

# Appendix M Safety Validation Report for AVOID Dataset using the CuneiForm method

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## Safety Validation Report for AVOID Dataset using the CuneiForm method

Dataset Safety Report  
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The output of AVOIDDS Case Study



Part of PhD project Supervised by  
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## 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                                 |
|         |   |

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## 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).

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# 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.

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# 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.**

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# Satisfying ALARP Requirements

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AVOIDDS does not pass the ALARP criteria for the coverage of 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).

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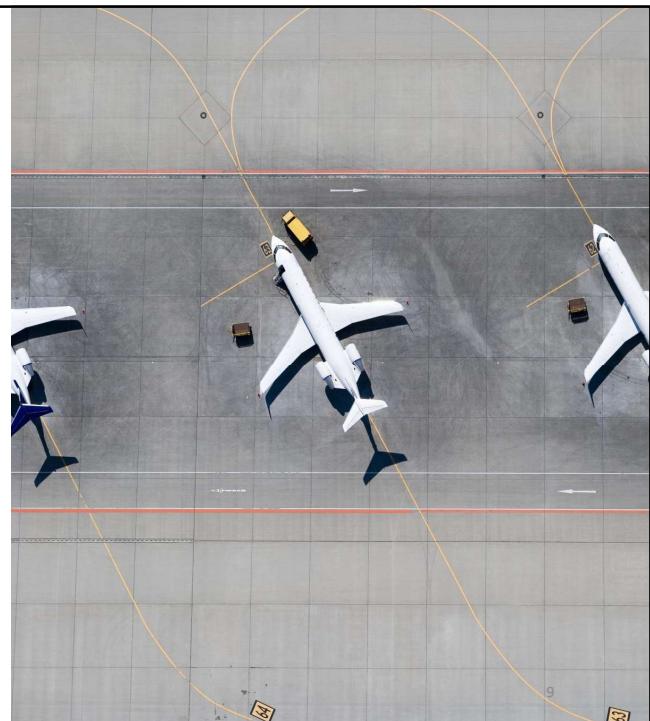
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## Conclusion

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

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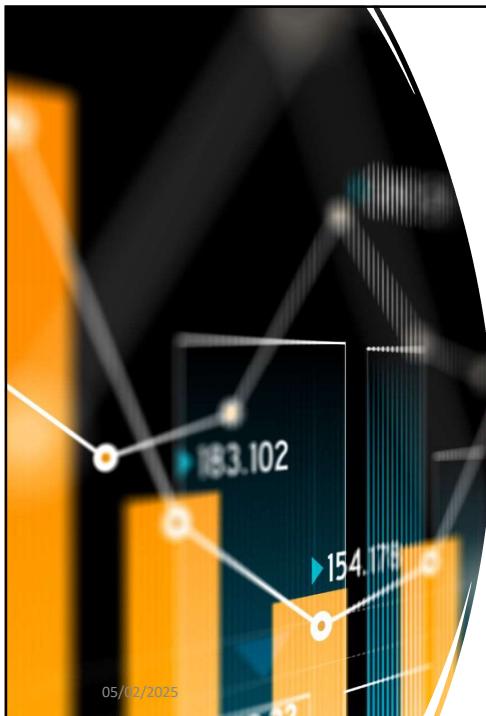
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## AVOID Dataset description

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](https://purl.stanford.edu/hj293cv5980).

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## 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.

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## 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  |
|---------------------------|--|
| <b>Weather Conditions</b> | clear, high cirrus, scattered clouds, broken clouds, overcast, stratus |
| <b>Time of Day</b>        | morning, midday, afternoon, and late afternoon.                        |

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

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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:

|                 |                   |                  |                 |                  |                |
|-----------------|-------------------|------------------|-----------------|------------------|----------------|
|                 |                   |                  |                 |                  |                |
| Front up left   | Front up center   | Front up right   | Rear down right | Rear down center | Rear down left |
|                 |                   |                  |                 |                  |                |
| Left            | Front             | Top              | Bottom          | Rear             | Right          |
|                 |                   |                  |                 |                  |                |
| Front down left | Front down center | Front down right | Rear up left    | Rear up center   | Rear up right  |

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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 \* 9 = 729 Nindans further away = 1/729 frame area

4320 pixels  
7680 pixels  
1024 pixels  
1 Nindan distance TOI

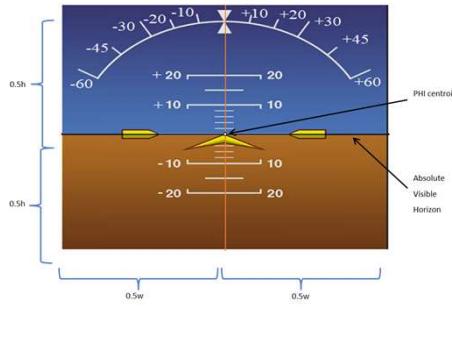
| Category (wrt human verifier)         | Pictorial Distance (Dx) Range | Example |
|---------------------------------------|-------------------------------|---------|
| Extremely Unrecognisable TOI Distance | Dx > 1600 nindans             |         |
| Moderately Recognisable TOI Distance  | 729 > Dx <= 1600 nindans      |         |
| Recognisable TOI Distance             | 300 > Dx <= 729 nindans       |         |
| Clear Close TOI Distance              | 40 > Dx <= 300 nindans        |         |
| Dangerously Close TOI Distance        | Dx <= 40 nindans              |         |

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## 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           | $-90 \leq \text{ROLL} \leq 90$ | $-90 \leq \text{PITCH} \leq -80$ |

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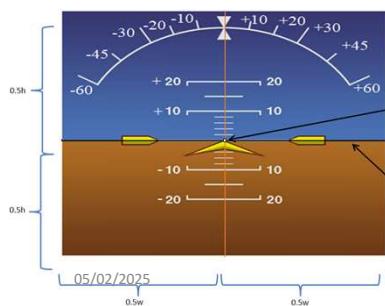
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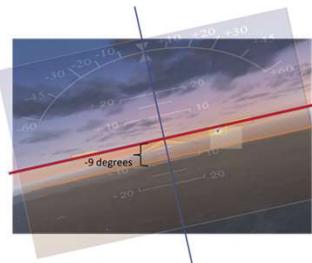
## Definition of ALARP: Horizon attitude categories to achieve ALARP requirements

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

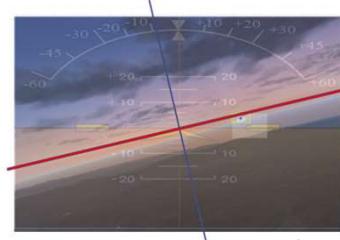
| Horizon attitude category           | Roll Range                     | Pitch Range                      |
|-------------------------------------|--------------------------------|----------------------------------|
| Level Horizon                       | $-1 \leq \text{ROLL} \leq 1$   | $-1 \leq \text{PITCH} \leq 1$    |
| 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 | $-90 \leq \text{ROLL} \leq 90$ | $45 < \text{PITCH} \leq 80$      |
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| Lowered Level Horizon               | $-1 \leq \text{ROLL} \leq 1$   | $-45 \leq \text{PITCH} \leq -1$  |
| Positively Tilted Lowered Horizon   | $1 < \text{ROLL} \leq 90$      | $-45 \leq \text{PITCH} \leq -1$  |
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| Acute Angled Rocket Sky View        | $-90 \leq \text{ROLL} \leq 90$ | $-80 \leq \text{PITCH} \leq -45$ |
| Ascending Rocket Sky View           | $-90 \leq \text{ROLL} \leq 90$ | $-90 \leq \text{PITCH} \leq -80$ |



PHI pitch angle



PHI roll angle

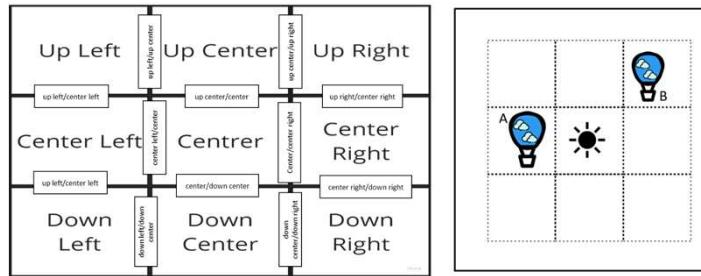


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To reduce the risk of perception failure due to insufficient development dataset coverage, statistically sound samples should demonstrate the following training class coverage criteria:

|                        |                       |                         |
|------------------------|-----------------------|-------------------------|
| 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 |



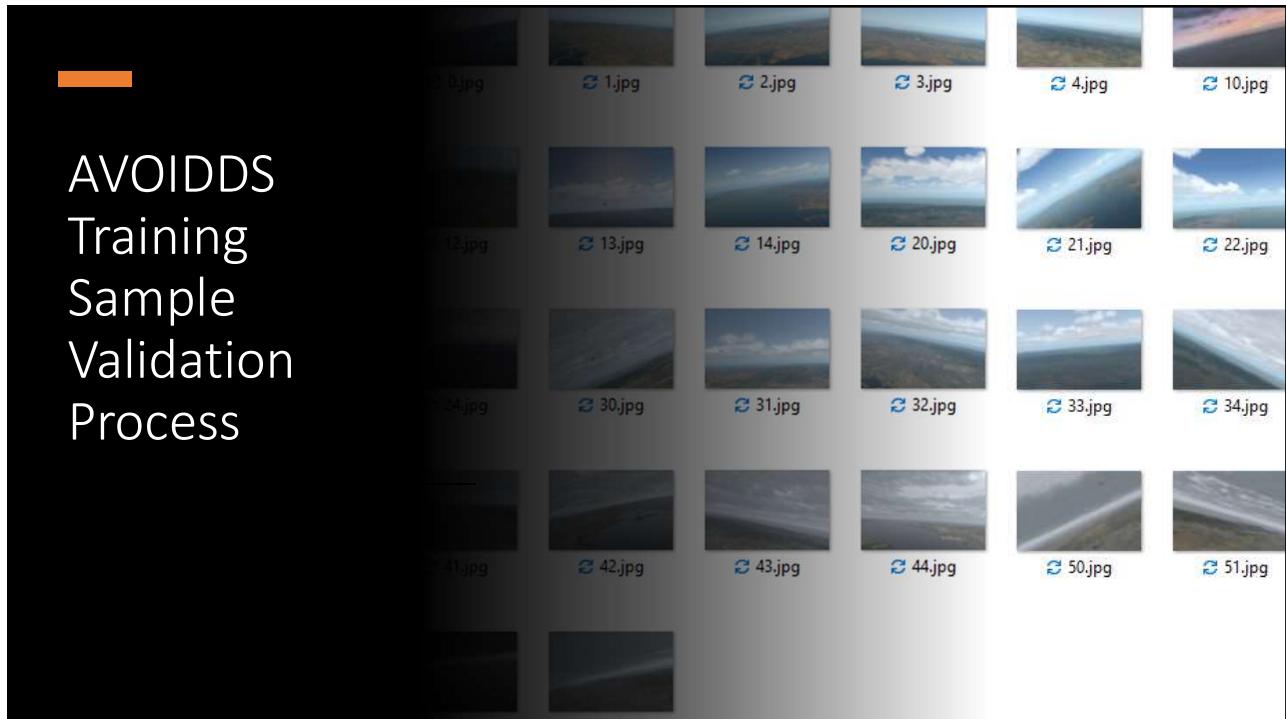
## Definition of ALARP: TOI's positioning Training classes to achieve ALARP requirements

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## AVOIDDS Training Sample Validation Process



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## Examining AVOIDDS Training Strategy in Covering Clouds type

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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.

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## Missing Training and Black Swan Scenarios



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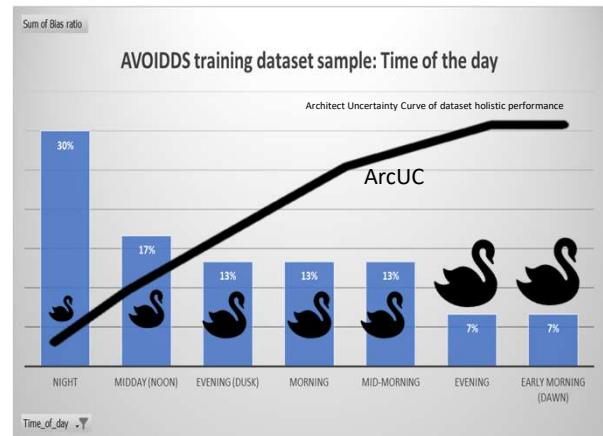
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## Examining AVOIDDS Training Strategy in Covering Time-of-Day Training Classes

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.



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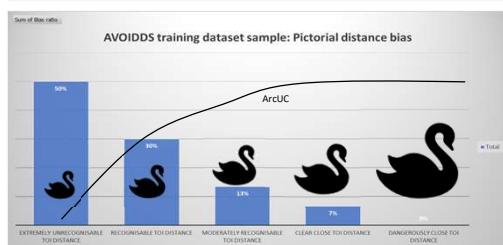
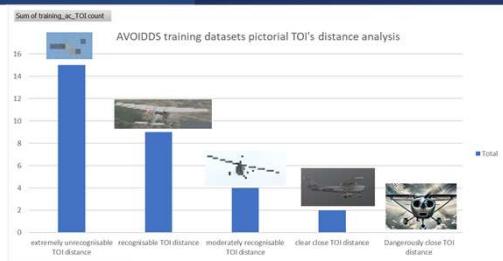
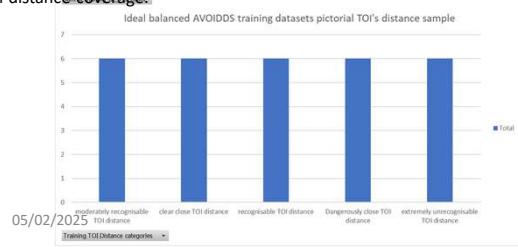
## Examining AVOIDDS Training Strategy in Covering Pictorial Distance Training Classes:

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 :

- 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.

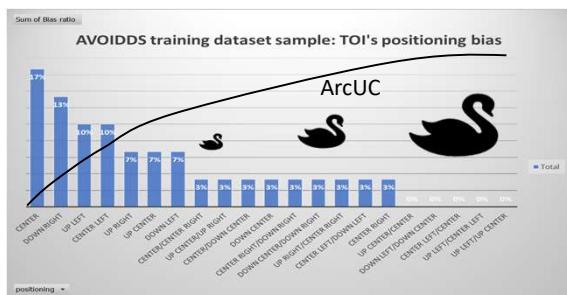
Consequently, the dataset does not satisfactorily fulfil the ALARP requirement for pictorial distance coverage.



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## 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 of 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.

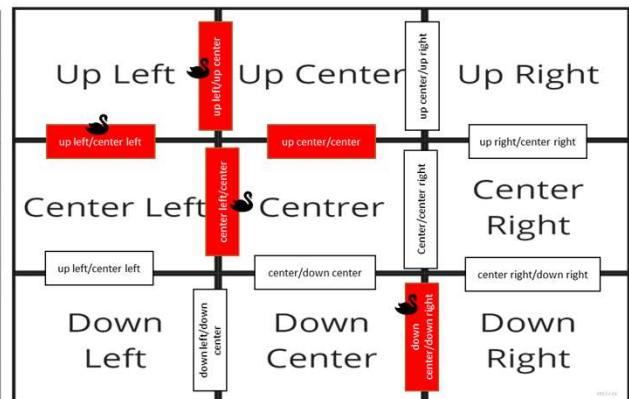
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## Examining AVOIDDS Training Strategy in Covering TOI's Positioning Training Classes:



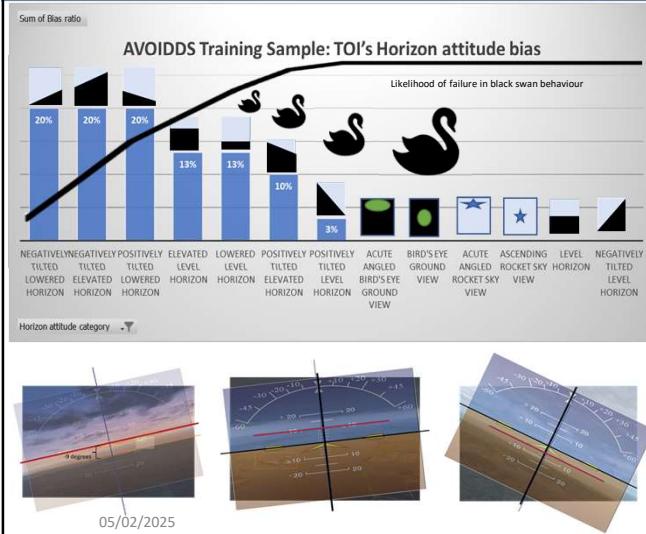
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## AVOIDDS Training Sample TOI's Horizon attitude analysis



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.

