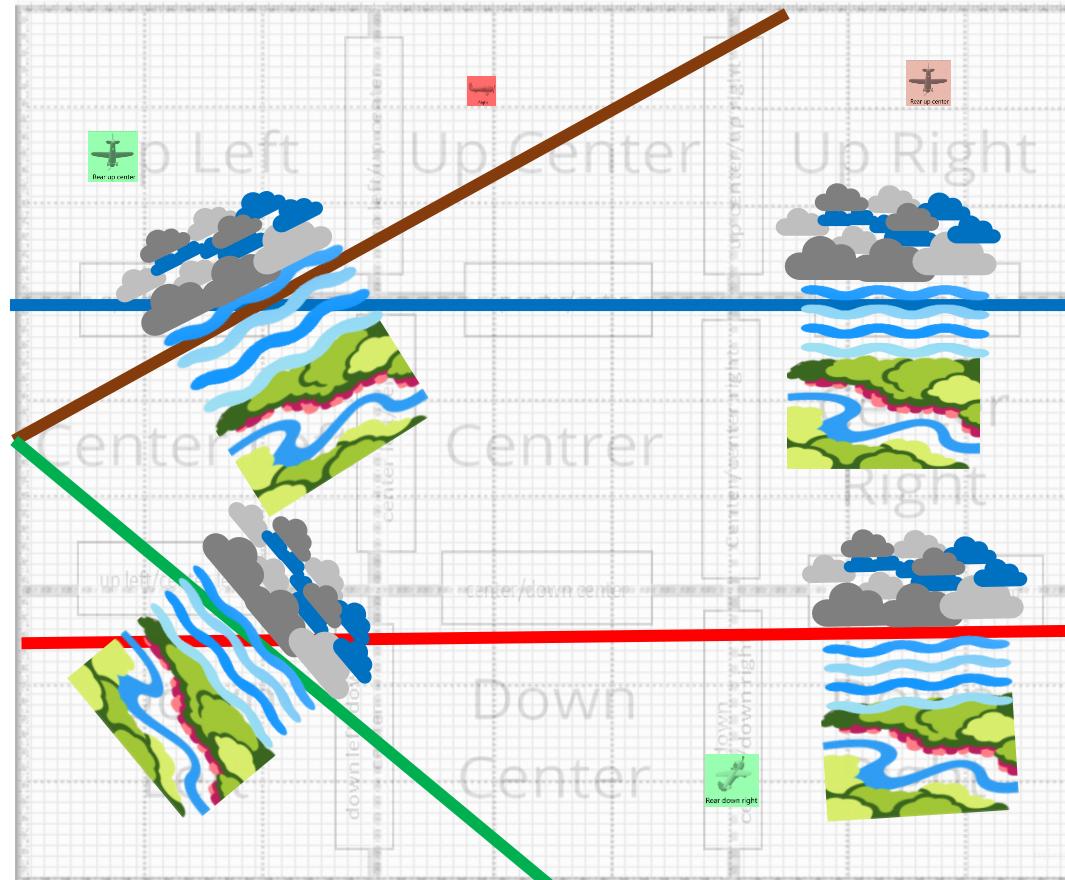
CuneiForm Training Class 4



Time of Day	Early Morning (Dawn){10}, Mid-Morning{11}, Night{12}
Instantiated Image	cessna_ac_training40 cessna_ac_training41 cessna_ac_training42 cessna_ac_training43 cessna_ac_training44



CuneiForm Training Class 4



40.jpg

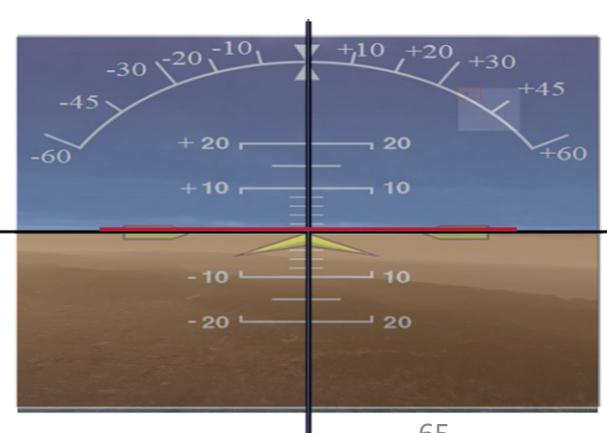
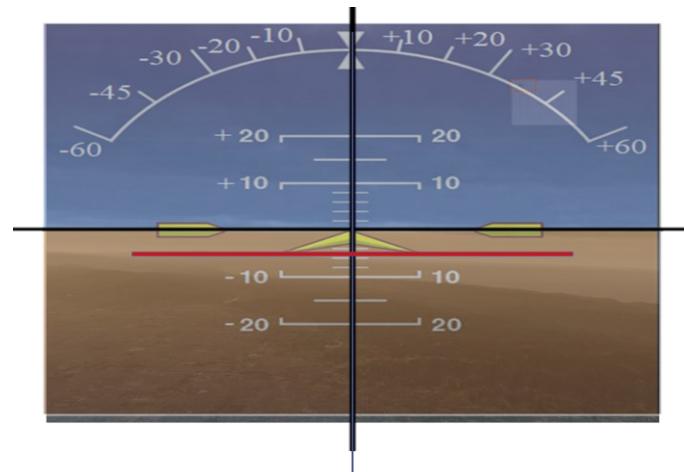
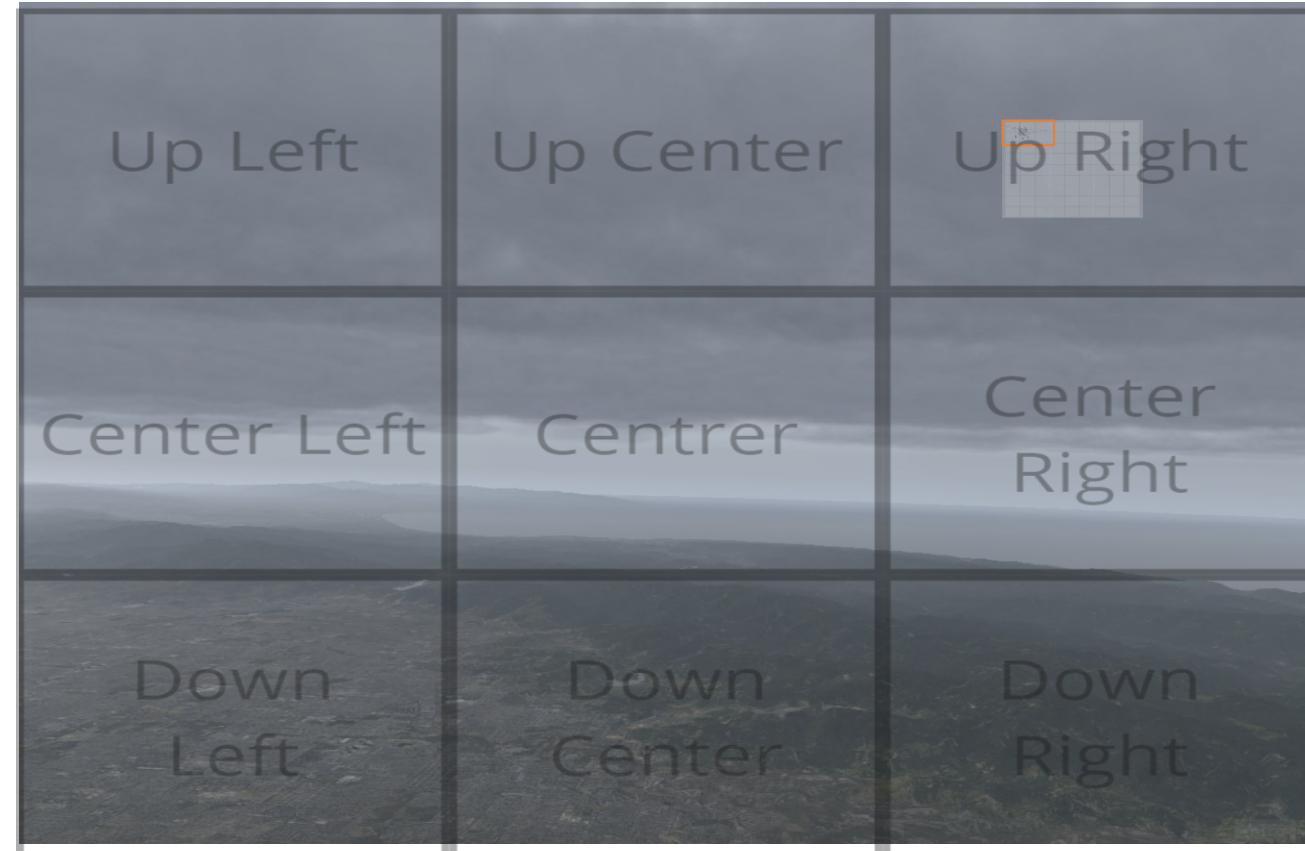
ODD Dimension	Training class spec
Weather Conditions	overcast,
Time of Day	morning, 03:52:05
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Extremely Unrecognisable TOI Distance (2324)
TOI's Pictorial positioning	up right
TOI's 3D orientation	rear up center
Horizon attitude	Roll: 0, Pitch: -6



