Exploring New Designs of Tie Rods to Reduce Cost in Manufacturing Boeing Aircraft
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Introduction

Background: Tie rods are a two-pin system that provides support throughout the aircraft structure. This design enables applications with both tension and compression loads. As a basic but very versatile component, tie rods can be used in a variety of applications—from structuring large interior parts like a stowage bins to supporting flight control systems inside the cockpit (both shown below).

Objectives: Our team aims to explore different design and manufacturing options for tie rods. These options will be evaluated for efficiency based on:
- Manufacturing: The new designs should utilize optimal production times and be feasible to produce for current Boeing manufacturers.
- Cost: Designs should be cost-effective to produce in terms of material, labor, and production costs.
- Engineering function: The new design should have appropriate weight ratio and strength to carry loads in both tension and compression.
- Ease of use: The new design should be easy to install, adjust and maintain by Boeing employees.

Cost-Benefit Analysis

Raw Material Cost
- Swaged Volume 12.71 in³ (currently being used at The Boeing Company)
- Clamp Adjust Volume 16.28 in³
- Camber Bolt Volume 16.65 in³

Aluminum 6061 with a T6 heat treatment was chosen by the Mechanical Engineers stress analysis of the designs.

Simulation Model and Analysis

To simulate the space envelope required for the tie rods, we constructed a cardboard mockup.

- A mockup can be used to test if the rod functions well from an ergonomic perspective.
- Installation and adjustment times have importance throughout the entire life of the rod, and there is value in knowing which rod design has the most ease of use.

Human Factors Analysis

To simulate the space envelope required for the tie rods, we constructed a cardboard mockup.

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Index of Performance

The Clamp Adjust design returned the highest weighted score

What-if Scenario Results

Using our SIMIO model, we ran an experiment to determine which rod will cost the least to manufacture in large quantities. Below are the results for overall cost to manufacture 500 rods for each of the three designs.

Recommendations

We found that making design improvements is feasible and not overly expensive to manufacture. We recommend that Boeing evaluates the possibility of introducing a new rod with design elements influenced by our rods. However, Boeing and its suppliers will have to determine which changes will best impact their operations, especially from a human-factors standpoint.

- Aluminum 6061 T-6
- Explore more flexible CNC machines with more automation
- Recycle unused material
- Manufacture one part and one tie rod type at a time

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