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## Possible Hazards identified

| Perception Failure mode  | Perception Safety requirement   |
|--|---|
| <b>Ambiguity in Object Identification:</b><br><b>Risk:</b> The system might fail to recognize other aircraft when they are at a long distance or have an orientation that makes them difficult to identify. For example, if an aircraft is coming from an unconventional angle (e.g., upside down or tilted), the system might misinterpret its position and distance, leading to incorrect avoidance actions.   | <b>Mitigation:</b> The perception system must be trained to handle diverse orientations, particularly those that might appear unconventional due to the flight dynamics of the aircraft or environmental conditions.  |
| <b>Difficulties in Recognizing Distant or Low-Visibility Objects:</b><br><b>Risk:</b> In low-light (e.g., night), weather, or long-range scenarios, the system might fail to detect aircraft that are at extreme distances or partially obscured by clouds, smoke, or other atmospheric factors. The system's performance could degrade, especially in critical situations where detection and timely reaction are necessary to avoid collisions.          | <b>Mitigation:</b> The system should be trained to handle ambiguous or partial visual information by recognizing objects at varying distances and through weather conditions like broken clouds or low visibility. Proper handling of low-contrast or poorly illuminated objects will ensure that the system remains effective even in suboptimal conditions. |
| <b>Uncertainty in Aircraft Orientation and Behavior:</b><br><b>Risk:</b> Aircraft can appear in various orientations due to their flight path (e.g., ascending, descending, tilted). If the perception system cannot accurately determine the orientation or trajectory of another aircraft, it might misinterpret its movement or predict the wrong course of action. This is particularly dangerous when aircraft are near each other or crossing paths. | <b>Mitigation:</b> The system must be trained to interpret diverse aircraft orientations, especially in scenarios where they might not be level, and to account for dynamic flight behavior. This would ensure that it can differentiate between aircraft in a stable flight path versus those in unusual orientations, thus avoiding collision.              |

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# Training Dataset Requirement (retrospective)

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The dataset shall expose the perception model to the following experiences:

1. a **single engine propeller aircraft{1.1}** **centrally positioned{2.1}** **under broken clouds{3.1}** in the **Early Morning {4.1}**, with its **rear tilted up-left{5.1}**, at a **recognisable distance{6.1}**, against a **Negatively Tilted Lowered Horizon{7.1}**.
2. A **Mid-Morning{4.2}** image, where the aircraft is **center-left{2.3}**, at a **moderately recognisable distance{6.3}**, with a **front-up-right orientation{5.2}**, framed against a **Lowered Level Horizon{7.3}**.
3. A **night {4.3}** depiction with the **aircraft {1.1}** toward the **centre and centre-right{2.4}**, at an **extremely unrecognisable distance{6.2}**, its **front tilted downward left {5.4}**, against a **Positively Tilted Elevated Horizon{7.5}**.
4. A **Night{4.4}** scene with the **aircraft {1.1} centred{2.1}**, at an **extremely unrecognisable distance{6.2}**, oriented to the **right{5.3}**, under a **Negatively Tilted Elevated Horizon{7.4}**.
5. A **scene in the Early Morning {4.1}** with the **aircraft{1.1}** in the **Down-right corner{2.2}**, at an **extremely unrecognisable distance{6.2}**, against a **Positively Tilted Lowered Horizon{7.2}**, with its [missing orientation].

## AI Training CuneiForms

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

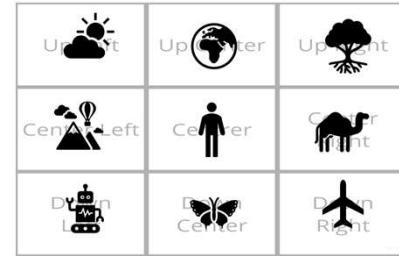
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# AI Training CuneiForm 0

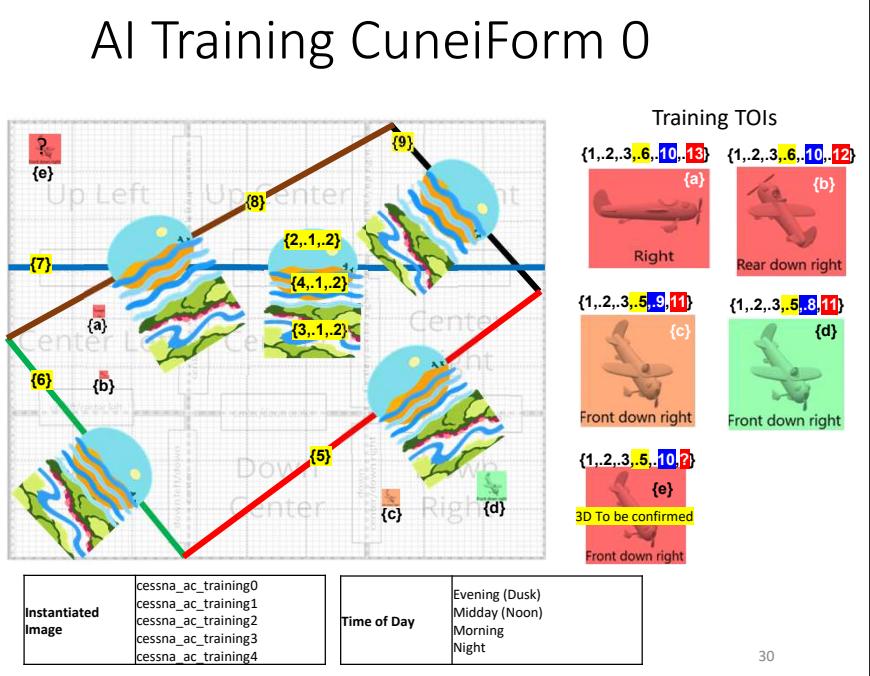


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| Abstract CuneiForm Characteristics (dimensions)      | Abstract CuneiForm Characteristics definitions  |
|--|---|
| TOIs definition and their aesthetic complexity       | Single-engine propeller aeroplane {1}   |
| TOI Motion and Dynamic optical 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{?}   |



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# AI Training CuneiForm 0

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# 0.jpg

| ODD Dimension             | Training class spec         |
|---------------------------|-----------------------------|
| <b>Weather Conditions</b> | clear                       |
| <b>Time of Day</b>        | Evening (Dusk).<br>18:15:31 |

| CuneiForm Dimension                       | Training class spec |
|---|---------------------|
| <b>TOI's pictorial distance (nindans)</b> | $6561/6 = 1093.5$   |
| <b>TOI's Pictorial positioning</b>        | Down right          |
| <b>TOI's 3D orientation</b>               | front down right    |
| <b>Horizon attitude</b>                   | Roll: -5, Pitch: -2 |

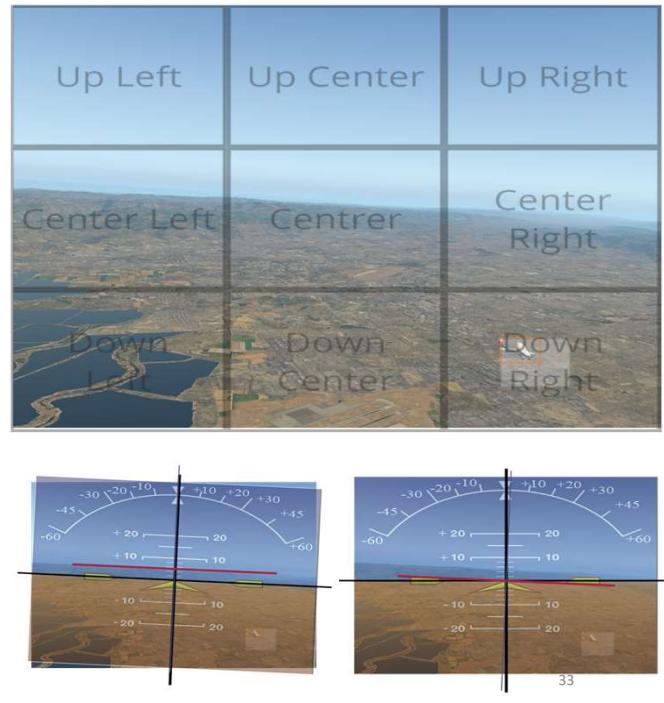
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## 1.jpg

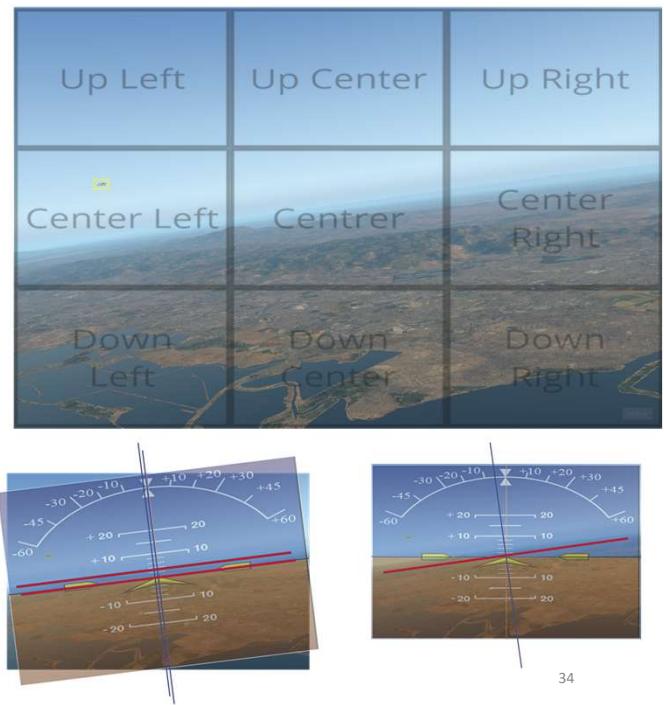
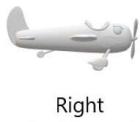
| ODD Dimension                      | Training class spec         |
|------------------------------------|-----------------------------|
| Weather Conditions                 | clear                       |
| Time of Day                        | late afternoon,<br>19:20:53 |
| CuneiForm Dimension                | Training class spec         |
| TOI's pictorial distance (nindans) | $6561/15 = 437.4$           |
| TOI's Pictorial positioning        | down right                  |
| TOI's 3D orientation               | front down right            |
| Horizon attitude                   | Roll: 1, Pitch: 7           |



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## 2.jpg

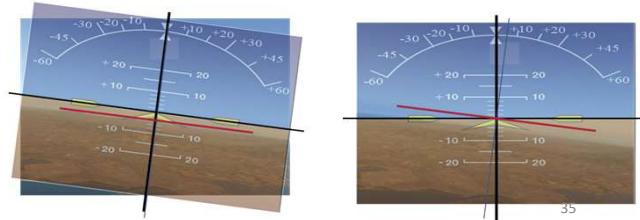
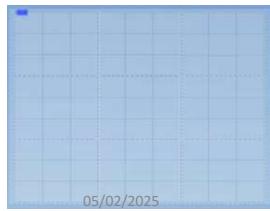
| ODD Dimension                      | Training class spec        |
|------------------------------------|----------------------------|
| Weather Conditions                 | clear                      |
| Time of Day                        | Midday (Noon),<br>11:16:17 |
| CuneiForm Dimension                | Training class spec        |
| TOI's pictorial distance (nindans) | $6561/2 = 3280.5$          |
| TOI's Pictorial positioning        | center left                |
| TOI's 3D orientation               | right                      |
| Horizon attitude                   | Roll: -5, Pitch: 3         |



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## 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) | 6561/0.2            |
| TOI's Pictorial positioning        | up center           |
| TOI's 3D orientation               | Unknown             |
| Horizon attitude                   | Roll: 5, Pitch: -4  |



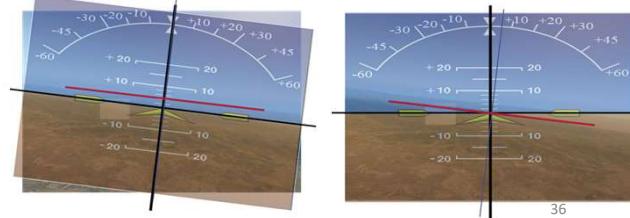
35

## 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) | 6561/1              |
| TOI's Pictorial positioning        | center left         |
| TOI's 3D orientation               | rear down right     |
| Horizon attitude                   | Roll: 5, Pitch: 4   |



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| 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                | <b>Motion trajectory:</b> Linear motion captured in consecutive images where the aeroplane appears to move in a straight line at a constant speed (no acceleration) {1.2}. <b>Dynamic optical state:</b> 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 | <b>Motion trajectory:</b> is static {2.1,3.1,4.1} <b>Dynamic optical state:</b> 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}   |

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AI Training CuneiForm 1

Training TOIs

- {1,2,3,5,9,11} {1,2,3,4,9,12}
- {a} {b}
- {c} {d}
- {e}

Instantiated Image: cessna\_ac\_training10, cessna\_ac\_training11, cessna\_ac\_training12, cessna\_ac\_training13, cessna\_ac\_training14

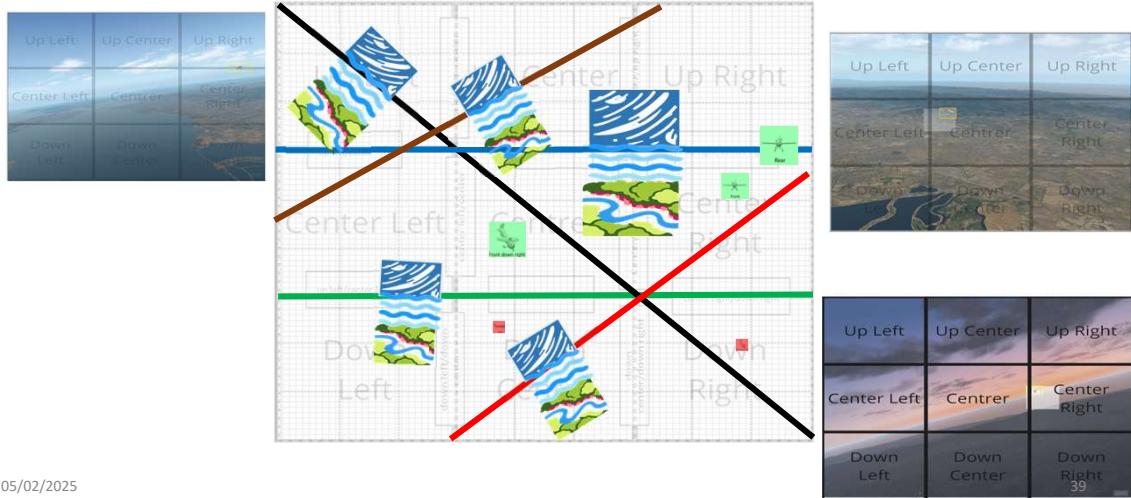
Time of Day: Evening (Dusk), Midday (Noon), Morning, Night

high cirrus clouds

38

## AI Training CuneiForm 1

The clouds in AVOIDS training do not validate the cuneiform.