Rear up center



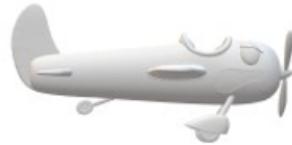
05/02/2025



65

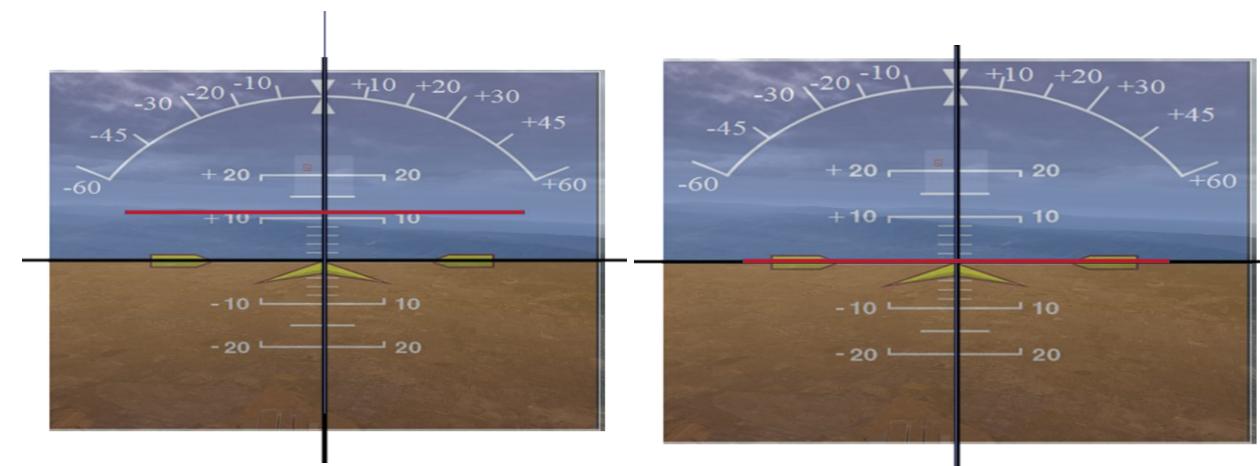
41.jpg

ODD Dimension	Training class spec
Weather Conditions	overcast,
Time of Day	midday, 12:19:34
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Extremely Unrecognisable TOI Distance (22131)
TOI's Pictorial positioning	up center
TOI's 3D orientation	right
Horizon attitude	Roll: 0, Pitch: 11



