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Optimizing Wiring Routes in Airplanes

Team Name: *Maze Runners*

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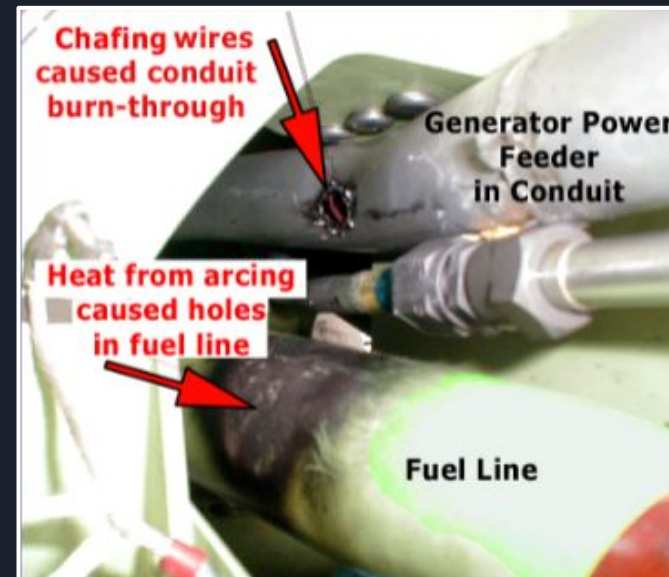BOEING

Team members and responsibilities

1. **Project Lead:** Vincent Lebovitz
2. **Communications Lead:** Tarini Thiagarajan
3. **Technical Lead:** Riley Ylagan
4. **Technical:** Aanchal and Michael; All of us

Problem Introduction

- In field of aviation, trend of substituting hydraulic and pneumatic systems with electrical ones
- Designs for airplanes were made decades before wiring requirements (EWIS regulations)
- Resulted in miles of wires weighing over a ton
- Lack of synergy between system organization, wire design, and installation
- Electrical wiring interconnect systems (EWIS) are defined as:
  - *Any wire, wiring device, or combination of these, including termination devices, installed in any area of the airplane for the purpose of transmitting electrical energy between two or more intended termination points*
- Need for planes to optimize routing of wires to adhere to EWIS requirements and reduce weight of the plane reducing fuel costs

Examples of Wiring Challenges

Problem Statement

1. We are building a software prototype in Python for Boeing engineers that will utilize open source 3D CAD layouts to optimize wire routing with the goal of minimizing wire length, which will improve the lack of synergy between wire design, system organization, and installation.

2. This project will help our customer achieve:
   a. Decrease potential for rework of wiring
   b. Decrease time and costs for wiring
   c. Decrease aggregate weight of a plane (due to minimization of wire length)
   d. Increase efficiency of the plane

Project Objectives

1. Optimize wire routes for <u>multiple</u> wires in <u>3D</u> with at least <u>two constraints</u>, such as curvature and separation
2. Has to run and execute within a <u>couple of hours or days</u>
3. Must decide the optimal <u>start</u> and <u>end</u> points of wiring routes
4. Needs to comply with <u>EWIS requirements</u>

Key Findings in Literature

- Potential Software Tools for Building 3D Layouts
  - CATIA allows for the placement of components in a 3D environment
  - Integration of KBE into a Harness Design and Engineering framework
- Key Areas of Focus for Routing Optimization
  - Understanding and use of A* and Dijkstra's shortest path algorithms
  - Combination of the algorithms with weighting factors to abide by EWIS regulations

Literature Review

AN EFFICIENT METHOD FOR MULTIOBJECTIVE OPTIMAL CONTROL AND OPTIMAL CONTROL SUBJECT TO INTEGRAL CONSTRAINTS by Ajeet Kumar

A methodology to enable automatic 3D routing of aircraft Electrical Wiring Interconnection System by Z. Zhu, G. La Rocca, M. J. L. van Tooren

Weight saving in the electrical distribution systems of aircraft using innovative concepts by Micheal Terorde, Detlef Schulz, Arno Lucken