Project Overview – Captain America Shield

1. Project Context

This project was created to develop a **Captain America shield that is both aesthetically accurate and functional**, capable of withstanding **intense use and frequent handling** during performances, acrobatics, and lending between colleagues. The goal was to showcase a combination of **creativity, maker skills, and practical problem-solving** applied to a real-world object.

To overcome limitations of existing models, the shield was **designed from scratch in SolidWorks**, balancing geometric precision, structural reliability, optimized modularity, and ease of production on standard FDM 3D printers.

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2. Design Objectives

General Objective

Design a **functional and durable Captain America shield**, manufacturable with 3D printing, capable of handling active use, frequent handling, and transportation, while maintaining aesthetic fidelity and material efficiency.

Specific Objectives

1. **Reliability and durability:** ensure the shield withstands handling, impacts, and transportation without compromising integrity.
2. **Functional modularity:** divide the design into modules that allow painting, repair, and replacement of parts without relying solely on adhesives.
3. **3D printing optimization:** consider layer orientation, minimize supports, and ensure compatibility with standard printers.
4. **Parametric, scalable design:** allow size adaptations without losing fit, tolerance, or aesthetics.
5. **Separation of aesthetics and structure:** ensure visual elements do not affect the main structure's strength.

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3. Design and Fabrication

The shield was **fully designed in SolidWorks** and divided into modules for painting, printing, and assembly. Main pieces include:
- **Shield (red and metallic paint):** divided into 12 parts.
- **Ring (metallic paint):** divided into 8 parts.
- **Star base (blue paint):** sections supporting the star and allowing vertical printing.
- **Star (metallic paint):** 5 V-shaped sections.

PLA+ was used as the main material, with 0.3 mm layer height and an estimated print time of 46 hours.

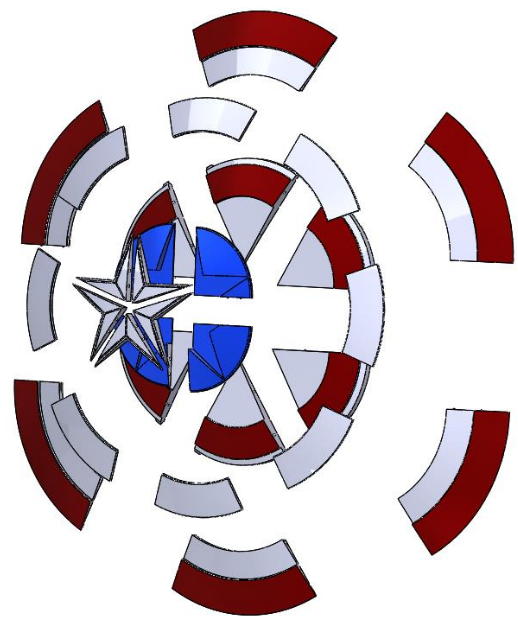

Figure 1 Exploded view of pieces parts

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4. Assembly and Structure

Modules were assembled primarily using **E6000 and cyanoacrylate**, creating a **flexible yet strong system** that absorbs impacts and frequent handling. Thin screws were added at critical points to reinforce joints without compromising modularity.

Suggested image (optional): photo of partially assembled shield showing modularity.

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5. Finishing

Rust-Oleum metallic and Montana metallic paints were used, with satin varnish for protection. Each module was painted individually to ensure uniform coverage and facilitate future touch-ups.

Figure 2 Painted pieces

6. Project Limitations

- Full FEM simulation was not performed due to the **complexity of modeling the PLA–adhesive–layer interface**. Analysis focused on critical elements transmitting loads to the user's arm.
- Validation was based on practical use and observation: no structural failures have been observed.
- The joint system relies on correct printing and adhesive application; higher loads may require adjustments or reinforcement.
- The design was optimized for a specific size; significant scaling would need further validation.

7. Conclusions

This project demonstrates the ability to combine **creativity, maker skills, and practical problem-solving** to produce a functional, aesthetically accurate shield capable of withstanding active use and frequent handling.

The shield is **strong, modular, and adaptable**, and the hybrid joint system (cyanoacrylate + E6000 + screws in critical points) balances rigidity and flexibility for real-world use.

Beyond the final product, this project represents a **learning and experimentation exercise**, advancing parametric design, additive manufacturing, and practical problem-solving skills, laying a solid foundation for future functional 3D creations.