Right

05/02/2025



42.jpg

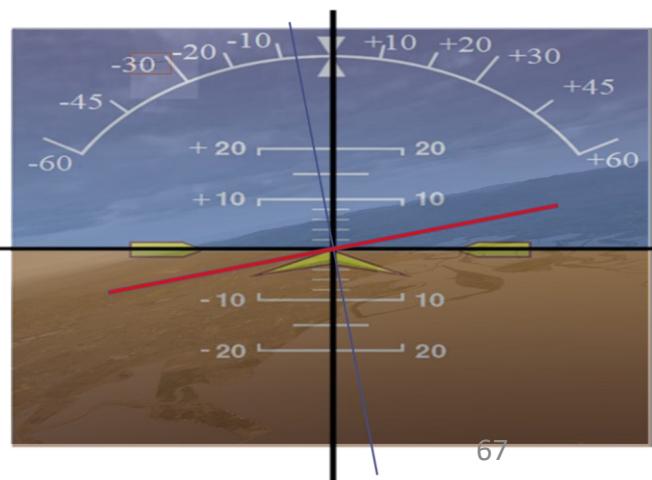
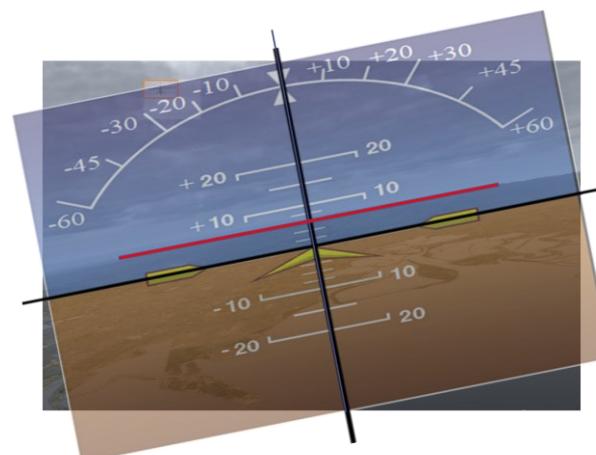
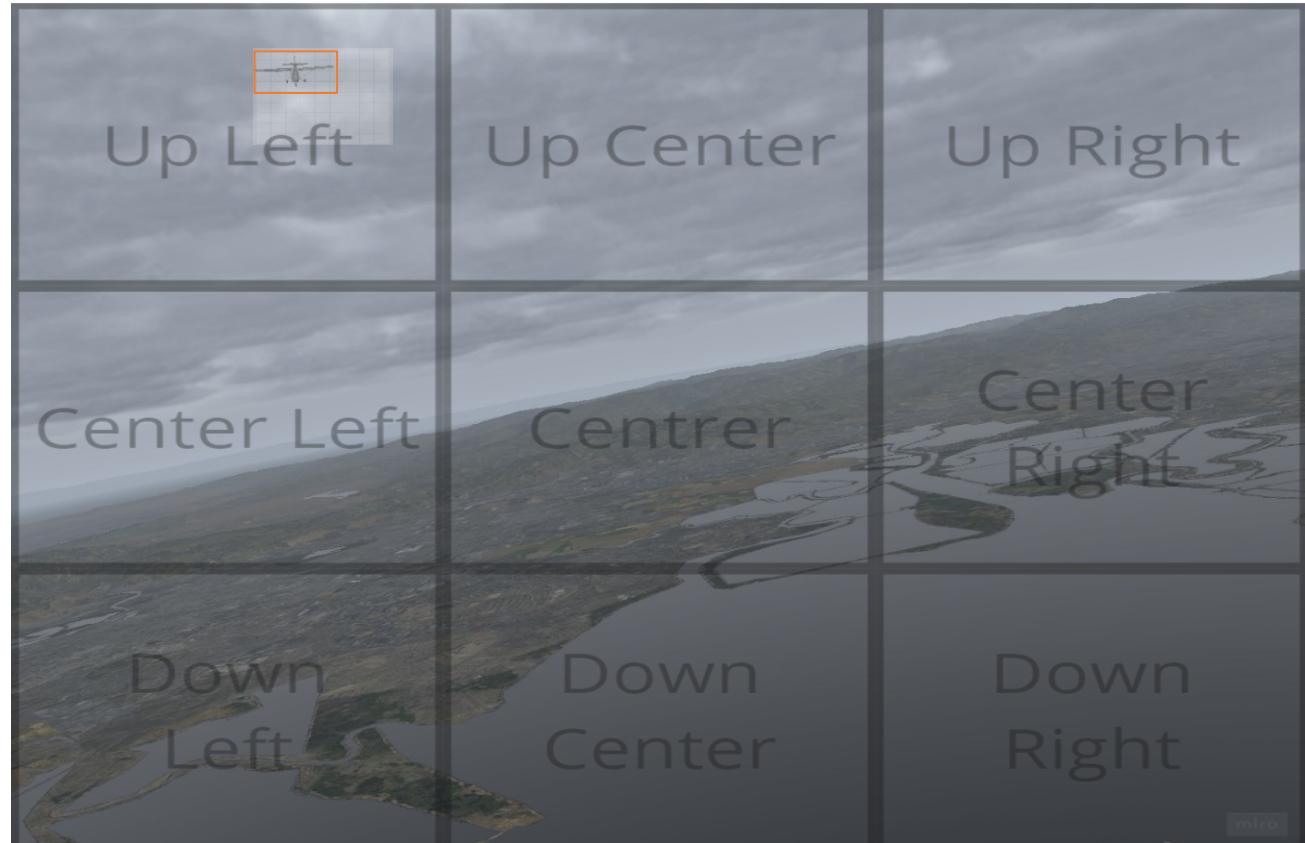
ODD Dimension	Training class spec
Weather Conditions	overcast
Time of Day	midday, 12:58:14
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Moderately Recognisable TOI Distance (1164)
TOI's Pictorial positioning	Up left
TOI's 3D orientation	Rear up center
Horizon attitude	Roll: -8, Pitch: 6



Rear up center



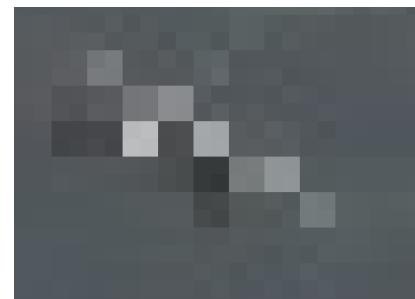
05/02/2025



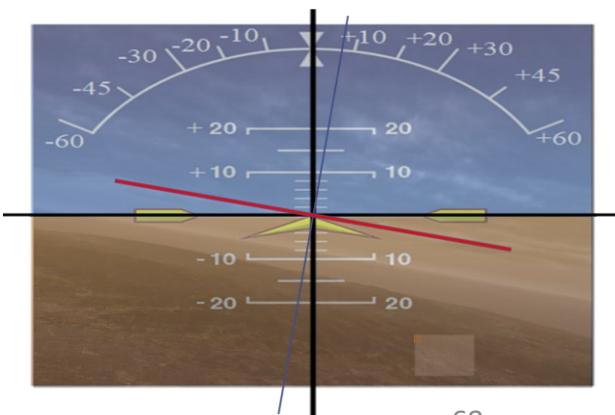
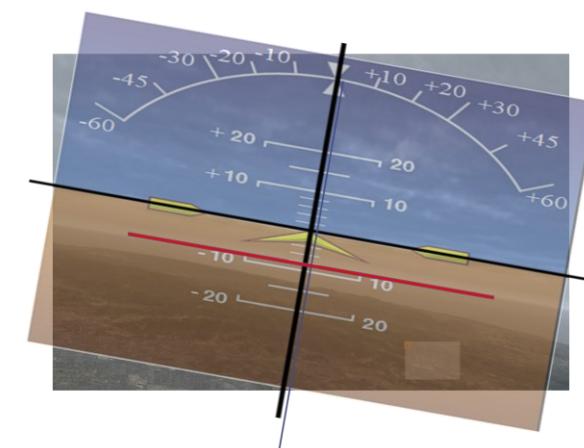
43.jpg

ODD Dimension	Training class spec
Weather Conditions	overcast,
Time of Day	morning, 10:36:00
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Extremely Unrecognisable TOI Distance (62459)
TOI's Pictorial positioning	down right
TOI's 3D orientation	Unknown
Horizon attitude	Roll: 8, Pitch: -9

?