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### AVOIDDS Sample Training: 10.jpg

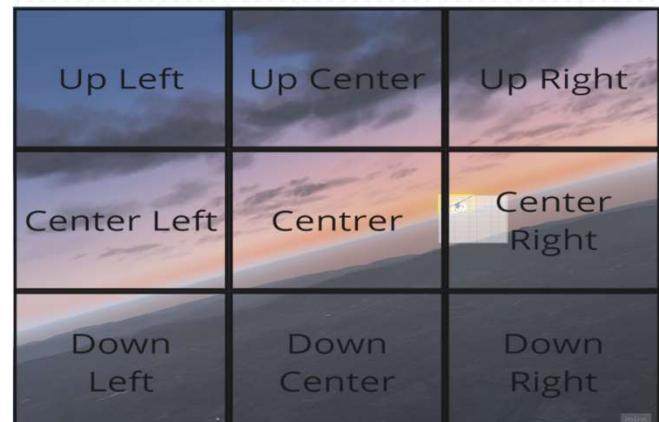
| ODD Dimension                      | Training class spec        |
|------------------------------------|----------------------------|
| Weather Conditions                 | high cirrus                |
| Time of Day                        | Evening (Dusk)<br>18:11:31 |
| CuneiForm Dimension                | Training class spec        |
| TOI's pictorial distance (nindans) | $6561/15 = 437.4$          |
| TOI's Pictorial positioning        | center right               |
| TOI's 3D orientation               | Front                      |
| Horizon attitude                   | Roll: -10, Pitch: -9       |



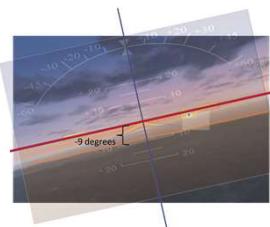
Front



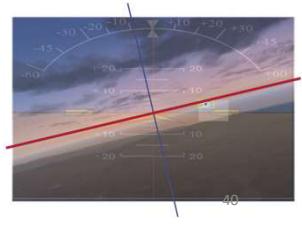
05/02/2025



PHI pitch angle



PHI roll angle



40

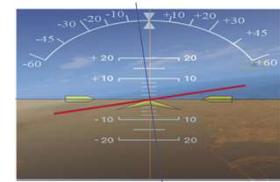
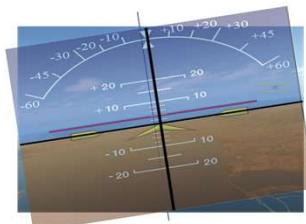
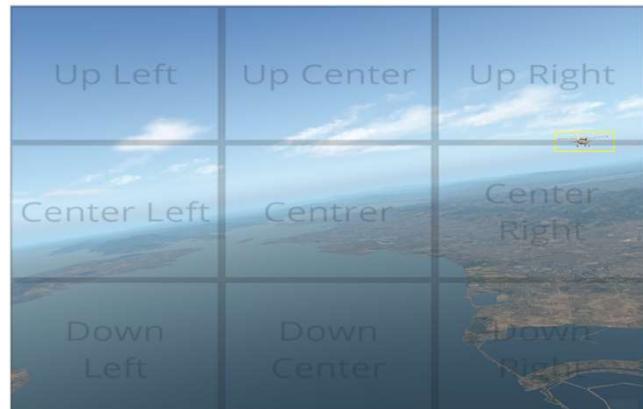
## 14.jpg

| ODD Dimension                             | Training class spec         |
|---|-----------------------------|
| <b>Weather Conditions</b>                 | high cirrus                 |
| <b>Time of Day</b>                        | Evening (Dusk),<br>19:42:11 |
| <b>CuneiForm Dimension</b>                | <b>Training class spec</b>  |
| <b>TOI's pictorial distance (nindans)</b> | $6561/21 = 312.4$           |
| <b>TOI's Pictorial positioning</b>        | up right/center right       |
| <b>TOI's 3D orientation</b>               | rear                        |
| <b>Horizon attitude</b>                   | <b>Roll: -5, Pitch: 4</b>   |



Rear

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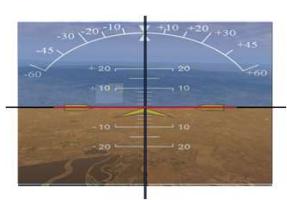
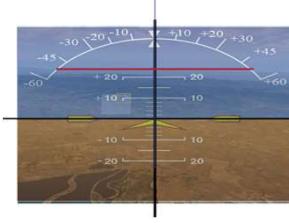
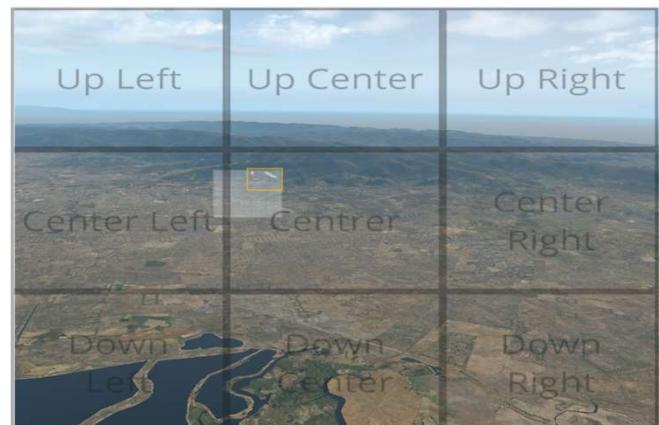
41

## 12.jpg

| ODD Dimension                             | Training class spec        |
|---|----------------------------|
| <b>Weather Conditions</b>                 | high cirrus                |
| <b>Time of Day</b>                        | late afternoon             |
| <b>CuneiForm Dimension</b>                | <b>Training class spec</b> |
| <b>TOI's pictorial distance (nindans)</b> | $6561/12 = 546.75$         |
| <b>TOI's Pictorial positioning</b>        | center                     |
| <b>TOI's 3D orientation</b>               | front down right           |
| <b>Horizon attitude</b>                   | <b>Roll: 0, Pitch: 25</b>  |



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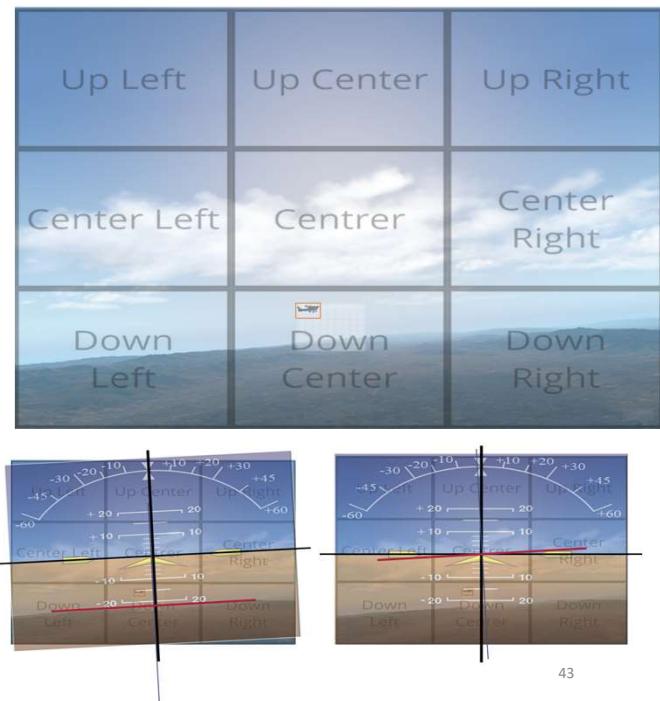
42

## 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) | 6561/6               |
| TOI's Pictorial positioning        | down center          |
| TOI's 3D orientation               | right                |
| Horizon attitude                   | Roll: -1, Pitch: -22 |



Right  
05/02/2025



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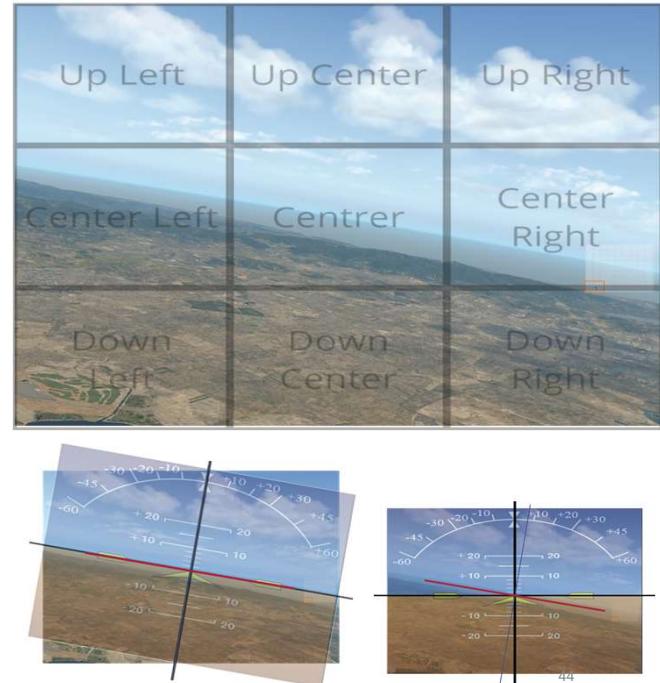
43

## 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) | 6561/4 = 1640.25        |
| TOI's Pictorial positioning        | center right/down right |
| TOI's 3D orientation               | front down right        |
| Horizon attitude                   | Roll: 5, Pitch: 0       |



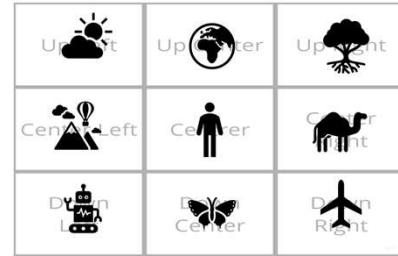
Front down right  
05/02/2025



44

44

# AI Training CuneiForm 2



05/02/2025

45

45

| 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                | <b>Motion trajectory:</b> Linear motion captured in consecutive images where the aeroplane appears to move in a straight line at a constant speed (no acceleration) {1.2}. <b>Dynamic optical state:</b> 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 | <b>Motion trajectory:</b> is static {2.1,3.1,4.1} <b>Dynamic optical state:</b> 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{?}  |
| 05/02/2024   |   |

**AI Training CuneiForm 2**

Instantiated Image

cessna\_ac\_training20  
cessna\_ac\_training21  
cessna\_ac\_training22  
cessna\_ac\_training23  
cessna\_ac\_training24

Training TOIs

|                |               |
|----------------|---------------|
| {1,2,3,5,8,12} | {1,2,3,4,8,9} |
|                |               |
| Rear up right  | Left          |

|                |                |
|----------------|----------------|
| {1,2,3,6,7,10} | {1,2,3,5,8,11} |
|                |                |
| Rear           | Rear up left   |

|                    |      |
|--------------------|------|
| {1,2,3,7,10,14}    |      |
|                    |      |
| 3D To be confirmed | Left |

Time of Day

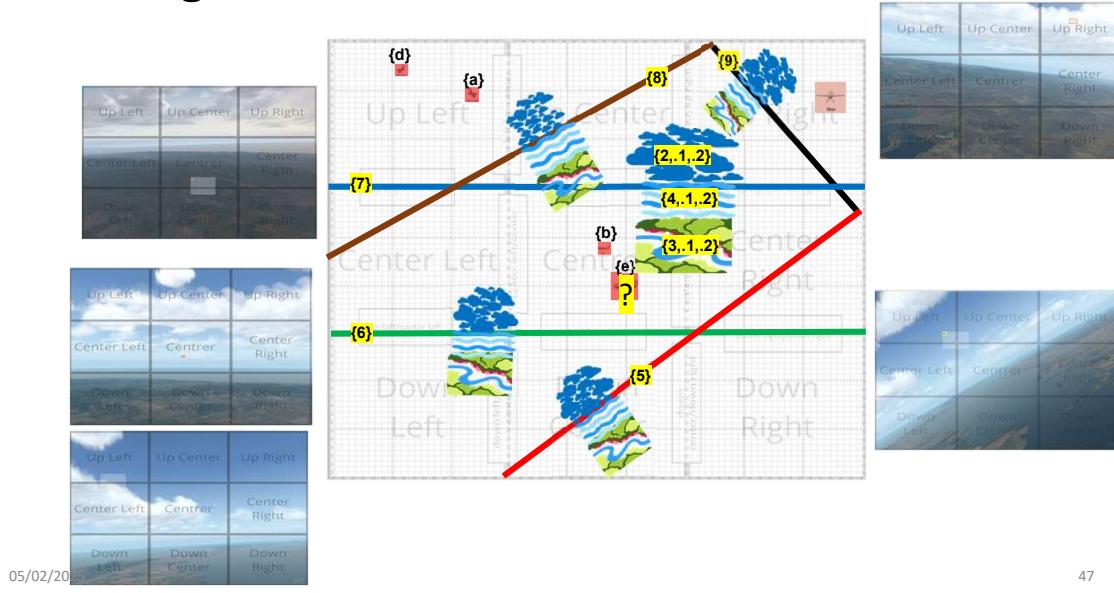
Evening (Dusk)  
Midday (Noon)  
Morning  
Night

46

Scattered clouds

46

## AI Training CuneiForm 2



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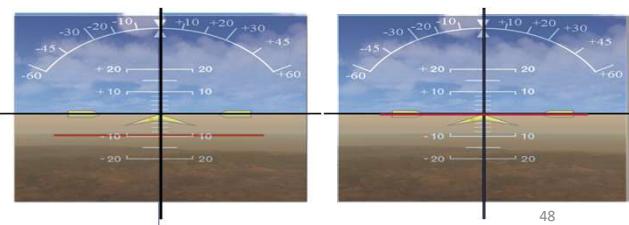
20.jpg

| 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) | 6561/1              |
| TOI's Pictorial positioning        | center              |
| TOI's 3D orientation               | left                |
| Horizon attitude                   | Roll: 0, Pitch: -10 |



Left

05/02/2025



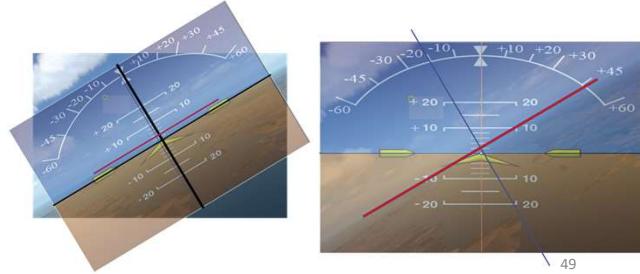
48

## AVOIDDS Sample Training: 21.jpg

| ODD Dimension                             | Training class spec  |
|---|----------------------|
| <b>Weather Conditions</b>                 | scattered clouds     |
| <b>Time of Day</b>                        | Morning 06:56:32     |
| <b>CuneiForm Dimension</b>                | Training class spec  |
| <b>TOI's pictorial distance (nindans)</b> | $6561/2 = 3280.5$    |
| <b>TOI's Pictorial positioning</b>        | Up left              |
| <b>TOI's 3D orientation</b>               | Rear up left         |
| <b>Horizon attitude</b>                   | Roll: -11, Pitch: +3 |



Rear up left  
05/02/2025



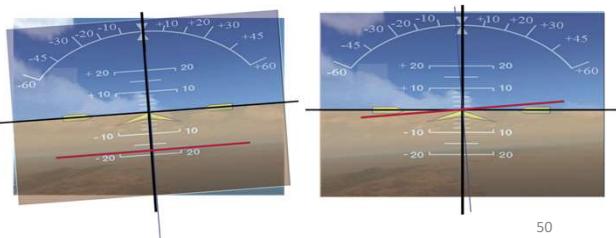
49

## 22.jpg

| ODD Dimension                             | Training class spec  |
|---|----------------------|
| <b>Weather Conditions</b>                 | scattered clouds     |
| <b>Time of Day</b>                        | morning, 01:14:22    |
| <b>CuneiForm Dimension</b>                | Training class spec  |
| <b>TOI's pictorial distance (nindans)</b> | $6561/1$             |
| <b>TOI's Pictorial positioning</b>        | Up left              |
| <b>TOI's 3D orientation</b>               | rear up right        |
| <b>Horizon attitude</b>                   | Roll: -2, Pitch: -18 |



Rear up right  
05/02/2025



50

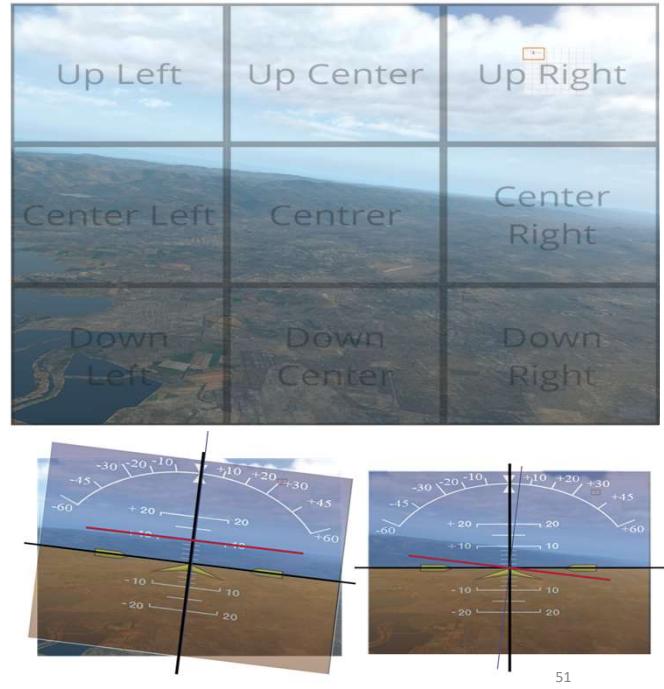
50

## 23.jpg

| ODD Dimension                      | Training class spec         |
|------------------------------------|-----------------------------|
| Weather Conditions                 | scattered clouds            |
| Time of Day                        | late afternoon,<br>20:41:29 |
| CuneiForm Dimension                | Training class spec         |
| TOI's pictorial distance (nindans) | $6561/6 = 1093.5$           |
| TOI's Pictorial positioning        | up right                    |
| TOI's 3D orientation               | rear                        |
| Horizon attitude                   | Roll: 5, Pitch: 10          |



Rear  
05/02/2025



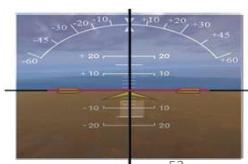
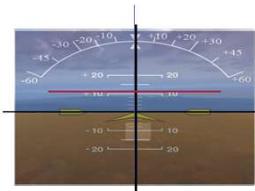
51

## 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) | $6561/1$            |
| TOI's Pictorial positioning        | center              |
| TOI's 3D orientation               | Unknown             |
| Horizon attitude                   | Roll: 0, Pitch: 11  |

3D?

