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College of Engineering

3D-Printed Aviation Control Stick Boot

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Aero Knowledge Center

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Mission

This project focuses on creating a 3D-printed control stick boot for small aircraft that effectively protects against foreign object debris (FOD) and meets specific client requirements:

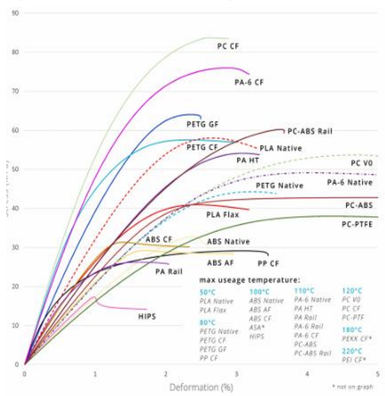
- **FOD Protection**: Prevents foreign objects from entering the control stick mechanism, enhancing safety.
- **Full Range of Motion**: Allows for 360-degree movement, ensuring unrestricted control stick operation.
- **Easy Assembly**: Designed for quick, straightforward assembly to simplify maintenance and installation.
- **Fail-Proof Operation**: Ensures reliability and functionality under all operational conditions.
- **Aesthetic Appeal**: Meets the client's request for a visually unique design that captures attention and adds value to the cockpit environment.

Each of these objectives is aimed at achieving both functional performance and visual appeal, as specified by our client, Aero Knowledge Center (AKC).

Research

Our research identified key materials and design insights for creating an effective 3D-printed control stick boot:

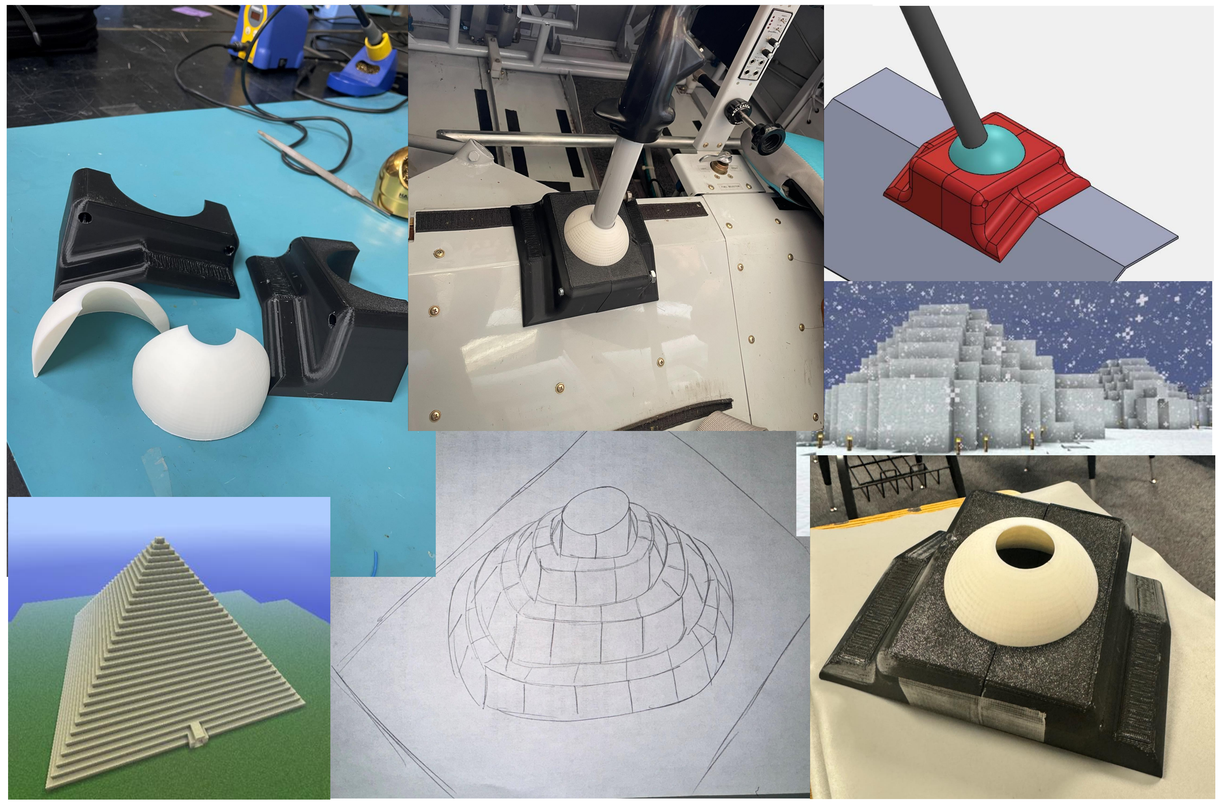
- **Material Choice**: Combining carbon fiber for strength and TPU for flexibility balances durability and movement.
- **Fail-Proof Design**: Essential to prevent jamming and block foreign object debris (FOD).
- **Market Trends**: Favor innovative designs with dynamic movement.