05/02/2025



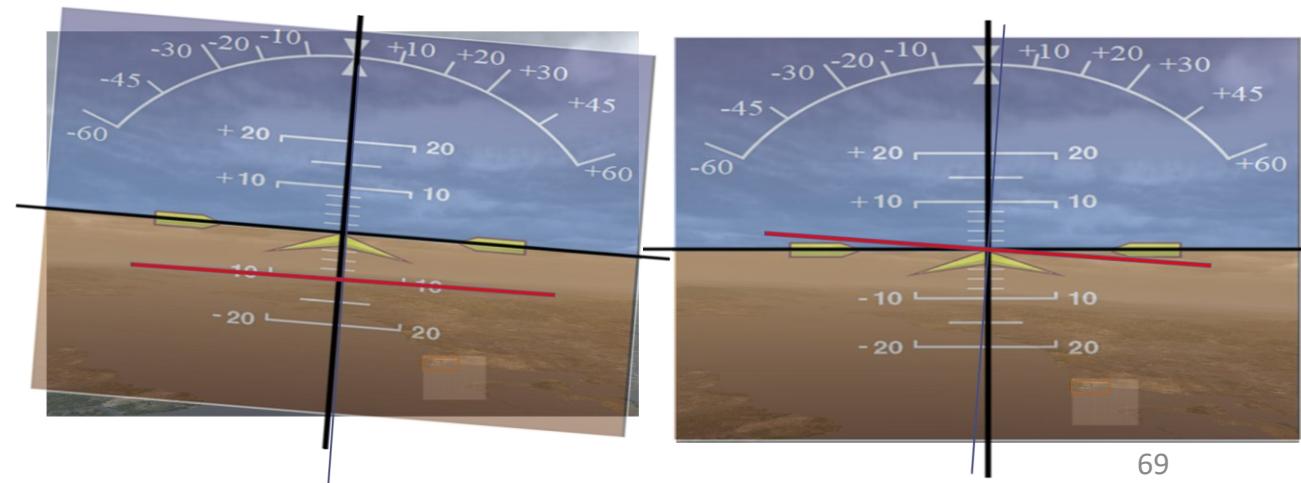
68

44.jpg

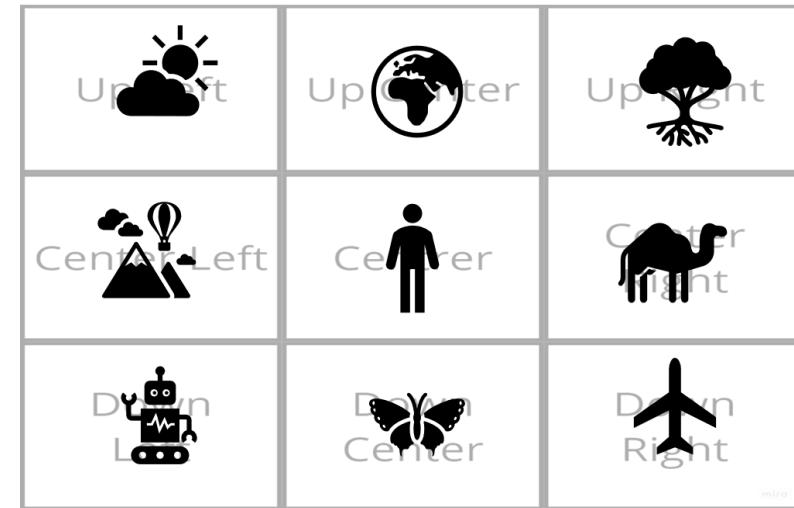
ODD Dimension	Training class spec
Weather Conditions	overcast
Time of Day	morning, 17:59:44
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Moderately Recognisable TOI Distance (1038)
TOI's Pictorial positioning	down center/down right
TOI's 3D orientation	rear down right
Horizon attitude	Roll: 2, Pitch: -10