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52



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| 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                | <b>Motion trajectory:</b> Linear motion captured in consecutive images where the aeroplane appears to move in a straight line at a constant speed (no acceleration) {1.2}. <b>Dynamic optical state:</b> 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                             | <b>Negatively Tilted Lowered Horizon(5)</b> <b>Positively Tilted Lowered Horizon(6)</b> <b>Lowered Level Horizon(7)</b> <b>Negatively Tilted Elevated Horizon(8)</b> <b>Positively Tilted Elevated Horizon(9)</b>                             |
| TOI's Pictorial Positioning                          | Center(1,4)<br>Down right(1,5)<br>center left(1,6)<br>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)<br>front up right(1,12)<br>Right(1,13)<br>front down left(1,14)  |
| 05/02/2025   |   |

**AI Training CuneiForm 3**

The diagram shows a 3D perspective view of terrain and clouds, divided into regions: Up Left, Up Center, Center, Center Left, Center Right, Down Left, Down Center, and Down Right. A red diagonal line from the top-left passes through points labeled (5), (8), (9), and (e). A green diagonal line from the bottom-left passes through points labeled (7), (6), (d), and (c). Points are numbered (1..1,2), (2..1,2), (3..1,2), (4..1,2), (5..1,2), (6..1,2), (7..1,2), (8..1,2), (9..1,2), and (e). To the right, a legend titled "Training TOIs" lists categories and corresponding icons and numbers:

- {1,2,3,4,10,11} {a} Rear up left
- {1,2,3,7,10,14} {b} Front down left
- {1,2,3,4,10,13} {c} Right
- {1,2,3,7,10,14} {d} 3D To be confirmed Right
- {1,2,3,6,9,12} {e} Front up right

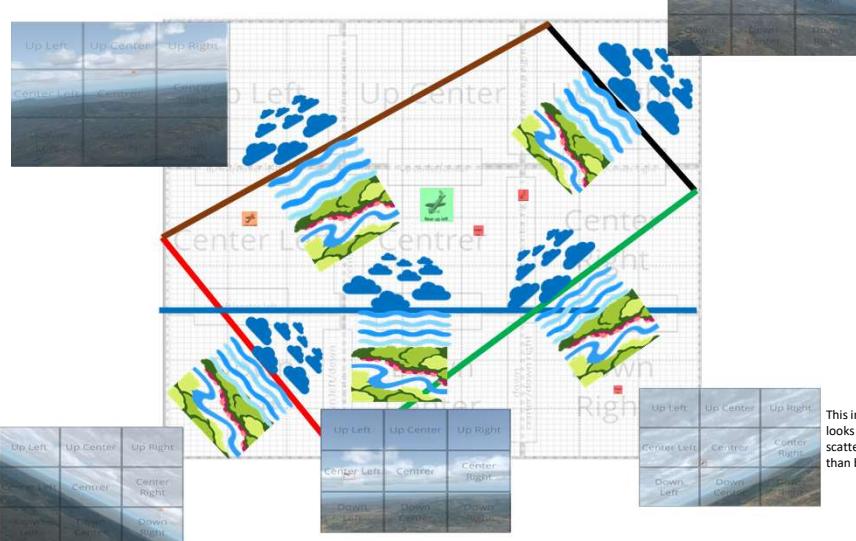
Below the diagram are two small images: a blue sky with white clouds and a cluster of blue clouds.

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

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## AI Training CuneiForm 3



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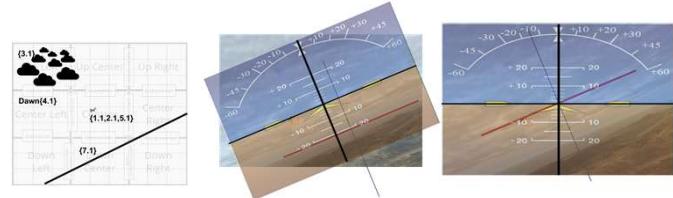
55

## 30.jpg

| ODD Dimension                      | Training class spec               |
|------------------------------------|-----------------------------------|
| Weather Conditions                 | broken clouds                     |
| Time of Day                        | Early Morning (Dawn),<br>05:26:23 |
| CuneiForm Dimension                | Training class spec               |
| TOI's pictorial distance (nindans) | $6561/9 = 729$                    |
| TOI's Pictorial positioning        | center                            |
| TOI's 3D orientation               | rear up left                      |
| Horizon attitude                   | Roll: -15, Pitch: -20             |



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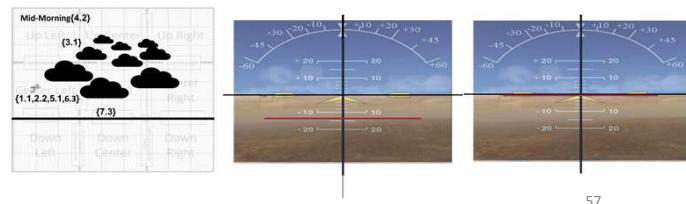
56

## 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) | $6561/8 = 820.125$    |
| TOI's Pictorial positioning        | center left           |
| TOI's 3D orientation               | front up right        |
| Horizon attitude                   | Roll: 0, Pitch: -14   |



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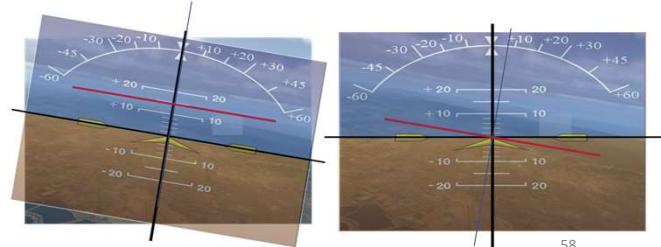
57

## 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) | $6561/2 = 3280.5$   |
| TOI's Pictorial positioning        | center/center right |
| TOI's 3D orientation               | front down left     |
| Horizon attitude                   | Roll: 7, Pitch: 15  |



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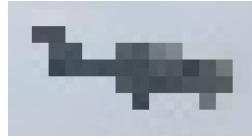
58

## 33.jpg

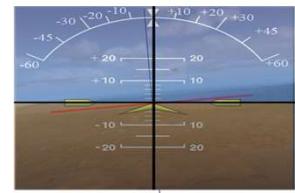
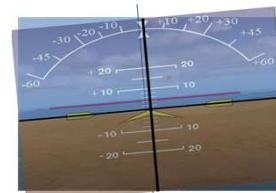
| ODD Dimension                      | Training class spec |
|------------------------------------|---------------------|
| Weather Conditions                 | broken clouds       |
| Time of Day                        | Night, 23:26:59     |
| CuneiForm Dimension                | Training class spec |
| TOI's pictorial distance (nindans) | 6561/1              |
| TOI's Pictorial positioning        | center              |
| TOI's 3D orientation               | right               |
| Horizon attitude                   | Roll: -3, Pitch: 4  |



Right



05/02/2025

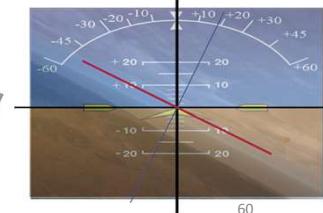
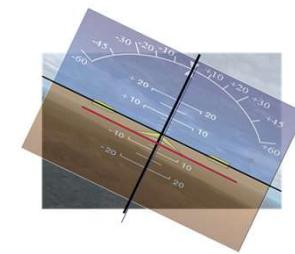
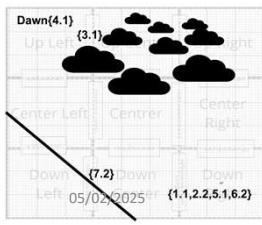


59

59

## 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) | 6561/1                         |
| TOI's Pictorial positioning        | down right                     |
| TOI's 3D orientation               | Unknown                        |
| Horizon attitude                   | Roll: 18, Pitch: -6            |



60

60



61

| 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                | <b>Motion trajectory:</b> Linear motion captured in consecutive images where the aeroplane appears to move in a straight line at a constant speed (no acceleration) {1.2}. <b>Dynamic optical state:</b> 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}  |
| 05/02/2025   |   |

**AI Training CuneiForm 4**

The diagram shows a 3D perspective view of a landscape with hills, clouds, and a river. A red line represents the aeroplane's path. Points along the path are labeled with identifiers: (a) Up Right, (b) Up Center, (c) Up Left, (d) Center Left, (e) Center, (f) Center Right, (g) Down Center, and (h) Down Right. To the right, there is a legend for "Training TOIs" showing various configurations of the airplane and background objects, each with a unique identifier. Below the main diagram is a table with three rows: "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), and "Instantiated Image" (cessna\_ac\_training40, cessna\_ac\_training41, cessna\_ac\_training42, cessna\_ac\_training43, cessna\_ac\_training44).

**Training TOIs**

- {1,2,3,6,10,14} {a} {1,2,3,6,11,15} {b}
- {1,2,3,6,10,13} {c} {1,2,3,5,11,13} {d}
- {1,2,3,4,10,13} {e}

3D To be confirmed Right

Overcast clouds

Instantiated Image

cessna\_ac\_training40  
cessna\_ac\_training41  
cessna\_ac\_training42  
cessna\_ac\_training43  
cessna\_ac\_training44

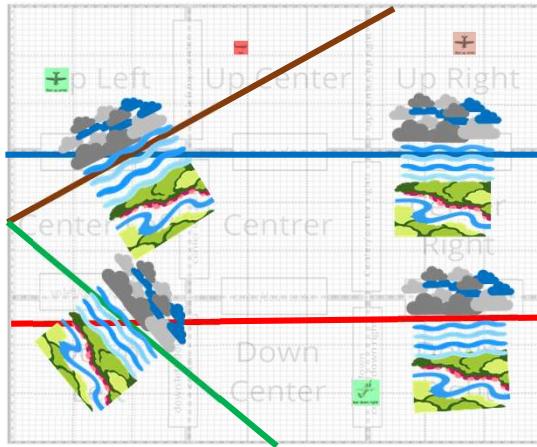
62

62

## AI Training CuneiForm 4



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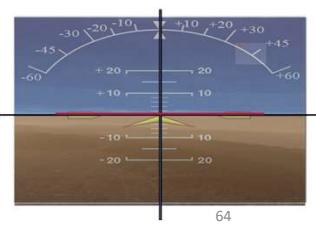
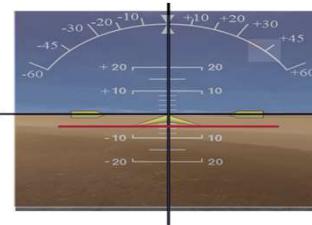
## 40.jpg

| 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) | 6561/8              |
| 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



64

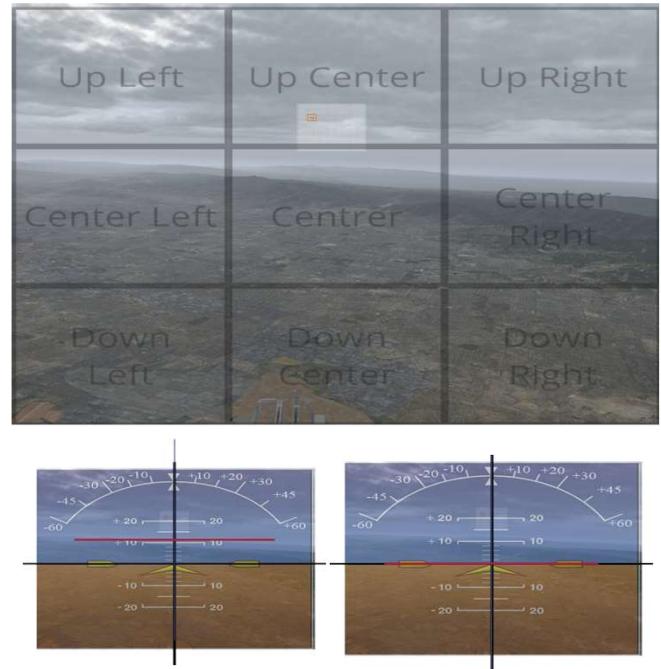
64

## 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) | 6561/1              |
| TOI's Pictorial positioning        | up center           |
| TOI's 3D orientation               | right               |
| Horizon attitude                   | Roll: 0, Pitch: 11  |



Right  
05/02/2025



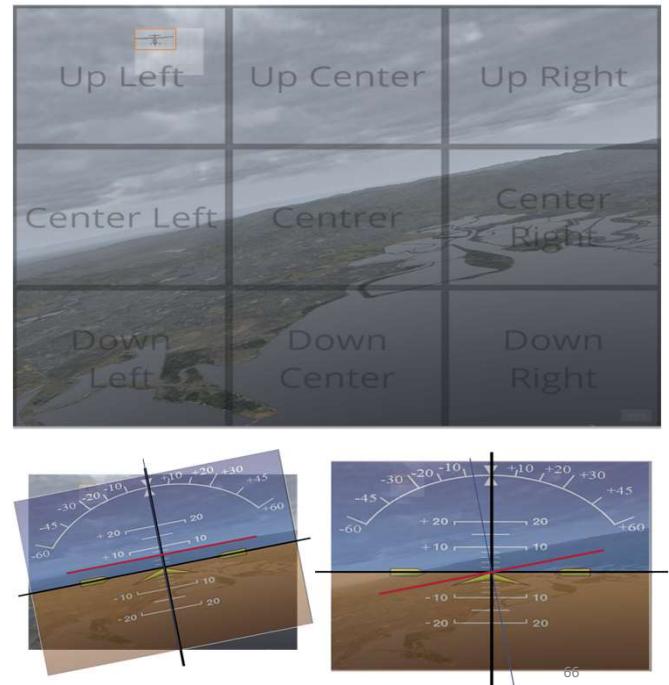
65

## 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) | 6561/16 = 410       |
| TOI's Pictorial positioning        | Up left             |
| TOI's 3D orientation               | Rear up center      |
| Horizon attitude                   | Roll: -8, Pitch: 6  |



