INTRODUCTION

In the event of an emergency, aircraft doors produced by Latécoère implement a pneumatic cylinder to assist passengers and crew in their operation. However, these cylinders are difficult to maintain, expensive, heavy, and prone to leakage.

Problem Statement

Our objective is to investigate a way to both store elastic energy and provide actuation via composite material, in order to assist airline passengers with opening fuselage doors in case of emergency.

CORE FUNCTIONS

• The springs must reach specific force requirements at multiple stages of compression.
• The springs must fit within a specified spatial envelope with minimal deviation.
• The springs must show a 25-year life expectancy.
• The springs must adhere to aviation standards and environmental requirements.

DESIGN AND DEVELOPMENT

FEA Study #1 (Figure 3)

• Parameters of interest: Shape
• Conditions: Vertical displacement of 64%
• Outcome: S is too rigid, O cannot nest effectively, springs deliver small forces (<1% of required load)

FEA Study #2 (Figure 4)

• Parameters of interest: Elliptic Ratio, # of plies, Arc vs Ellipse
• Conditions: Vertical displacement of 64%
• Outcome: Excess plies and thinner profile create larger forces and increased failure rates. Arc delivers more force than ellipse

Other Design Considerations for Testing

• Materials: Polyurethane vs Epoxy
• Length of Spring: How length affects load capacity and failure
• Other Shapes: Arm bending with rigid body

RESULTS/VALIDATION

Polyurethane/Epoxy Testing Results:

• Results: Epoxy specimens provide greater force, decreasing length of spring provides greater force, with flat specimens outperforming pre-curved molded specimens

CONCLUSION & FUTURE WORK

• Reaching 64% displacement is possible without failure, but tens or hundreds of specimens are needed to reach 9kN.
• Polyurethane does not cause forces as high as the Epoxy samples
• In progress:
  ○ Epoxy arm bending tests
  ○ Instron material testing data analysis
  ○ Creep testing

Acknowledgements

We appreciate the help and support of:
- Prof. Aniruddh Vashisth (supervisor)
- Sebastien Devillez and Latécoère (sponsors)