05/02/2025

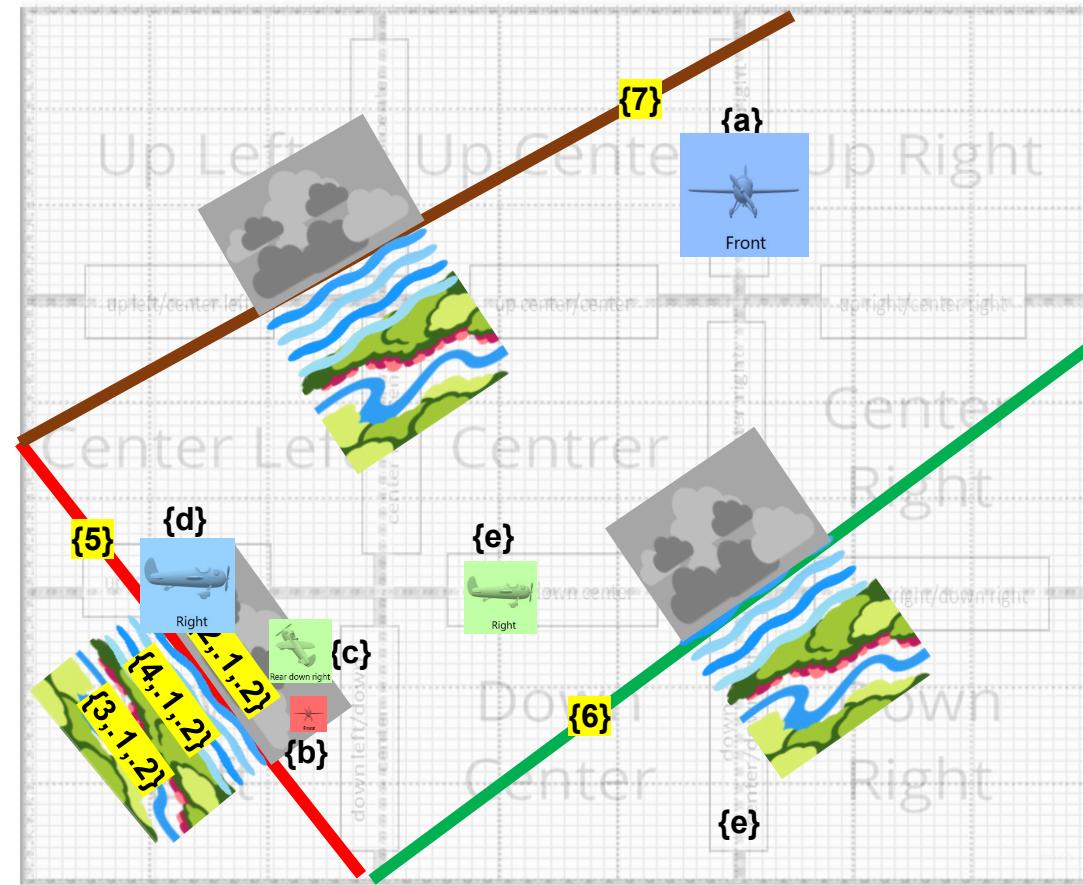


CuneiForm Training Class 5

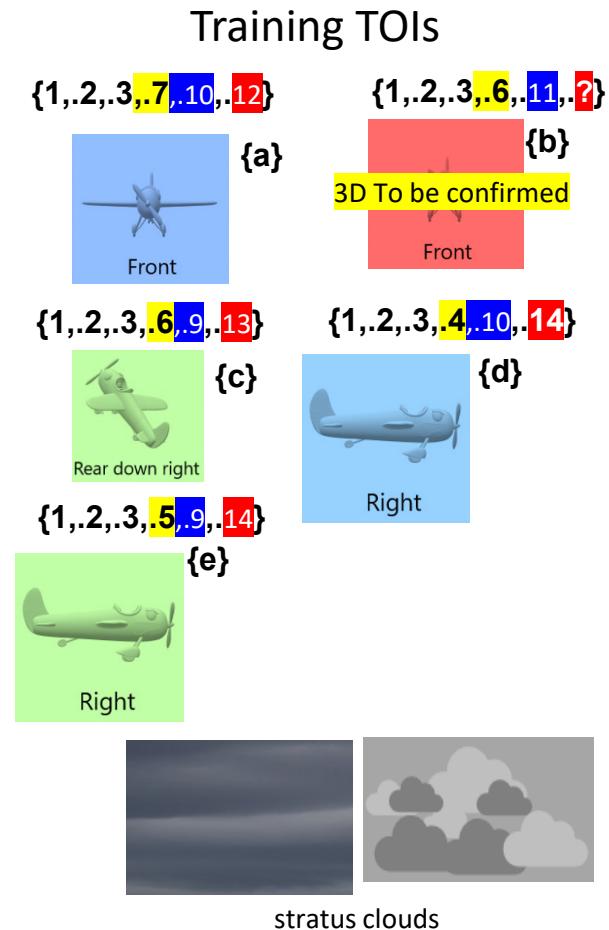


Abstract CuneiForm Characteristics (dimensions)	Abstract CuneiForm Characteristics definitions
TOIs definition and their aesthetic complexity	Single-engine propeller aeroplane {1}
TOI Motion and Dynamic optical states	Motion trajectory: Linear motion captured in consecutive images where the aeroplane appears to move in a straight line at a constant speed (no acceleration) {1.2}. Dynamic optical state: captured without optical blur {1.3}.
Background Objects associated with TOIs	Stratus Clouds{2} green-terrain {3} water surface{4}
Background Objects Motion and Dynamic optical states	Background objects' motion trajectory is static {2.1,3.1,4.1} Dynamic optical state: no motion blur{2.2,3.2,4.2}
Visible horizon attitude	Negatively Tilted Lowered Horizon{5} Positively Tilted Lowered Horizon{6} Negatively Tilted Elevated Horizon{7}
TOI's Pictorial Positioning	center left/down left{1.4} center/down center{1.5} down left{1.6} up center/up right{1.7}
TOI's Pictorial Distance	recognisable TOI distance{1.9}, clear close TOI distance{1.10}, extremely unrecognisable TOI distance{1.11},
TOI's 3D Orientation	Front{1.12} rear down right{1.13} Right{1.14} Unknown{1.15}

CuneiForm Training Class 5

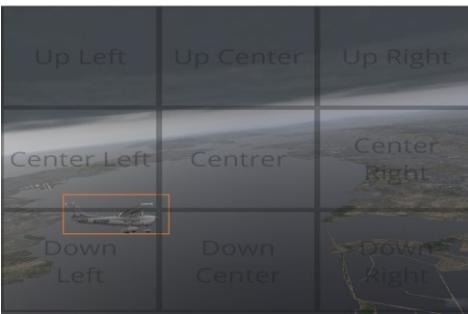


Time of Day	Early Morning (Dawn){10}, Mid-Morning{11}, Night{12}
Instantiated Image	cessna_ac_training50 cessna_ac_training51 cessna_ac_training52 cessna_ac_training53 cessna_ac_training54