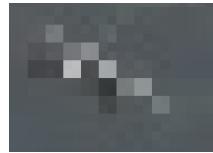
Rear up center  
05/02/2025



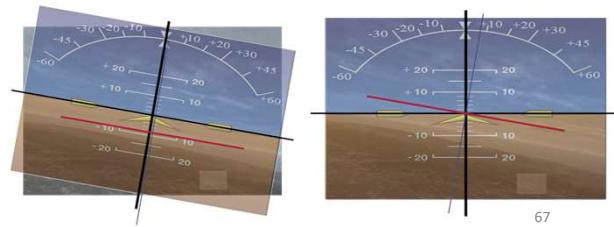
66

## 43.jpg

| ODD Dimension                             | Training class spec       |
|---|---------------------------|
| <b>Weather Conditions</b>                 | overcast,                 |
| <b>Time of Day</b>                        | morning, 10:36:00         |
| CuneiForm Dimension                       | Training class spec       |
| <b>TOI's pictorial distance (nindans)</b> | 6561/1                    |
| <b>TOI's Pictorial positioning</b>        | down right                |
| <b>TOI's 3D orientation</b>               | Unknown                   |
| <b>Horizon attitude</b>                   | <b>Roll: 8, Pitch: -9</b> |



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67

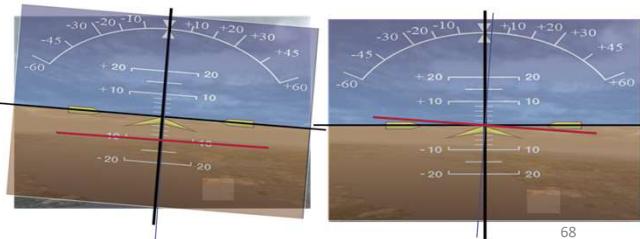
67

## 44.jpg

| ODD Dimension                             | Training class spec        |
|---|----------------------------|
| <b>Weather Conditions</b>                 | overcast                   |
| <b>Time of Day</b>                        | morning, 17:59:44          |
| CuneiForm Dimension                       | Training class spec        |
| <b>TOI's pictorial distance (nindans)</b> | $6561/10 = 656.1$          |
| <b>TOI's Pictorial positioning</b>        | down center/down right     |
| <b>TOI's 3D orientation</b>               | rear down right            |
| <b>Horizon attitude</b>                   | <b>Roll: 2, Pitch: -10</b> |



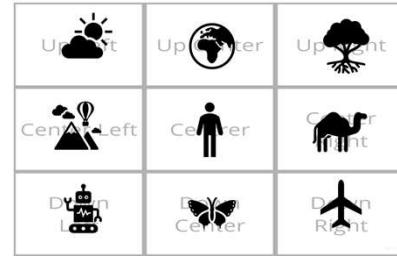
05/02/2025



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68

# AI Training CuneiForm 5



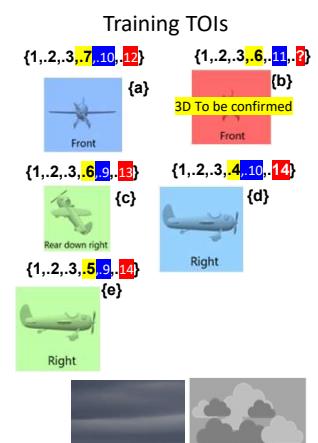
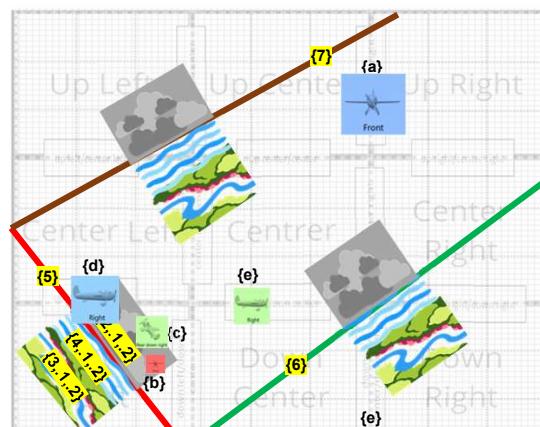
05/02/2025

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69

| 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                | <b>Motion trajectory:</b> Linear motion captured in consecutive images where the aeroplane appears to move in a straight line at a constant speed (no acceleration) {1.2}. <b>Dynamic optical state:</b> 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}   |

# AI Training CuneiForm 5



|             |  |
|-------------|--|
| Time of Day | Early Morning (Dawn){10}, Mid-Morning{11}, Night{12} |
|-------------|--|

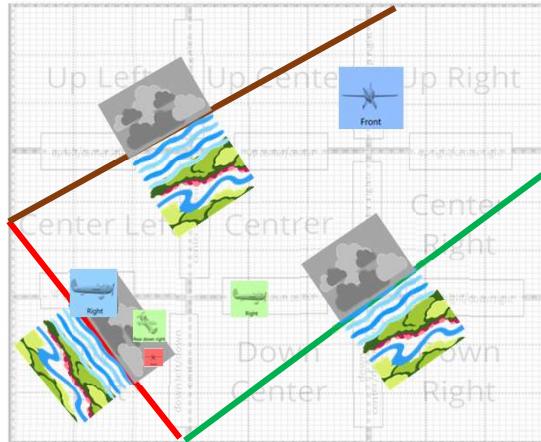
|                    |  |
|--------------------|--|
| Instantiated Image | cessna_ac_training50<br>cessna_ac_training51<br>cessna_ac_training52<br>cessna_ac_training53<br>cessna_ac_training54 |
|--------------------|--|

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## AI Training CuneiForm 5



54.jpg



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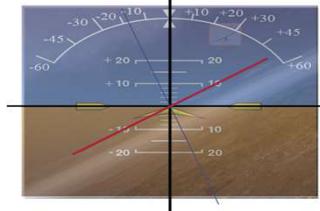
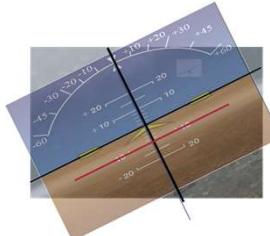
71

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) | $6561/72 = 91.1$      |
| TOI's Pictorial positioning        | up center/up right    |
| TOI's 3D orientation               | Front                 |
| Horizon attitude                   | Roll: -18, Pitch: -10 |



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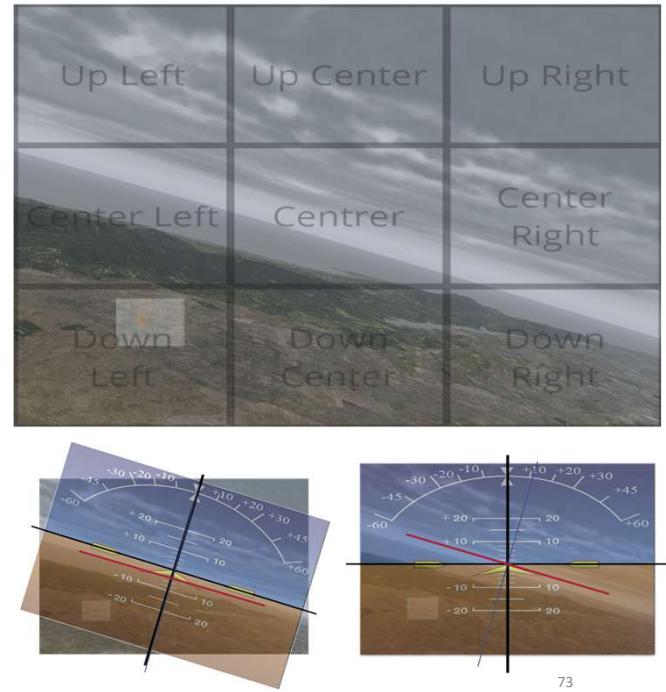
72

## 51.jpg

| ODD Dimension                      | Training class spec         |
|------------------------------------|-----------------------------|
| Weather Conditions                 | stratus                     |
| Time of Day                        | late afternoon,<br>20:50:56 |
| CuneiForm Dimension                | Training class spec         |
| TOI's pictorial distance (nindans) | 6561/1                      |
| TOI's Pictorial positioning        | down left                   |
| TOI's 3D orientation               | unknown                     |
| Horizon attitude                   | Roll: 12, Pitch: -4         |



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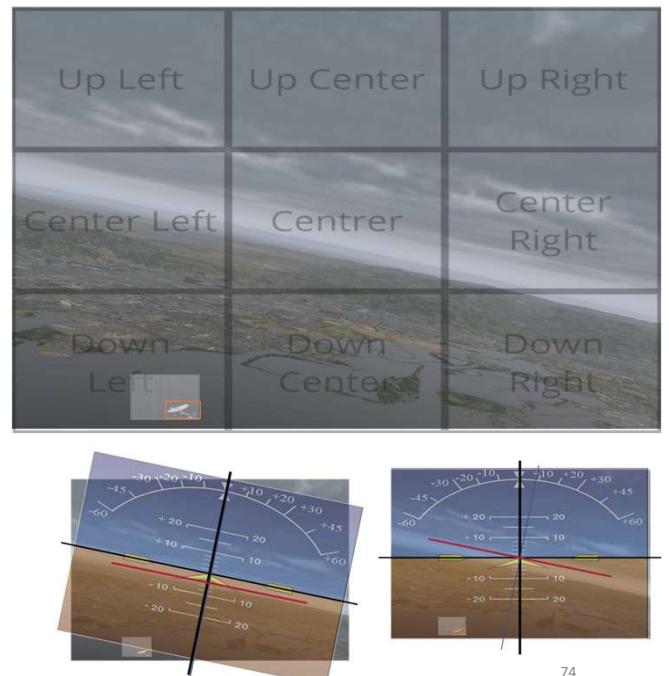
73

## 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) | 6561/12 = 546.75    |
| TOI's Pictorial positioning        | down left           |
| TOI's 3D orientation               | rear down right     |
| Horizon attitude                   | Roll: 8, Pitch: -4  |



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## 53.jpg

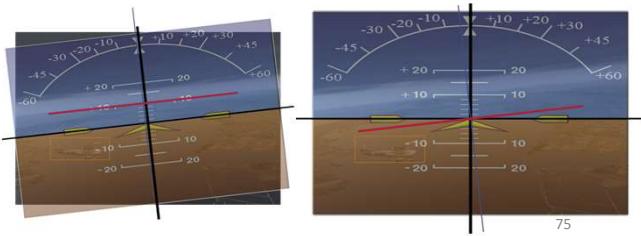
| ODD Dimension                             | Training class spec   |
|---|-----------------------|
| <b>Weather Conditions</b>                 | stratus               |
| <b>Time of Day</b>                        | morning               |
| <b>CuneiForm Dimension</b>                | Training class spec   |
| <b>TOI's pictorial distance (nindans)</b> | $6561/162 = 40.5$     |
| <b>TOI's Pictorial positioning</b>        | center left/down left |
| <b>TOI's 3D orientation</b>               | right                 |
| <b>Horizon attitude</b>                   | Roll: -3, Pitch: 10   |



Right



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75

## 54.jpg

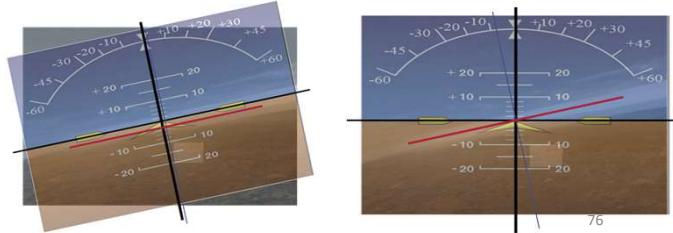
| ODD Dimension                             | Training class spec |
|---|---------------------|
| <b>Weather Conditions</b>                 | stratus             |
| <b>Time of Day</b>                        | midday, 12:10:28    |
| <b>CuneiForm Dimension</b>                | Training class spec |
| <b>TOI's pictorial distance (nindans)</b> | $6561/15 = 437.4$   |
| <b>TOI's Pictorial positioning</b>        | center/down center  |
| <b>TOI's 3D orientation</b>               | right               |
| <b>Horizon attitude</b>                   | Roll: -8, Pitch: -3 |



Right



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# AVOIDDS

## Testing dataset sample

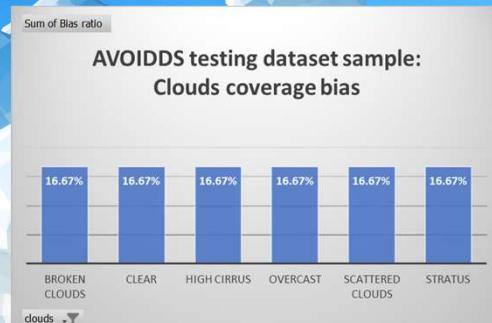
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Examining  
AVOIDDS  
Testing  
Strategy in  
Covering  
Clouds type  
testing classes

05/02/2025



The cloud coverage of the testing dataset is balanced, ensuring that the perception system is exposed to equal experiences. The dataset satisfactorily meets the ALARP (As Low As Reasonably Practicable) requirement. Furthermore, there is no evidence of bias in the analysis.

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

78

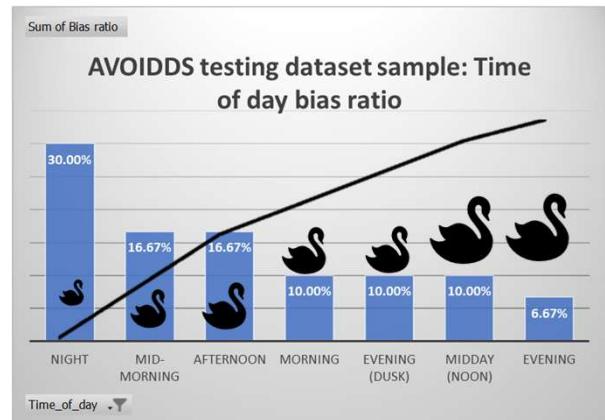
78

## Examining AVOIDDS Testing Strategy in Covering Time of the Day testing classes

There exists an imbalance in coverage, with 47% of instances recorded at night or at mid-morning demonstrating strong bias.

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

This dataset passes the ALARP criteria in terms of covering all possible time-of-the-day categories. Albeit, unbalanced coverage.



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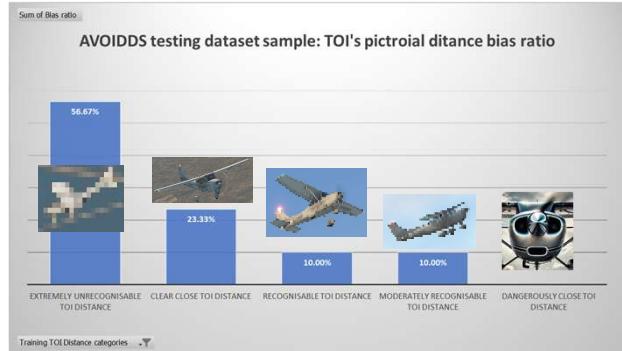
## Examining AVOIDDS Testing Strategy in Covering Pictorial Distance testing classes

The dataset exhibits significant imbalance, with nearly 80% of test cases covers 20% of required categories. Categorised as occurring at “extremely unrecognizable distance” and “clear close distance”. Notably, there is a complete absence of instances classified as :

- dangerously close distances

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 requirement for pictorial distance coverage.