- **Friction and Wear**: Minimizing these is crucial for long-term functionality.

We recommend additional prototyping and testing to refine the design and ensure it meets safety and performance standards.

Final Design and Future Design



Final Design

Key Aspects of the Final Design:

- **Durable Material**: Constructed using TPU for flexibility and resilience, ensuring long-term performance.
- **Modular Construction**: Composed of interlocking hemispherical layers to allow smooth 360-degree motion.
- **Fail-Proof Design**: Engineered to prevent jamming and securely block FOD from entering the control stick mechanism.
- **Aesthetic Appeal**: A visually engaging design that aligns with client preferences for innovative, eye-catching solutions.
- **Ease of Assembly**: Designed for quick and hassle-free installation and removal during maintenance procedures.
- **3D-Printed Manufacturing**: Fully optimized for additive manufacturing to minimize costs and simplify production.

Next Steps

Key Aspects of the Future Design:

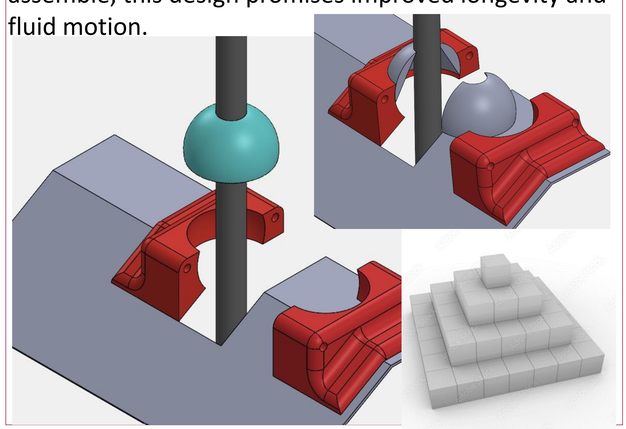
Igloo/Pyramid Geometry: A unique structure that allows adaptive motion with individual "blocks" stacking or shifting based on stick direction.
Dynamic Block Mechanism: Blocks are designed to expand, stack, or shift seamlessly, resembling steps or walls depending on movement direction.
Enhanced Safety Features: Incorporates blockers on the bottom of each block to prevent jamming or unintended disassembly.
Smooth Motion Adaptation: Allows the control stick to move freely while maintaining a sturdy seal against debris.
Improved Longevity: Refined materials and design elements reduce friction and wear, increasing the lifespan of the boot.
Rigorous Testing Priority: Emphasizes safety testing to ensure the blockers and dynamic mechanisms work reliably in all conditions.

Concept Development

In developing concepts for a 3D-printed control stick boot, we explored multiple designs to meet the client's requirements for 360-degree motion, fail-proof operation, and visual appeal. Initial research focused on similar products, materials, and dynamic designs, leading us to four main concepts, later refined to the top two:

- **Design Principles**:
  - Mesh structures, ball joints, piston mechanisms, and telescoping elements guided initial designs.
  - Material selection and joint mechanisms were crucial for achieving flexibility and durability.
- **Top Designs**:
  - **Design 3 (Piston-Based Displacement)**: Features pistons with ball joints for controlled, smooth movement, protecting against FOD and providing a mechanical, eye-catching appearance. However, the multiple moving parts may increase wear over time.

Design 4 (Telescoping Hemisphere): Uses telescoping hemispheres for dynamic, layered movement that adapts smoothly with the control stick, offering visual appeal with reduced friction. Although more complex to assemble, this design promises improved longevity and fluid motion.



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