CuneiForm Training Class 5

53.jpg



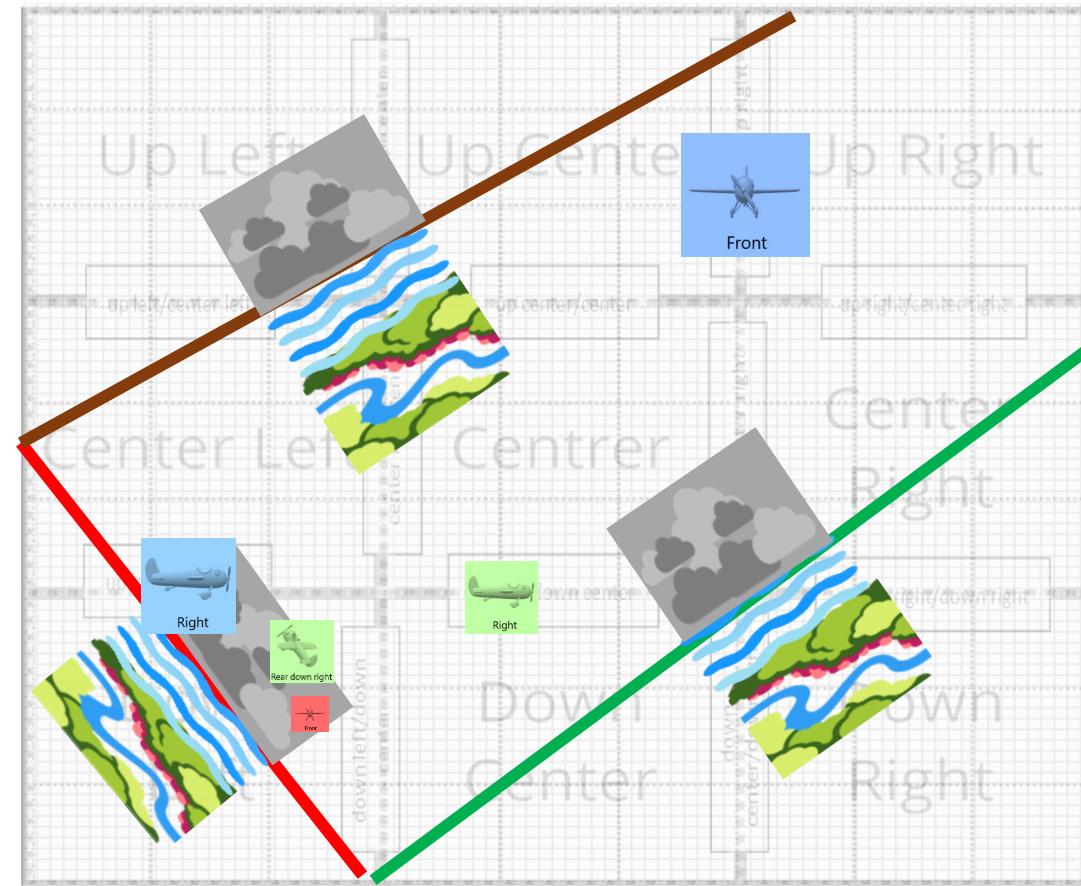
52.jpg



51.jpg



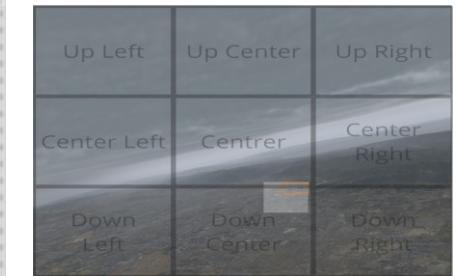
05/02/2025



50.jpg



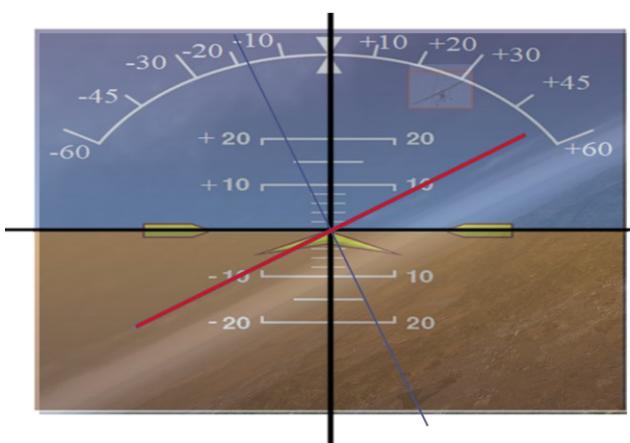
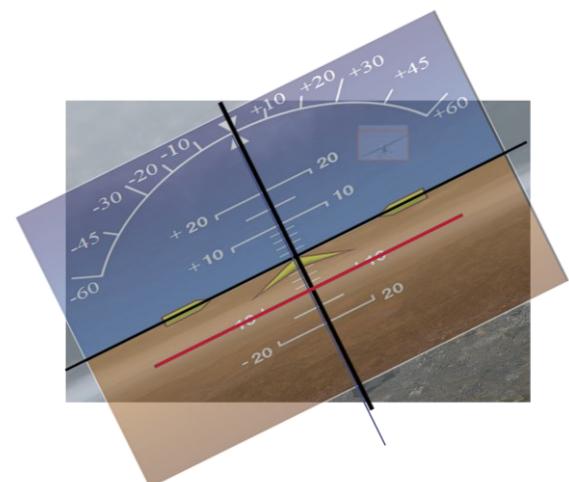
54.jpg



72

50.jpg

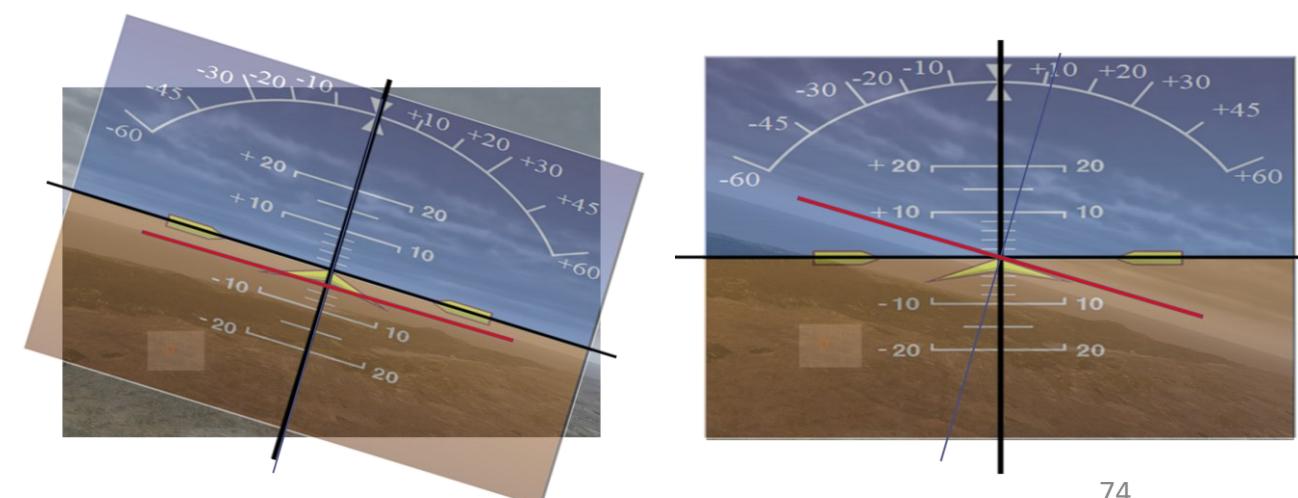
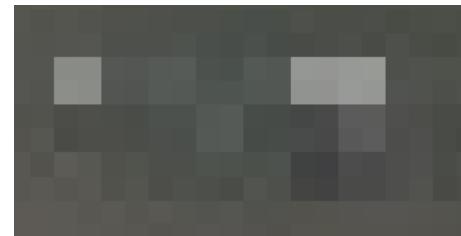
ODD Dimension	Training class spec
Weather Conditions	stratus
Time of Day	Mid-Morning, 10:07:30
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Recognisable TOI Distance (303)
TOI's Pictorial positioning	up center/up right
TOI's 3D orientation	Front
Horizon attitude	Roll: -18, Pitch: -10



51.jpg

ODD Dimension	Training class spec
Weather Conditions	stratus
Time of Day	late afternoon, 20:50:56
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Extremely Unrecognisable TOI Distance (61101)
TOI's Pictorial positioning	down left
TOI's 3D orientation	unknown
Horizon attitude	Roll: 12, Pitch: -4

?