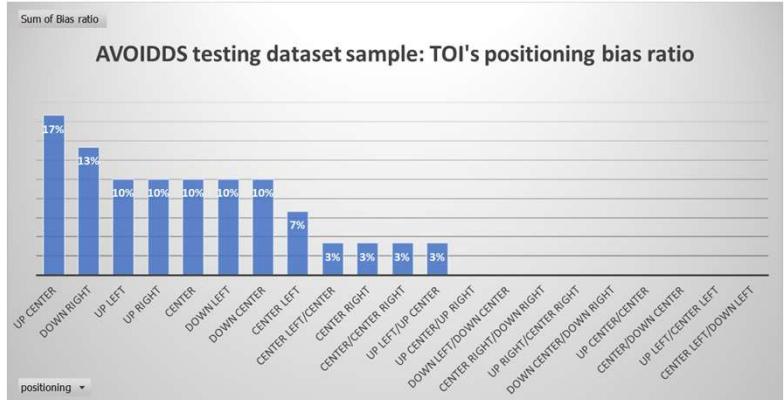
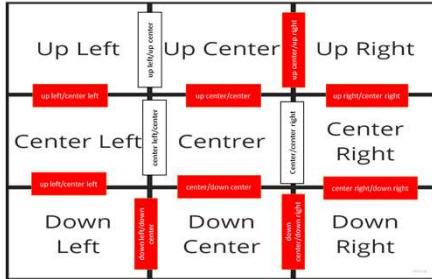


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80

80

## Examining AVOIDDS Testing Strategy in Covering TOI's positioning testing classes

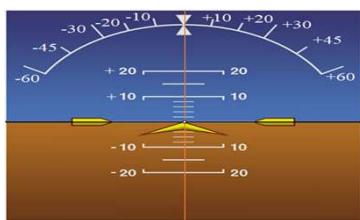


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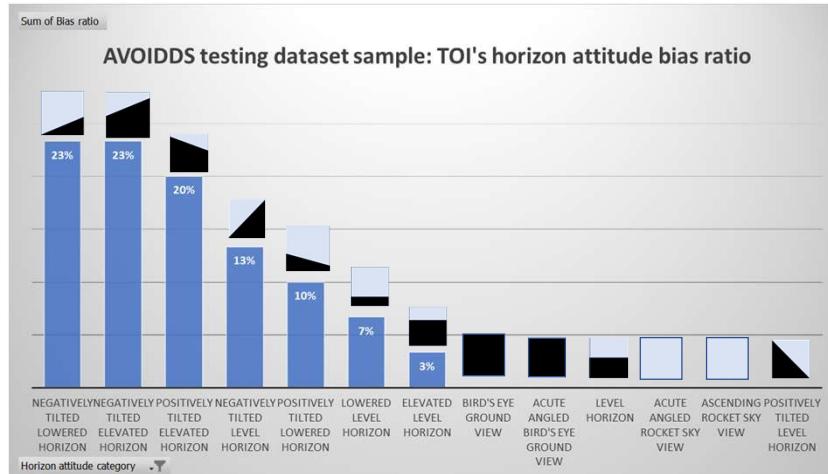
81

81

## Examining AVOIDDS Testing Strategy in Covering Pictorial Horizon attitude testing classes



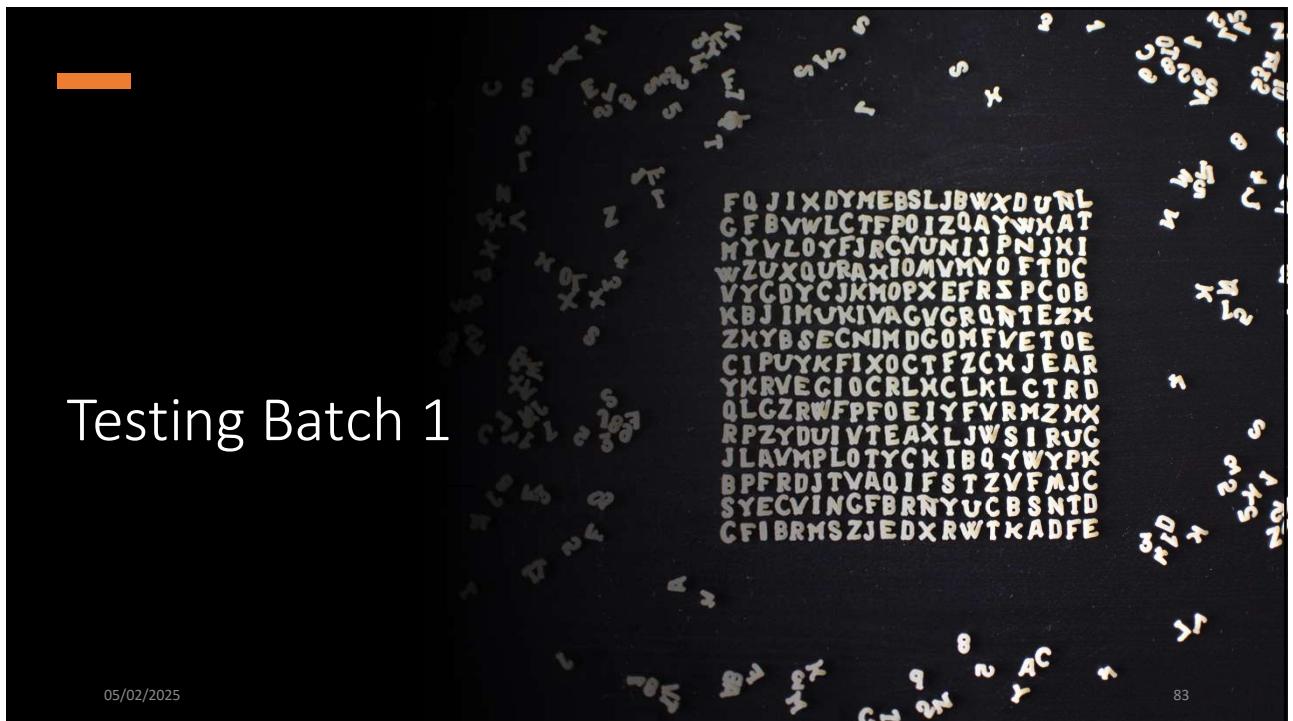
| Horizon attitude category           | Roll Range   | Pitch Range   |
|-------------------------------------|--------------|---------------|
| Level Horizon                       | -15°ROLL<1   | -15°PITCH<1   |
| Positively Tilted Level Horizon     | 15°ROLL<90°  | -15°PITCH<1   |
| Negatively Tilted Level Horizon     | -90°ROLL<-1  | -15°PITCH<1   |
| Elevated Level Horizon              | -15°ROLL<1   | 15°PITCH<45   |
| Positively Tilted Elevated Horizon  | 15°ROLL<90°  | 15°PITCH<45   |
| Negatively Tilted Elevated Horizon  | -90°ROLL<-1  | 15°PITCH<45   |
| Acute Angled Bird's Eye Ground View | -90°ROLL<90° | 45°PITCH<90   |
| Bird's Eye Ground View              | -90°ROLL<90° | 80°PITCH<90   |
| Lowered Level Horizon               | -15°ROLL<1   | -45°PITCH<-1  |
| Positively Tilted Lowered Horizon   | 15°ROLL<90°  | -45°PITCH<-1  |
| Negatively Tilted Lowered Horizon   | -90°ROLL<-1  | -45°PITCH<-1  |
| Acute Angled Rocket Sky View        | -90°ROLL<90° | -80°PITCH<-45 |
| Ascending Rocket Sky View           | -90°ROLL<90° | -90°PITCH<-60 |



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82



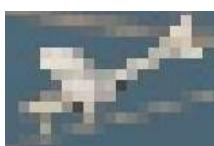
83

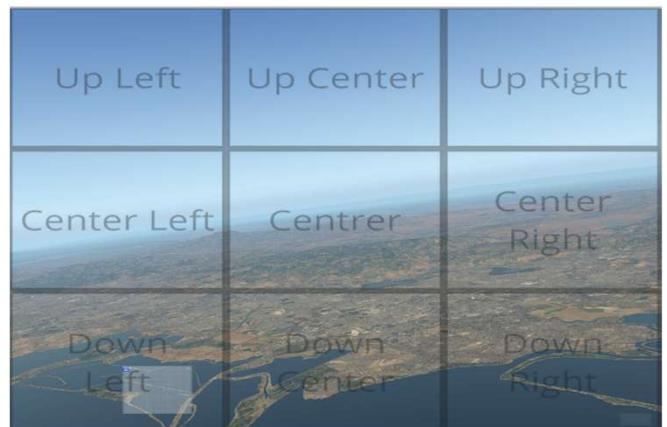
**5.jpg**

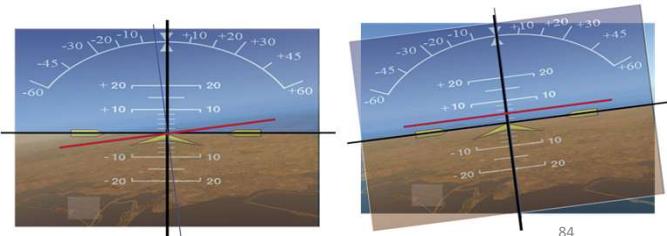
| ODD Dimension                      | Training class spec |
|------------------------------------|---------------------|
| Weather Conditions                 | clear               |
| Time of Day                        | morning, 11:02:35   |
| CuneiForm Dimension                | Training class spec |
| TOI's pictorial distance (nindans) | 6561/1              |
| TOI's Pictorial positioning        | down left           |
| TOI's 3D orientation               | front down left     |
| Horizon attitude                   | Roll: -5, Pitch: 5  |



Front down left





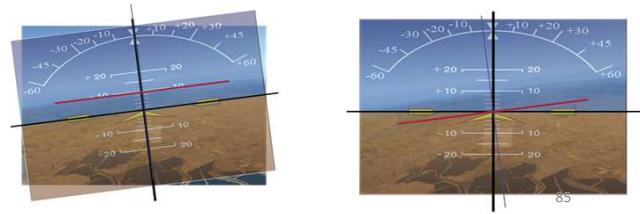


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## 6.jpg

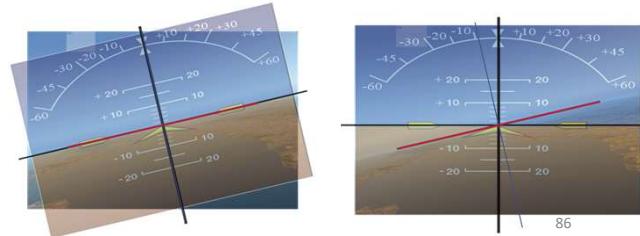
| ODD Dimension                             | Training class spec |
|---|---------------------|
| <b>Weather Conditions</b>                 | clear               |
| <b>Time of Day</b>                        | Afternoon, 17:36:15 |
| <b>CuneiForm Dimension</b>                | Training class spec |
| <b>TOI's pictorial distance (nindans)</b> | $6561/3 = 2187$     |
| <b>TOI's Pictorial positioning</b>        | center              |
| <b>TOI's 3D orientation</b>               | front down right    |
| <b>Horizon attitude</b>                   | Roll: -5, Pitch: 10 |



85

## 9.jpg

| ODD Dimension                             | Training class spec |
|---|---------------------|
| <b>Weather Conditions</b>                 | clear               |
| <b>Time of Day</b>                        | afternoon, 13:49:48 |
| <b>CuneiForm Dimension</b>                | Training class spec |
| <b>TOI's pictorial distance (nindans)</b> | $6561/2 = 3280.5$   |
| <b>TOI's Pictorial positioning</b>        | Up left             |
| <b>TOI's 3D orientation</b>               | rear up left        |
| <b>Horizon attitude</b>                   | Roll: -9, Pitch: 0  |



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**15.jpg**

| ODD Dimension                             | Training class spec |
|---|---------------------|
| <b>Weather Conditions</b>                 | high cirrus         |
| <b>Time of Day</b>                        | morning, 10:30:24   |
| Cuneiform Dimension                       | Training class spec |
| <b>TOI's pictorial distance (nindans)</b> | $6561/6 = 3280.5$   |
| <b>TOI's Pictorial positioning</b>        | down center         |
| <b>TOI's 3D orientation</b>               | rear down right     |
| <b>Horizon attitude</b>                   | Roll: -8, Pitch: 0  |

Rear down right

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Up Left      Up Center      Up Right  
 Center Left      Center      Center Right  
 Down Left      Down Center      Down Right

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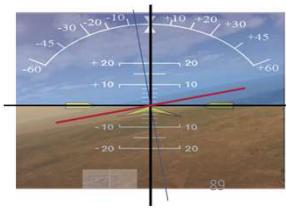
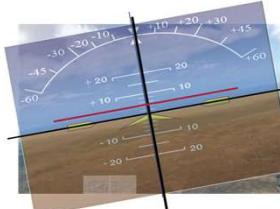
88

## 16.jpg

| ODD Dimension                             | Training class spec         |
|---|-----------------------------|
| <b>Weather Conditions</b>                 | high cirrus                 |
| <b>Time of Day</b>                        | late afternoon,<br>18:16:27 |
| <b>CuneiForm Dimension</b>                | <b>Training class spec</b>  |
| <b>TOI's pictorial distance (nindans)</b> | 6561/108                    |
| <b>TOI's Pictorial positioning</b>        | down left                   |
| <b>TOI's 3D orientation</b>               | front down right            |
| <b>Horizon attitude</b>                   | <b>Roll: -7, Pitch: 4</b>   |



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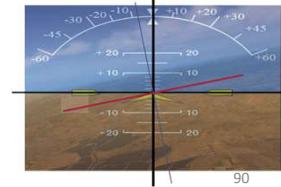
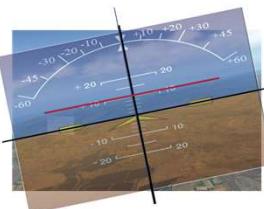
89

## 17.jpg

| ODD Dimension                             | Training class spec        |
|---|----------------------------|
| <b>Weather Conditions</b>                 | high cirrus                |
| <b>Time of Day</b>                        | morning, 09:10:48          |
| <b>CuneiForm Dimension</b>                | <b>Training class spec</b> |
| <b>TOI's pictorial distance (nindans)</b> | 6561/2 =3280.5             |
| <b>TOI's Pictorial positioning</b>        | center left                |
| <b>TOI's 3D orientation</b>               | rear up left               |
| <b>Horizon attitude</b>                   | <b>Roll: -8, Pitch: 10</b> |



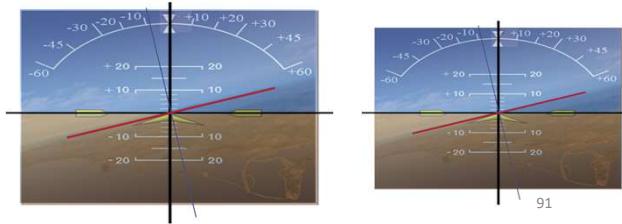
05/02/2025



90

## 18.jpg

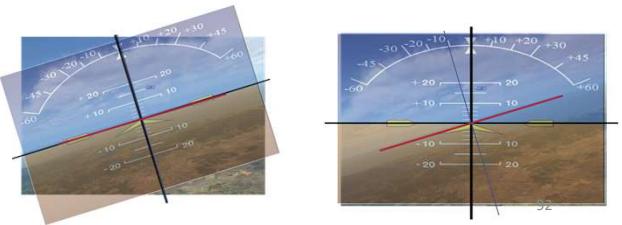
| ODD Dimension                      | Training class spec |
|------------------------------------|---------------------|
| Weather Conditions                 | high cirrus         |
| Time of Day                        | afternoon, 14:13:05 |
| CuneiForm Dimension                | Training class spec |
| TOI's pictorial distance (nindans) | $6561/12 = 546.75$  |
| TOI's Pictorial positioning        | up center           |
| TOI's 3D orientation               | front up right      |
| Horizon attitude                   | Roll: -9, Pitch: 0  |



91

## 25.jpg

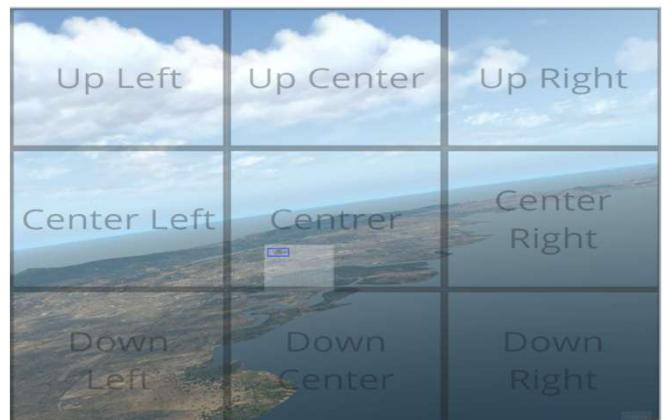
| ODD Dimension                      | Training class spec |
|------------------------------------|---------------------|
| Weather Conditions                 | high cirrus         |
| Time of Day                        | afternoon, 14:13:05 |
| CuneiForm Dimension                | Training class spec |
| TOI's pictorial distance (nindans) | $6561/6 = 1093.5$   |
| TOI's Pictorial positioning        | up center           |
| TOI's 3D orientation               | right               |
| Horizon attitude                   | Roll: -10, Pitch: 0 |



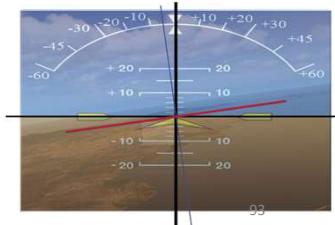
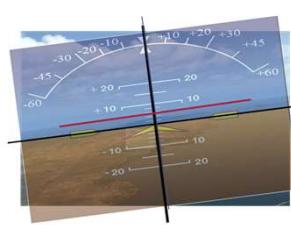
92

