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# Aircraft Storage Optimisation Project Overview

## Introduction

The project aims to develop a digital twin of an aircraft's cabin storage system to optimise the stowage of carry-on luggage. The project will identify opportunities to enhance storage efficiency, improve passenger experience, and reduce boarding times by focusing on a specific aircraft cabin section. Real-world scenarios and passenger behaviours will be simulated to provide actionable recommendations.

The model will target high-density or consistently full-capacity routes, ensuring relevance for airlines where storage optimisation is critical. The findings will be practical and implementable using average dimensions and focusing on scalable, cost-effective solutions. The results will address challenges in boarding processes, luggage orientations, and cabin storage configurations, offering insights into potential improvements for operational efficiency.

## Data Analysis

### Research

* **Carry-on Luggage Dimensions**
  + Identify the top 10 airlines frequently used by consumers.
  + Check their luggage dimensions and save visual examples detailing size and shape.
  + Use this data to explore storage optimisations based on different orientations and configurations.
* **Airline Boarding Processes**
  + Review airline websites and materials to understand current boarding methods.
  + Focus on processes such as class-based, zones, priority arrival, row-based, and tiered systems.
  + Assess how these processes influence carry-on luggage stowage and the number of passengers allowed to bring luggage aboard.
* **Storage Utilisation Rates**
  + Analyse how often overhead cabins are fully utilised.
  + Review airline policies regarding cabin storage to understand existing limitations.
  + Investigate passenger behaviours, such as preferences for carry-on luggage vs. checked luggage or backpacks.

### Deliverables

* Analytical reports summarising key findings on luggage dimensions, boarding processes, and storage utilisation.
* Infographics comparing carry-on luggage dimensions across the top 10 airlines.
* Flowcharts or process maps detailing boarding methods used by airlines.

## Digital Twin Modelling

### Research

* **Developing the Digital Twin**
  + Use Fusion 360 to create a digital twin model of the cabin's storage system.
  + Combine multiple data sources into a single model to simulate storage behaviour and predict performance under various scenarios.
* **Cabin and Luggage Specifications**
  + Use accurate dimensions for overhead bins and carry-on luggage based on averages.
  + Focus on materials and mechanical properties commonly used in cabin construction to understand their impact on functionality.
* **Compatibility with Simulation Tools**
  + Ensure the model is compatible with simulation software for seamless integration.
  + Incorporate modular design elements to allow future scalability.

### Deliverables

* High-fidelity 3D model of a specific section of the cabin storage area.
* Models of carry-on luggage for use in simulation.
* Before-and-after visualisations to show the effects of optimisation.
* Documentation detailing the modelling process, including cabin dimensions, luggage specifications, materials, and capacity improvements.

## Simulation Engineering

### Research

* **Passenger Boarding Scenarios**
  + Simulate different boarding processes to identify the most efficient methods.
  + Test scenarios tailored to high-density and full-capacity flights.
* **Luggage Sizes and Passenger Behaviours**
  + Analyse how varying luggage sizes and passenger behaviours impact storage efficiency.
  + Use categorised passenger profiles to model behaviour realistically.
* **Storage Layout Optimisation**
  + Simulate various layouts to identify the most effective configurations for overhead bins.
  + Test storage methods based on luggage orientation and cabin dimensions.

### Deliverables

* Simulation models demonstrating optimisation strategies.
* Analytical reports summarising the outcomes of simulations.
* Recommendations for storage system enhancements based on data-driven insights.

## Visualisation

### Responsibilities

* **Interactive Visualisations**
  + Develop 3D models that can be rotated, zoomed, and explored interactively.
  + Include filters to simulate different boarding and storage scenarios.
  + Use platforms like Power BI, Tableau, Unity, Unreal Engine, or WebGL for user-friendly visualisation.
* **Presentation Materials**
  + Design presentation slides to summarise project processes, findings, and conclusions.
  + Create infographics and dashboards to represent key data and insights visually.
* **User Documentation**
  + Write step-by-step guides and tutorials for interacting with visualisations.
  + Include troubleshooting tips and video tutorials for navigating scenarios effectively.

### Deliverables

* Interactive dashboards or visualisations showcasing digital twin and simulation results.
* Presentation slides summarising the project’s findings.
* User manuals and video tutorials for visualisations.

## Limitations and Solutions

* **Scope Reduction**
  + To ensure model feasibility and accuracy, focus on a specific cabin section, such as Economy Class rows.
  + Use average dimensions for luggage and bins to maintain general applicability while simplifying complexity.
* **Target High-value Airlines**
  + Prioritise airlines operating full-capacity flights or high-demand routes to ensure relevance and applicability.
  + Over large-scale structural changes, such as adjusting boarding processes or storage layouts, emphasise cost-effective changes.
* **Simplified Simulations**
  + Use categorised passenger profiles and smaller cabin sections to reduce computational complexity.
  + Run modular simulations for scalability and flexibility when testing various scenarios.
* **Passenger Behaviour Complexity**
  + Passengers will be grouped into behaviour categories (e.g., frequent flyers and families) to simplify simulations.