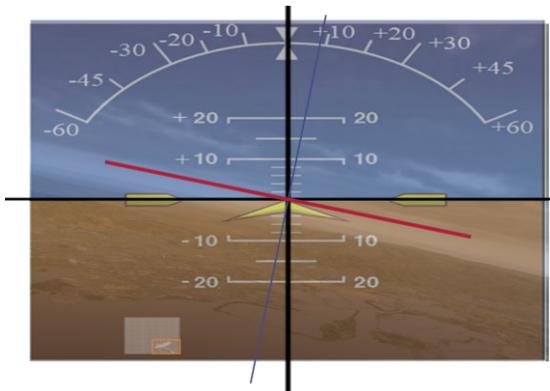
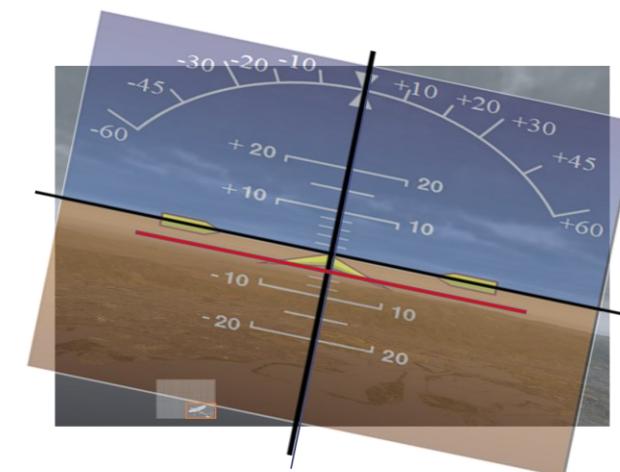
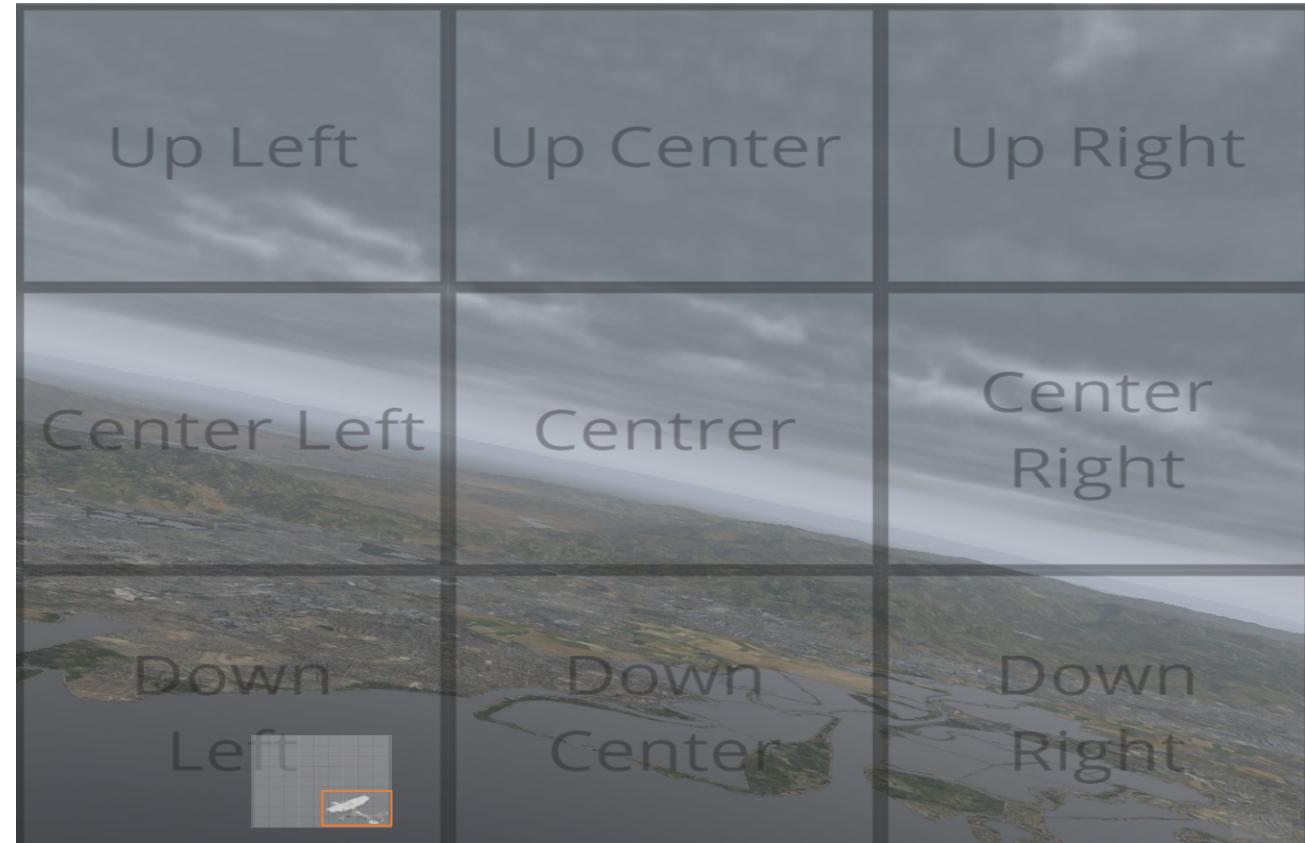


52.jpg

ODD Dimension	Training class spec
Weather Conditions	stratus
Time of Day	morning, 06:10:03
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Moderately Recognisable TOI Distance (979)
TOI's Pictorial positioning	down left
TOI's 3D orientation	rear down right
Horizon attitude	Roll: 8, Pitch: -4

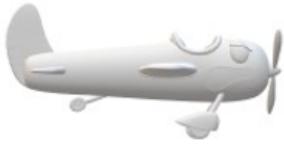


05/02/2025



53.jpg

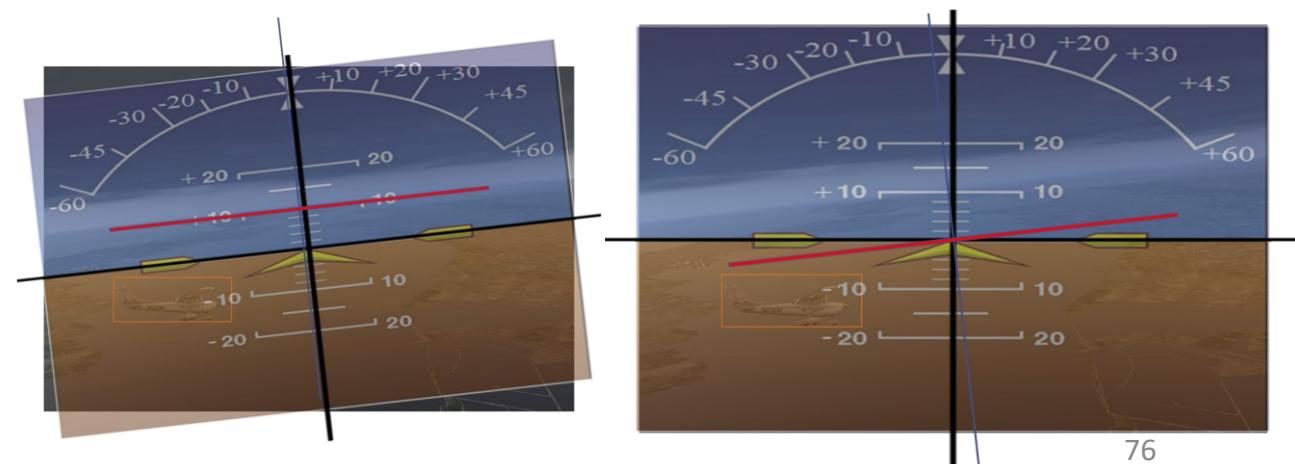
ODD Dimension	Training class spec
Weather Conditions	stratus
Time of Day	morning
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Clear Close TOI Distance (58)
TOI's Pictorial positioning	center left/down left
TOI's 3D orientation	right
Horizon attitude	Roll: -3, Pitch: 10