## 29.jpg

| ODD Dimension                      | Training class spec |
|------------------------------------|---------------------|
| Weather Conditions                 | scattered clouds    |
| Time of Day                        | morning, 09:59:40   |
| CuneiForm Dimension                | Training class spec |
| TOI's pictorial distance (nindans) | $6561/8 = 820.125$  |
| TOI's Pictorial positioning        | center              |
| TOI's 3D orientation               | Front up left       |
| Horizon attitude                   | Roll: -5, Pitch: 6  |



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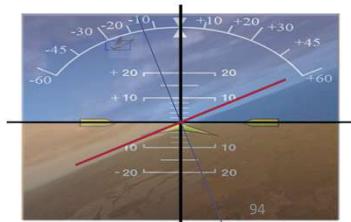
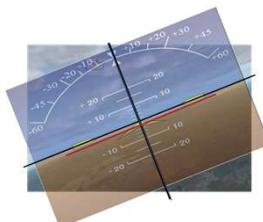
93

## 37.jpg

| ODD Dimension                      | Training class spec |
|------------------------------------|---------------------|
| Weather Conditions                 | broken clouds       |
| Time of Day                        | morning, 01:05:05   |
| CuneiForm Dimension                | Training class spec |
| TOI's pictorial distance (nindans) | $6561/41 = 160$     |
| TOI's Pictorial positioning        | Up left/up center   |
| TOI's 3D orientation               | rear up left        |
| Horizon attitude                   | Roll: -15, Pitch: 2 |



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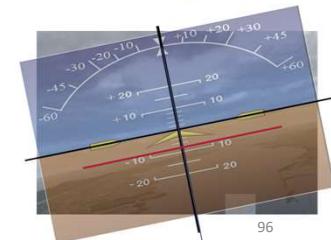
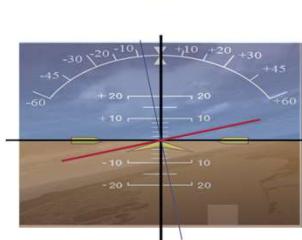
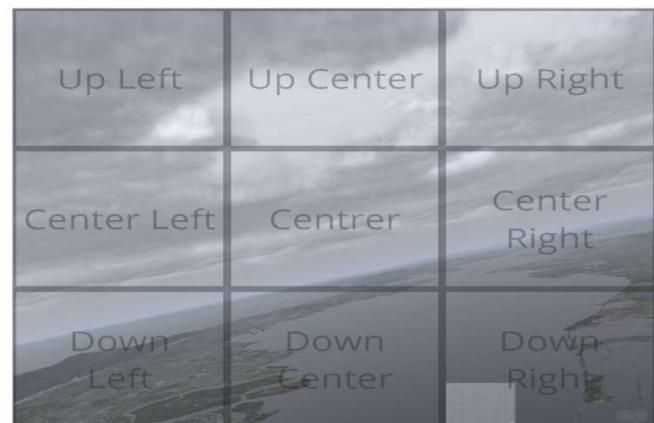
94



95

45.jpg

| ODD Dimension                      | Training class spec         |
|------------------------------------|-----------------------------|
| Weather Conditions                 | overcast                    |
| Time of Day                        | late afternoon,<br>23:33:10 |
| CuneiForm Dimension                | Training class spec         |
| TOI's pictorial distance (nindans) | $6561/4 = 1640.25$          |
| TOI's Pictorial positioning        | down right                  |
| TOI's 3D orientation               | rear down right             |
| Horizon attitude                   | Roll: -8, Pitch: -8         |



96

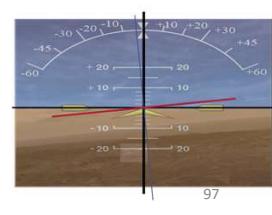
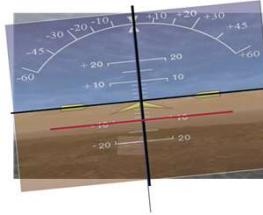
96

## 46.jpg

| ODD Dimension                      | Training class spec  |
|------------------------------------|----------------------|
| Weather Conditions                 | overcast             |
| Time of Day                        | morning, 10:03:07    |
| CuneiForm Dimension                | Training class spec  |
| TOI's pictorial distance (nindans) | $6561/54 = 121.5$    |
| TOI's Pictorial positioning        | down center          |
| TOI's 3D orientation               | front down left      |
| Horizon attitude                   | Roll: -4, Pitch: -10 |



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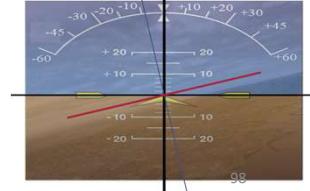
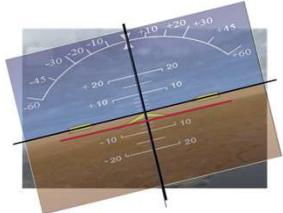
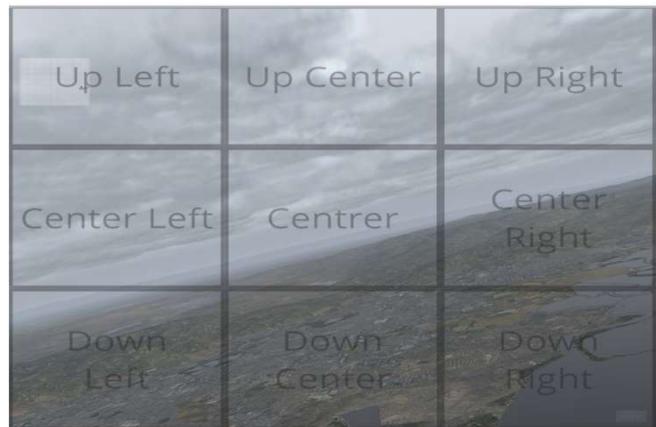
97

## 48.jpg

| ODD Dimension                      | Training class spec      |
|------------------------------------|--------------------------|
| Weather Conditions                 | overcast                 |
| Time of Day                        | late afternoon, 19:56:48 |
| CuneiForm Dimension                | Training class spec      |
| TOI's pictorial distance (nindans) | 6561/1                   |
| TOI's Pictorial positioning        | up left                  |
| TOI's 3D orientation               | rear up left             |
| Horizon attitude                   | Roll: -10, Pitch: -4     |



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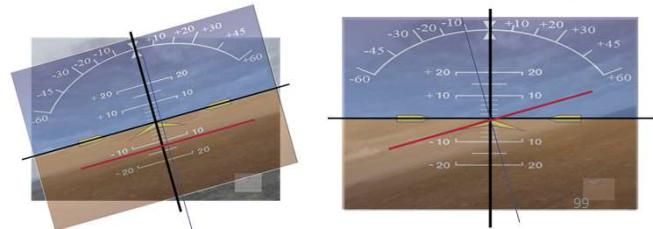
98

# 49.jpg

| ODD Dimension                             | Training class spec   |
|---|-----------------------|
| <b>Weather Conditions</b>                 | overcast,             |
| <b>Time of Day</b>                        | Morning 03:07:55      |
| CuneiForm Dimension                       | Training class spec   |
| <b>TOI's pictorial distance (nindans)</b> | $6561/19 = 345.31$    |
| <b>TOI's Pictorial positioning</b>        | down right            |
| <b>TOI's 3D orientation</b>               | rear down right       |
| <b>Horizon attitude</b>                   | Roll: -10, Pitch: -12 |



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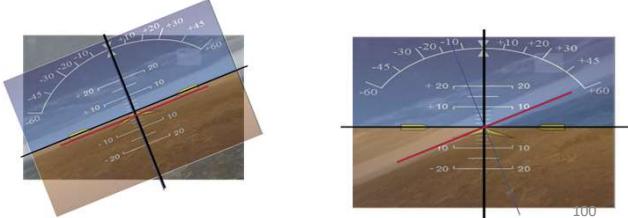
99

# 57.jpg

| ODD Dimension                             | Training class spec  |
|---|----------------------|
| <b>Weather Conditions</b>                 | stratus              |
| <b>Time of Day</b>                        | morning, 03:07:55    |
| CuneiForm Dimension                       | Training class spec  |
| <b>TOI's pictorial distance (nindans)</b> | $6561/8 = 820.125$   |
| <b>TOI's Pictorial positioning</b>        | up right             |
| <b>TOI's 3D orientation</b>               | rear up center       |
| <b>Horizon attitude</b>                   | Roll: -15, Pitch: -2 |



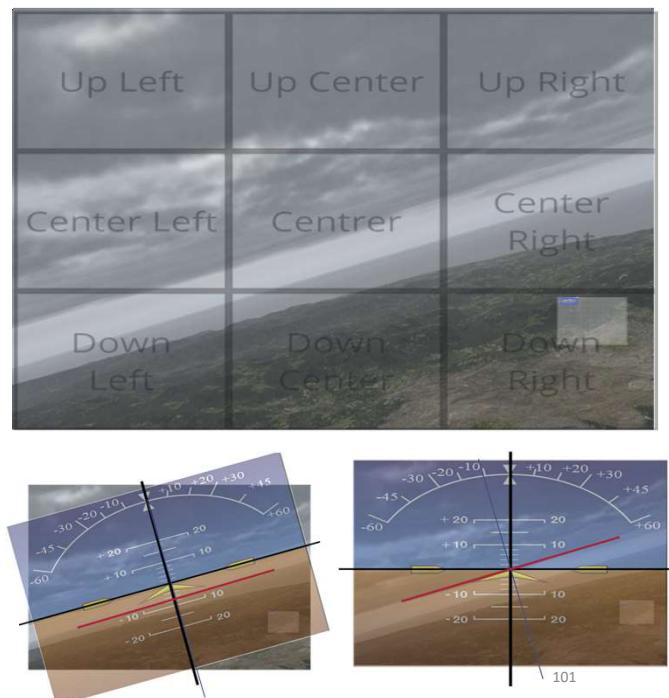
05/02/2025



100

58.jpg

| ODD Dimension                      | Training class spec  |
|------------------------------------|----------------------|
| Weather Conditions                 | stratus              |
| Time of Day                        | Midday 11:07:56      |
| CuneiForm Dimension                | Training class spec  |
| TOI's pictorial distance (nindans) | $6561/3 = 2187$      |
| TOI's Pictorial positioning        | down right           |
| TOI's 3D orientation               | front down left      |
| Horizon attitude                   | Roll: -10, Pitch: -5 |



101

Testing Batch 4

FQ JIXDYM EBSLJBWXDUNL  
GFBVWLCTFP OIZQUAYW XAT  
HYVLOYFJRCVUNIJPNJKI  
WZUXQURAXIOMVMVOFTDC  
VYGDYCJKMOPXEFRS PCOB  
KBJIMUKIVAGVGRQNTTEZX  
ZXYBSECNIMDGOMFVEIOE  
CIPUYKFI XOTFZCXJEAR  
YKRVECI0CRLXCLKLCTR D  
QLCZRWFPOEIYFVRMZXX  
RPZYDUIVTEAXLJWSIRUC  
JLAVMPLOTYCKIBQYWYPK  
BPFRDJTVAQIFSTZVF MJC  
SYECVINGFB RNYUCBSNTD  
CFIBRMSZJEDXRWTKA DFE

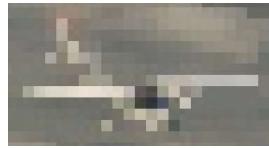
05/02/2025

102

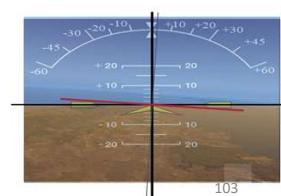
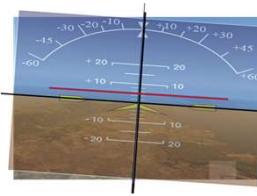
102

## 7.jpg

| ODD Dimension                             | Training class spec |
|---|---------------------|
| <b>Weather Conditions</b>                 | clear               |
| <b>Time of Day</b>                        | morning, 06:24:02   |
| <b>Cuneiform Dimension</b>                | Training class spec |
| <b>TOI's pictorial distance (nindans)</b> | 6561/1              |
| <b>TOI's Pictorial positioning</b>        | down right          |
| <b>TOI's 3D orientation</b>               | Front down right    |
| <b>Horizon attitude</b>                   | Roll: 3, Pitch: 5   |



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103

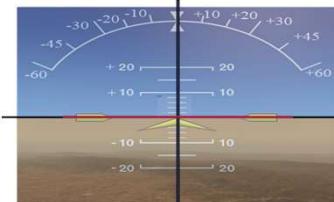
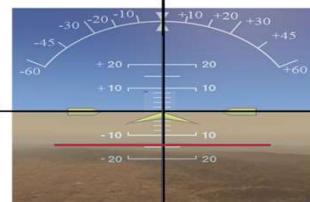
## 8.jpg

| ODD Dimension                             | Training class spec |
|---|---------------------|
| <b>Weather Conditions</b>                 | clear               |
| <b>Time of Day</b>                        | Afternoon, 15:11:08 |
| <b>Cuneiform Dimension</b>                | Training class spec |
| <b>TOI's pictorial distance (nindans)</b> | 6561/1              |
| <b>TOI's Pictorial positioning</b>        | center              |
| <b>TOI's 3D orientation</b>               | unknown             |
| <b>Horizon attitude</b>                   | Roll: 0, Pitch: -14 |

**Unknown  
Orientation?**



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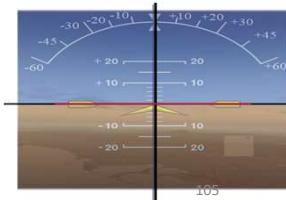
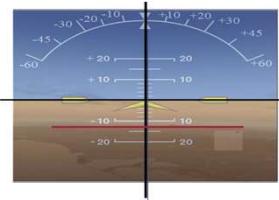
104

# 19.jpg

| ODD Dimension                             | Training class spec |
|---|---------------------|
| <b>Weather Conditions</b>                 | high cirrus         |
| <b>Time of Day</b>                        | morning, 08:27:31   |
| CuneiForm Dimension                       | Training class spec |
| <b>TOI's pictorial distance (nindans)</b> | $6561/2 = 3280.5$   |
| <b>TOI's Pictorial positioning</b>        | down right          |
| <b>TOI's 3D orientation</b>               | left                |
| <b>Horizon attitude</b>                   | Roll: 0, Pitch: -12 |



Left  
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105



Testing Batch 5

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106

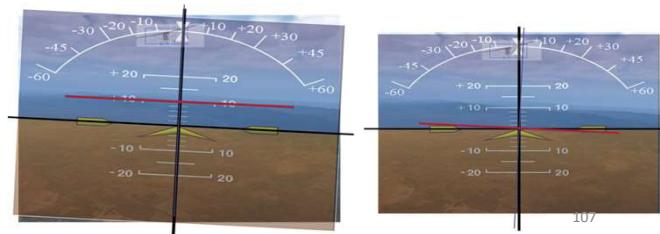
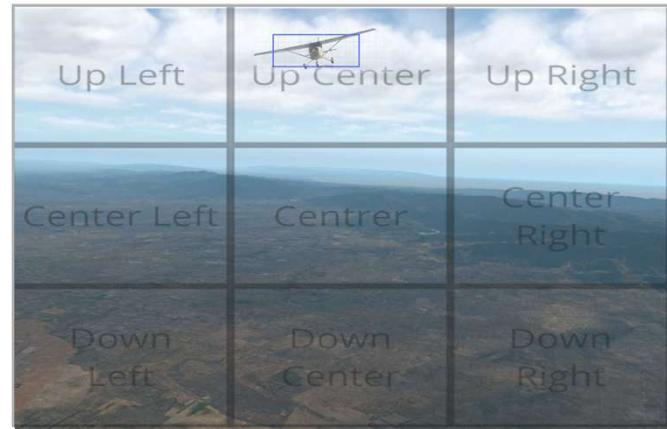
106

