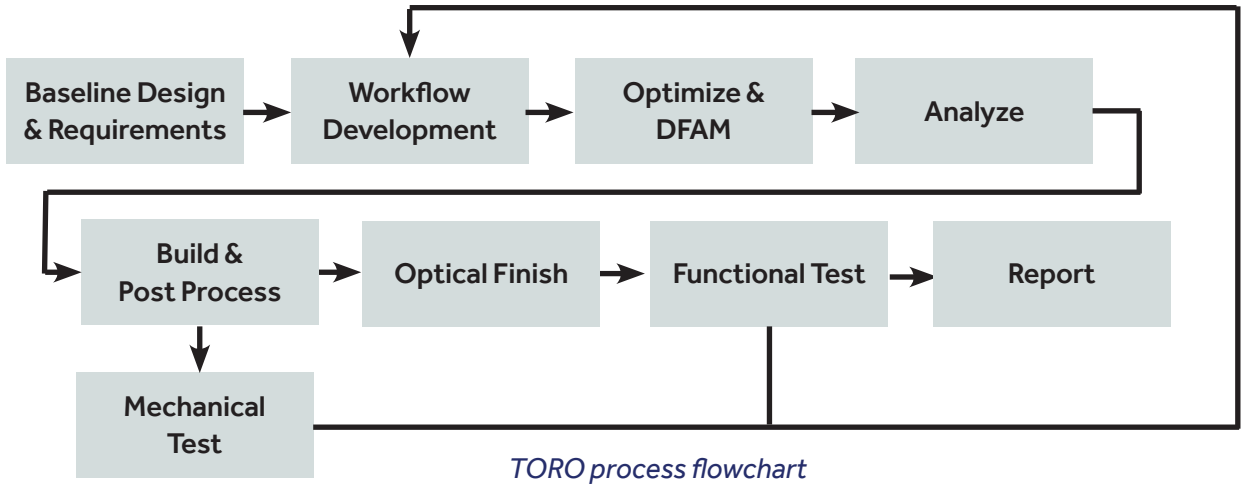
PROJECT SUMMARY 5505-001

Topology Optimized Reflective Optics (TORO) Additive for eXtreme Improvements in Optical Mounts (AXIOM)



TORO process flowchart

PROBLEM

Optical components for aerospace and defense are among the highest precision components produced worldwide. Extreme micro-stability, stiffness, weight, thermal, and geometric requirements demand the most advanced materials and designs. Despite advancements in topology optimization (TO) and additive manufacturing (AM) production of optical components, there are still optical applications that rely on traditional design and manufacturing methods using toxic and expensive materials like beryllium. The use of these toxic materials, which are expensive and pose significant health risks, is often justified when there are no other design or material choices available. These constraints threaten the mission of 'delivering performance at the speed of relevance' for emerging national security threats.

OBJECTIVE

In moving from a baseline design of a traditionally manufactured optical mirror/mount assembly to an exotic AM design enabled by advances in nTop Platform, the TORO team is prepared to meet the following objectives: 50% reduction in build cycle time, 70% cost reduction, 100% material toxicity reduction, 50% reduction in design cycle time, 10% increase in stiffness, 10% increase in shock mitigation, zero net change in optical stability, zero net change in geometric tolerance, and a 10% weight reduction.

AMERICA MAKES TECHNOLOGY DEVELOPMENT ROADMAP

This project aligns to:

DESIGN

ASTM PROCESS CATEGORY
Powder Bed Fusion

EQUIPMENT:
M2 Gen 1
M2 Gen 5
X Line 2000R

MATERIAL
AlSi7Mg
AlSi10Mg

TECHNICAL APPROACH

The TORO program seeks to achieve the program objectives through the use of state-of-the-art TO, lightweighting, and end-to-end AM processing within the nTop Platform software. The existing nTop platform software provides key advantages in geometry manipulation and design cycle time reduction, such as the ability to go from optimization results directly to slice files. In addition to leveraging existing capability in nTop Platform, the TORO program plans to generate new capabilities in the software that are applicable to optics workflows. Baseline designs generated by Raytheon Technologies (RTX) are being optimized through the new workflows created by nTopology, additively manufactured out of aluminum at RTX, tested by the National Institute for Aviation Research at Wichita State University, and iterated to demonstrate improvements in critical performance metrics over a baseline design.

Flowing requirements from defense contractors directly into commercially available software is a strength of this approach, enabling designs to address the critical performance metrics of stiffness, dampening, thermal management and stability, and geometric tolerance for optimizing optical components. New workflows generated within nTop Platform will be released throughout the program through the normal nTopology user release. These software improvements enable more cost-effective optical components with reduced lead-time compared to conventional design processes.

PROJECT START DATE

September 2020

EXPECTED END DATE

May 2022

EXPECTED DELIVERABLES

- Topology optimization and DFAM guidelines
- Test plan for prototype and demonstration
- Prototype design report
- Prototype test report
- Performance evaluation for demonstration part
- Business case analysis
- Guidelines for replacing exotic materials
- Optical design workflow(s) and custom blocks
- Display hardware
- Software release notes
- Final report

FUNDING

$841K total project budget
($560K public funding/$281K private funding)

PROJECT PARTICIPANTS

Project Principal:
Raytheon Technologies (RTX)

Other Project Participants:
nTopology
National Institute for Aviation Research (NIAR)

Public Participants:
U.S. Department of Defense

5505-001 TORO AXIOM