Right

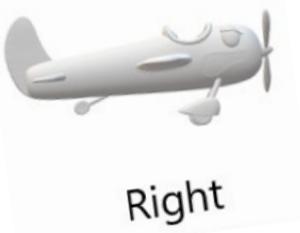


05/02/2025

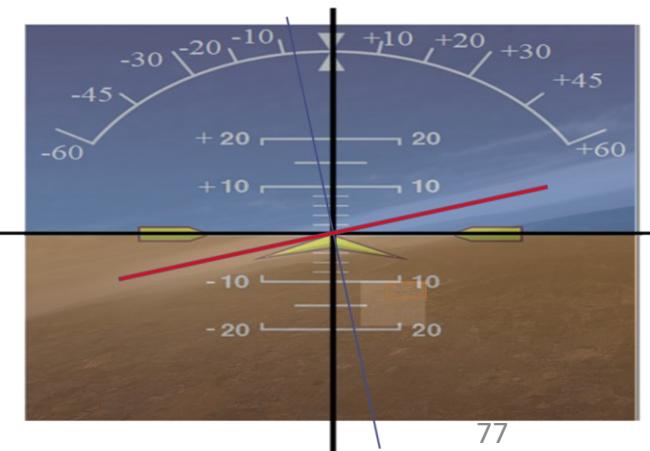
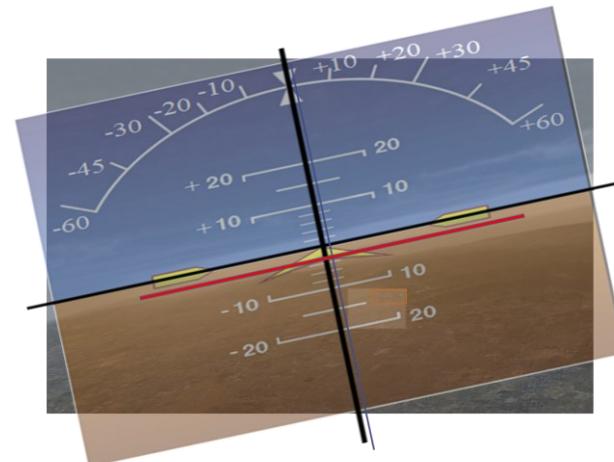


54.jpg

ODD Dimension	Training class spec
Weather Conditions	stratus
Time of Day	midday, 12:10:28
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Recognisable TOI Distance (673)
TOI's Pictorial positioning	center/down center
TOI's 3D orientation	right
Horizon attitude	Roll: -8, Pitch: -3



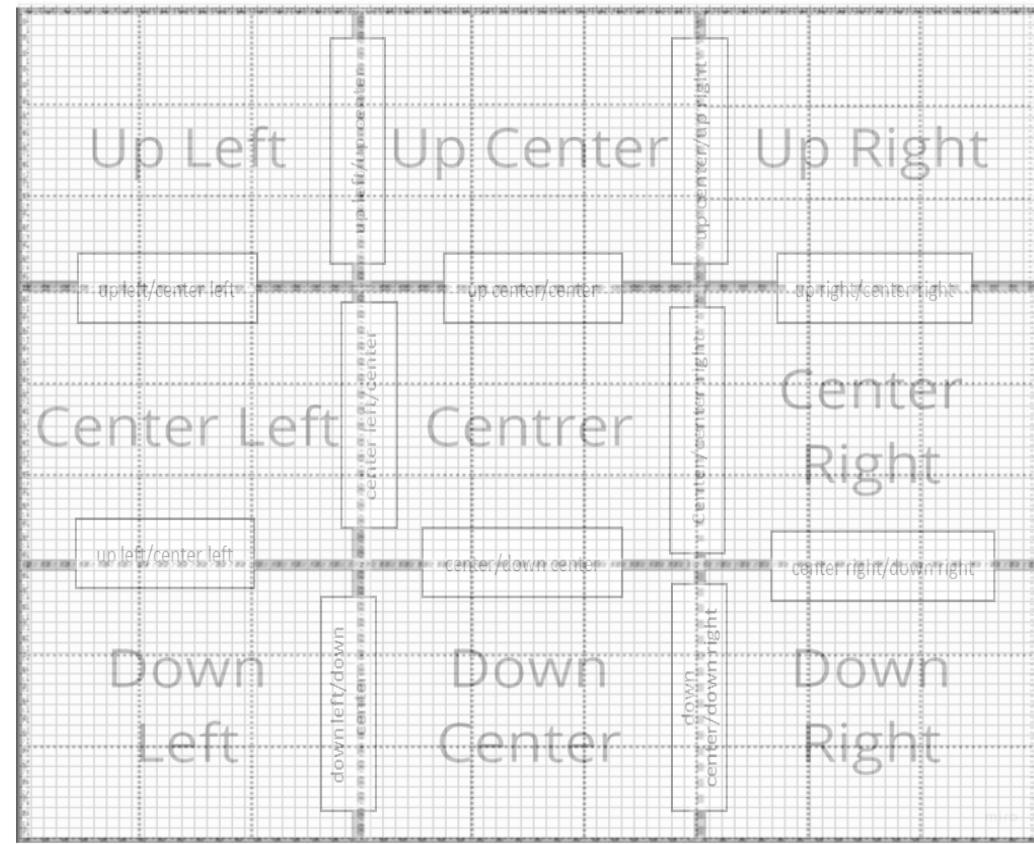
05/02/2025



Eagle Robot Case Study CueniForm Validation

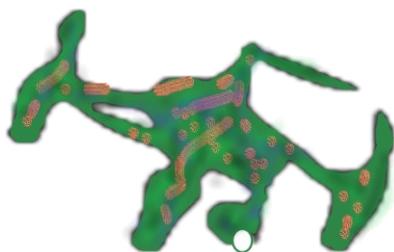


Cuneiform Canvas



Black Swan Scenario Image Compliance

ODD Dimension	Training class spec
Weather Conditions	Cloudy / Overcast
Time of Day	morning
CuneiForm Dimension	Training class spec
TOI's pictorial distance (nindans)	Clear Close TOI Distance TOI Distance (63.06)
TOI's Pictorial positioning	down Right
TOI's 3D orientation	Front Down Right
Horizon attitude	Roll: 0, Pitch: 0



Front Down Right