## 27.jpg

| ODD Dimension                             | Training class spec         |
|---|-----------------------------|
| <b>Weather Conditions</b>                 | scattered clouds            |
| <b>Time of Day</b>                        | late afternoon,<br>19:35:32 |
| CuneiForm Dimension                       | Training class spec         |
| <b>TOI's pictorial distance (nindans)</b> | $6561/117 = 56.07$          |
| <b>TOI's Pictorial positioning</b>        | up center                   |
| <b>TOI's 3D orientation</b>               | front                       |
| <b>Horizon attitude</b>                   | Roll: 2, Pitch: 10          |



Front  
05/02/2025



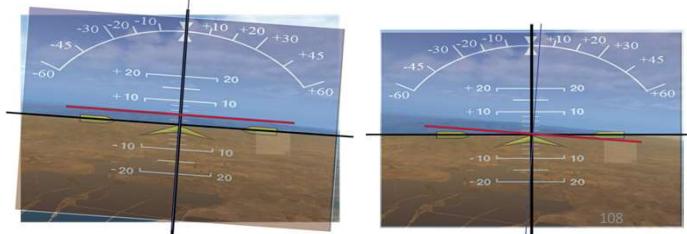
107

## 28.jpg

| ODD Dimension                             | Training class spec |
|---|---------------------|
| <b>Weather Conditions</b>                 | scattered clouds    |
| <b>Time of Day</b>                        | morning, 06:05:57   |
| CuneiForm Dimension                       | Training class spec |
| <b>TOI's pictorial distance (nindans)</b> | 6561/1              |
| <b>TOI's Pictorial positioning</b>        | center right        |
| <b>TOI's 3D orientation</b>               | rear down right     |
| <b>Horizon attitude</b>                   | Roll: 4, Pitch: 5   |



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## 36.jpg

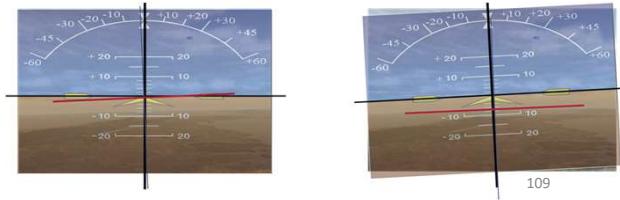
| ODD Dimension                      | Training class spec |
|------------------------------------|---------------------|
| Weather Conditions                 | broken clouds       |
| Time of Day                        | morning, 02:49:44   |
| CuneiForm Dimension                | Training class spec |
| TOI's pictorial distance (nindans) | 6561/4              |
| TOI's Pictorial positioning        | up right            |
| TOI's 3D orientation               | Unknown             |
| Horizon attitude                   | Roll: -1, Pitch: -5 |



Unknown Orientation?



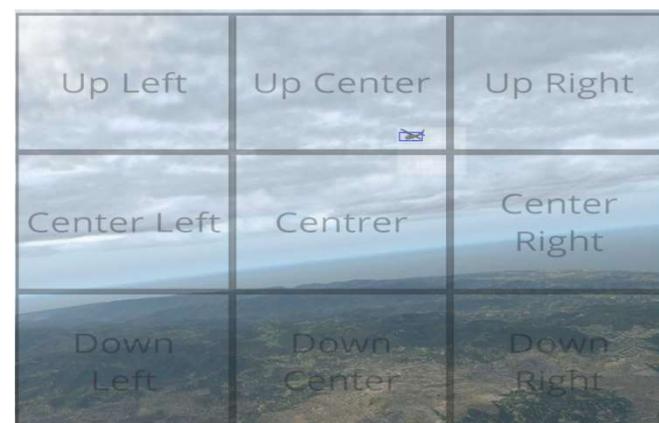
05/02/2025



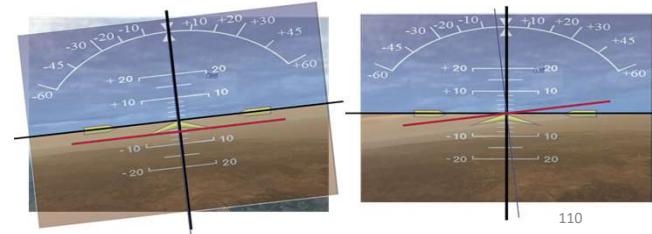
109

## 38.jpg

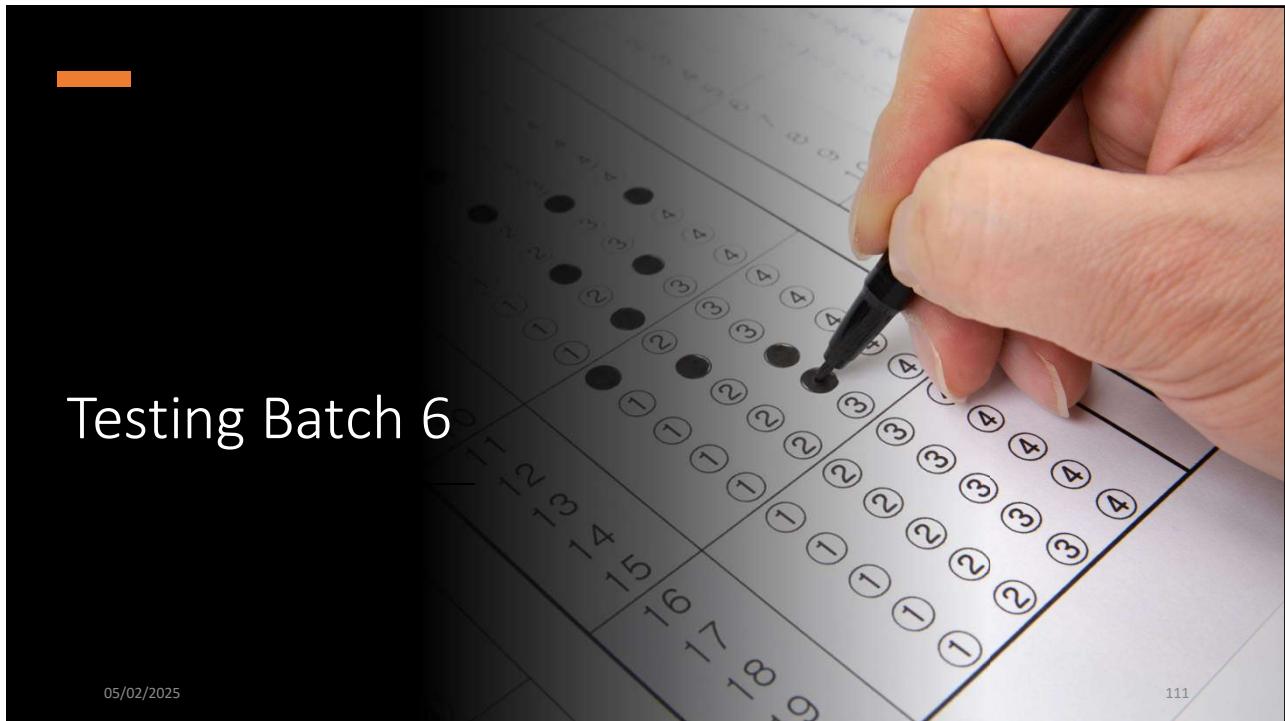
| ODD Dimension                      | Training class spec |
|------------------------------------|---------------------|
| Weather Conditions                 | broken clouds       |
| Time of Day                        | morning, 00:00:07   |
| CuneiForm Dimension                | Training class spec |
| TOI's pictorial distance (nindans) | 6561/12             |
| TOI's Pictorial positioning        | up center           |
| TOI's 3D orientation               | rear up left        |
| Horizon attitude                   | Roll: -5, Pitch: -5 |



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111

**47.jpg**

| ODD Dimension                             | Training class spec |
|---|---------------------|
| <b>Weather Conditions</b>                 | overcast            |
| <b>Time of Day</b>                        | Morning, 00:20:06   |
| CuneiForm Dimension                       | Training class spec |
| <b>TOI's pictorial distance (nindans)</b> | $6561/28 = 234.3$   |
| <b>TOI's Pictorial positioning</b>        | Center/center right |
| <b>TOI's 3D orientation</b>               | right               |
| <b>Horizon attitude</b>                   | Roll: 0, Pitch: 2   |

**Right**

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Up Left Up Center Up Right  
Center Left Center Center Right  
Down Left Down Center Down Right

112

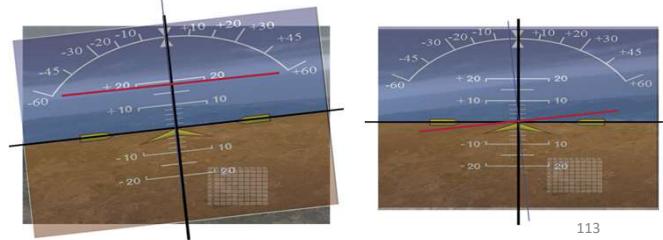
112

56.jpg

| ODD Dimension                      | Training class spec |
|------------------------------------|---------------------|
| Weather Conditions                 | stratus             |
| Time of Day                        | morning, 00:56:41   |
| CuneiForm Dimension                | Training class spec |
| TOI's pictorial distance (nindans) | 6561/2              |
| TOI's Pictorial positioning        | down center         |
| TOI's 3D orientation               | rear down right     |
| Horizon attitude                   | Roll: -4, Pitch: 19 |



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Testing Batch 7

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# 26.jpg

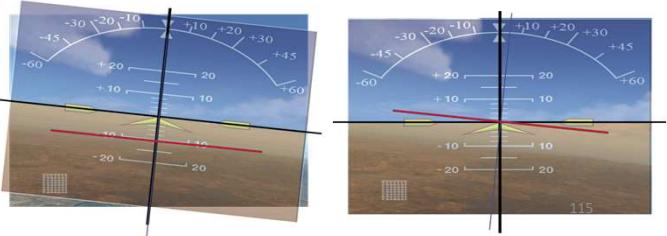
| ODD Dimension                      | Training class spec |
|------------------------------------|---------------------|
| Weather Conditions                 | scattered clouds    |
| Time of Day                        | afternoon, 15:52:41 |
| CuneiForm Dimension                | Training class spec |
| TOI's pictorial distance (nindans) | 6561/1              |
| TOI's Pictorial positioning        | down left           |
| TOI's 3D orientation               | Unknown             |
| Horizon attitude                   | Roll: 3, Pitch: 10  |



Unknown Orientation?



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115

# 35.jpg

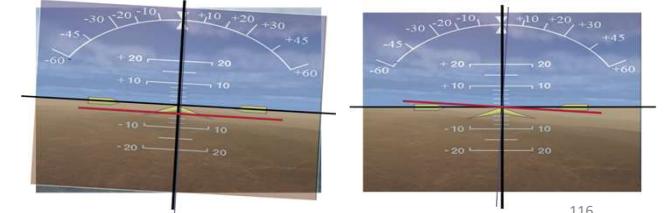
| ODD Dimension                      | Training class spec |
|------------------------------------|---------------------|
| Weather Conditions                 | broken clouds       |
| Time of Day                        | afternoon, 15:35:23 |
| CuneiForm Dimension                | Training class spec |
| TOI's pictorial distance (nindans) | 6561/1              |
| TOI's Pictorial positioning        | Up left             |
| TOI's 3D orientation               | unknown             |
| Horizon attitude                   | Roll: 2, Pitch: -4  |



Unknown Orientation?



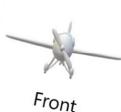
05/02/2025



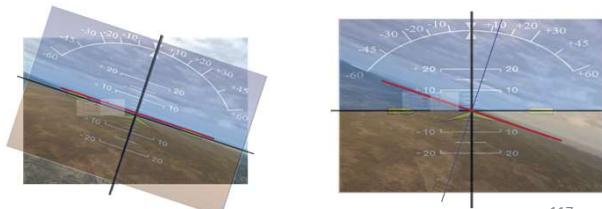
116

39.jpg

| ODD Dimension                             | Training class spec         |
|---|-----------------------------|
| <b>Weather Conditions</b>                 | broken clouds               |
| <b>Time of Day</b>                        | late afternoon,<br>17:50:56 |
| Cuneiform Dimension                       | Training class spec         |
| <b>TOI's pictorial distance (nindans)</b> | $6561/81 = 81$              |
| <b>TOI's Pictorial positioning</b>        | center left/center          |
| <b>TOI's 3D orientation</b>               | front                       |
| <b>Horizon attitude</b>                   | Roll: 13, Pitch: 2          |



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Testing Batch 8

FQ JIXDYMEBSLJBWXDUNL  
 GFBVWLCTFP0IZQUAYWXA  
 MYVLOYFJRCVUNIJPNJKI  
 WZUXQURAXIOMVMVOFTDC  
 VYGDYCJKMOPXEFRSPCOB  
 KBJIMUKIVAGVGRQNTEXX  
 ZXYBSECNIMDGOMFVEIOE  
 CIPUYKFIOTFZCXJEAR  
 YKRVEGIOCRLXCLKLCTR  
 QLCZRWFPOEIYFVRMZXX  
 RPZYDUIVTEAXLJWSIRUC  
 JLAVMPLOTYCKIBQYWYPK  
 BPFRDJTVAQIFSTZVFMC  
 SYECVINGFBRYUCBSNTD  
 CFIBRMSZJEDXRWTKA  
 DFE

05/02/2025

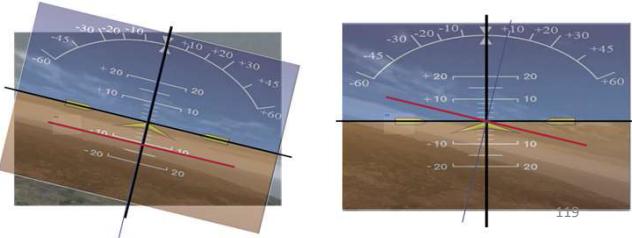
118

118

## 55.jpg

| ODD Dimension                             | Training class spec         |
|---|-----------------------------|
| <b>Weather Conditions</b>                 | stratus                     |
| <b>Time of Day</b>                        | late afternoon,<br>23:01:33 |
| CuneiForm Dimension                       | Training class spec         |
| <b>TOI's pictorial distance (nindans)</b> | 6561/2 =3280.5              |
| <b>TOI's Pictorial positioning</b>        | center left                 |
| <b>TOI's 3D orientation</b>               | unknown                     |
| <b>Horizon attitude</b>                   | Roll: 10, Pitch: -11        |

**Unknown  
Orientation?**



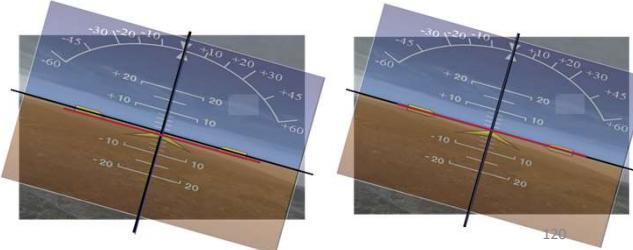
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## 59.jpg

| ODD Dimension                             | Training class spec |
|---|---------------------|
| <b>Weather Conditions</b>                 | stratus             |
| <b>Time of Day</b>                        | midday, 12:03:48    |
| CuneiForm Dimension                       | Training class spec |
| <b>TOI's pictorial distance (nindans)</b> | 6561/1              |
| <b>TOI's Pictorial positioning</b>        | up right            |
| <b>TOI's 3D orientation</b>               | Unknown             |
| <b>Horizon attitude</b>                   | Roll: 10, Pitch: -2 |

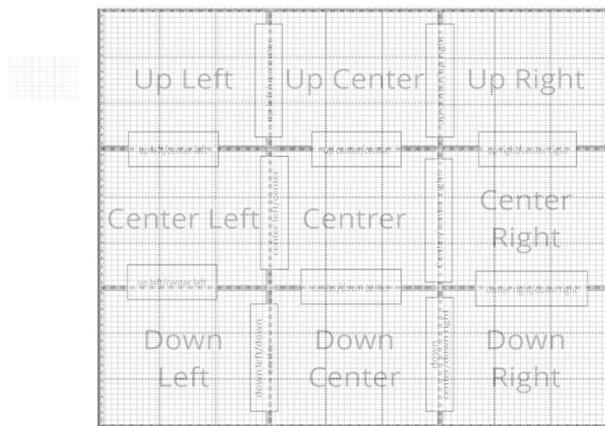
**Unknown  
Orientation?**



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## Cuneiform Canvas



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