CQFA CARREFOUR QUÉBÉCOIS DE LA FABRICATION ADDITIVE

# CASE STUDY

## MULTIPLE JIGS FOR THE MACHINING OF HIGH-COST TITANIUM AIRCRAFT PARTS

PART 1

**Project duration**

From 2018 to 2022

**Partners**

Centre de métallurgie du Québec (CMQ), A7 Integration, Coalia, Electro-Kut, École de technologie supérieure (ÉTS), SphèreCo Technologies, TRAF Industrial Products

**Materials**

Precipitation-hardened stainless steel: 15-5 PH (5 parts printed)

**Processes**

Hybrid DED (Directed Energy Deposition) – AMBIT S7 process from Hybrid Manufacturing Technologies

**Application fields**

Aerospace

## OBJECTIVES

**To optimize a machining jig that reduces costs and production time while maintaining or improving its properties through Additive manufacturing (AM).**

## BACKGROUND

Machining aerospace parts requires a variety of complex and diverse fixtures and tools. The process often involves significant costs and lead times to achieve the required precision. Machining lead times are further amplified by the high demand. Funded by the Natural Sciences and Engineering Research Council (NSERC) and the Consortium de recherche et d'innovation en aérospatiale au Québec (CRIAQ), the objective behind the MANU-1707 project titled "Création de ybridses démonstratrices de conception et de fabrication ybrids pour l'outillage aérospatial" was to evaluate and integrate AM into tooling production processes when machining aerospace parts while reducing costs and production lead times.

## THE CHALLENGE

AM is often considered too expensive when producing parts that do not provide a great deal of value-added. Inconel and titanium aerospace parts with complex and optimizable geometries, however, are often considered ideal candidates for AM. Machining jigs made from 6061 or 4340 aluminum tend to be less so. This is partly due to the lower cost of the material intended for machining when producing the jig; machining 90% of a steel part is typically less challenging than doing the same for a titanium part. If we consider machining costs alone, a commonly used AM design rule states that a part produced through machining will generally be less expensive than one produced through AM. Plus, a jig's geometry often shows less flexibility to topological optimization due to geometric constraints from the parts they hold, as well as by other sections of the jig.

The jigs analyzed in this case study involved high production costs, which the project sought to reduce. It should be noted that these jigs belonged to a set of comparable fixtures that could be optimized through similar methods.

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## THE SOLUTION

Following topological optimization, the solution involved the use of AM by directed energy deposition or, more specifically, the AMBIT S7 hybrid DED process from Hybrid Manufacturing Technologies. The original part contained a large rectangular section, which would have yielded little value-added if printed. For this section, two functional sections were deposited by DED onto a wrought block. Note that the WAAM (Wire arc AM) process was evaluated during the part's preliminary design selection. Despite a higher deposition rate than DED, however, the solid sections produced by WAAM required more machining. The hybrid DED allowed material to be added only where needed.

## BENEFITS/RESULTS

The hybrid DED solution helped reduce the jig assembly's weight in comparison to the original parts while integrating several pieces of hardware into the same part. The hardware required machining and its integration into the optimized design helped limit the required amount of post-print machining. The printing reduced the part's cost. The DED-printed part's component cost dropped by 39% when compared to a conventional part's manufacturing cost. Due to the subsequent machining involved, however, prototype costs increased with AM. Considering both cost fluctuations, the cost of the part's complete assembly went down by 13%. AM therefore achieved its objective: To significantly reduce the part's cost. This case study demonstrates how several AM processes can provide low-cost solutions that can compete with conventional machining methods, or serve alongside them.

## CONTACT

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