



Lightweight Helicopter Armament Mount Optimization

Cognitive Design Systems partnered with an aerospace defense client to optimize a critical **swing-arm assembly** for a helicopter armament mount.

The objective was to minimize mass without compromising structural integrity under dynamic firing loads. By leveraging topology optimization, Design Explorer, Manufacturing-Driven Design and meshless Finite Element Analysis (FEA), the team achieved a **30% reduction in weight**. While Titanium Ti-6Al-4V was evaluated, the final production utilized Stainless Steel via Additive Manufacturing to meet durability requirements while eliminating traditional tooling costs.

Engineering Challenge

The aerospace and defense sector faces a constant trade-off between payload capacity and fuel efficiency. The legacy armament mount was manufactured using traditional subtractive machining, resulting in a prismatic, blocky geometry that carried significant unnecessary mass.

- **Technical Hurdles:** The part must withstand high-cycle fatigue, recoil vibration, and G-forces.
- **Manufacturing Constraints:** The client required a solution that avoided the long lead times of die casting tooling and the material waste associated with CNC machining from solid billets.
- **Integration:** The design had to maintain exact preserve regions for the pivoting swing-arm mechanism and locking pins.





The Solution: Cognitive Design Workflow

1. DESIGN SPACE & LOAD CASES

The engineering team imported the legacy assembly into the simulation environment, defining critical mating surfaces, pivot points, and the locking lever interface as non-design space. Complex loading scenarios were applied, including vertical G-loads from flight maneuvering and lateral recoil shock from armament firing, with the original solid arm serving as the baseline for stiffness and safety factor targets.

2. GENERATIVE EXPLORATION

Using Topology Optimization and the Design Explorer interface, we performed a **Design of Experiments (85+ variations generated)** comparing Ti-6Al-4V for maximum strength-to-weight against Stainless Steel for cost-effective durability.

Three manufacturing approaches were evaluated: 5-axis CNC machining constraints, castable geometry with split lines and draft angles, and unconstrained organic optimization. The latter generated the most efficient load paths through truss/lattice structures, producing the fluid aesthetic seen in the final design.

3. PERFORMANCE & MANUFACTURABILITY (MDD)

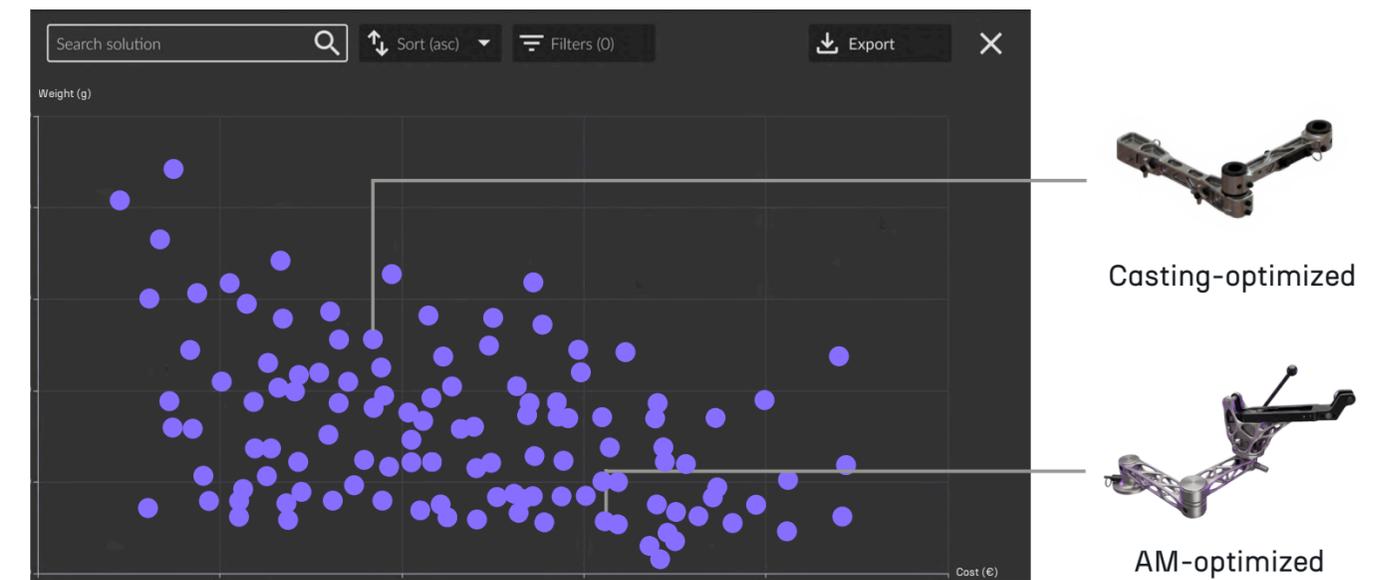
The free-form topology methodology proved superior to machined or cast variations. **Simulation-Driven Design (SDD)** module combined with **Meshless FEA** unlocked rapid iteration, removing material from low-stress regions while reinforcing high-stress areas at the pivots. With Additive Manufacturing as the production method, **Manufacturing-Driven Design (MDD)** algorithms ensured self-supporting lattice members free of stress risers. Despite Ti-6Al-4V's high performance, Stainless Steel delivered the required 30% weight reduction with superior abrasion resistance for field conditions.

4. VALIDATION

The final geometry passed comprehensive validation. Von Mises stress concentrations were dispersed through the organic webbing, eliminating hot spots found in the original machined corners. Torsional rigidity was maintained within 2% of specification, ensuring **accurate armament targeting**.

Key Metrics Comparison

	5-Axis Machining	AM
Material	Standard Steel	Stainless Steel
Mass	2.45 kg	1.71 kg
Max Stress	180 MPa	165 MPa
Lead Time	6 Weeks	2 Weeks



Design Exploration results in Cognitive Design

