CQFA CARREFOUR QUÉBÉCOIS DE LA FABRICATION ADDITIVE

CASE STUDY

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

PART 2

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

Bronze-infiltrated 420 stainless steel (2 parts printed)

Processes

Binder jetting with bronze infiltration – ExOne M-Flex process

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 stratégies démonstratrices de conception et de fabrication hybrides 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.

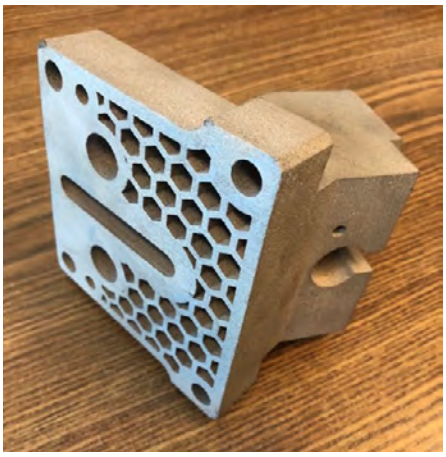
THE CHALLENGE

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.

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

CQFA CARREFOUR QUÉBÉCOIS DE LA FABRICATION ADDITIVE



THE SOLUTION

Following topological optimization, the solution involved the use of AM by binder jet or, more specifically, Exone's M-Flex process with bronze infiltration. This technology helped print the jig, which fused three independent parts into the initial jig while reducing both weight and cost. Considering the size of the jig, immediate post-printing sintering would have led to a porous part if low densification had been used. Conversely, if high densification had been used, the part would have resulted in tolerancing far beyond the jig's requirements. With bronze infiltration, the part's dimensional control could be achieved while keeping costs below that of other AM technologies.

BENEFITS/RESULTS

First, the binder jetting solution helped combine three parts of the original jig, thereby reducing the amount of hardware required for the assembly. It also resulted in a 20% weight reduction compared to the original jig. Finally, a 9% cost reduction occurred by producing the jig with AM, as opposed to conventional machining. This suggests that AM can generally be used interchangeably with conventional jig production, leading to small but significant cost savings. Within high-traffic and high-performance machine shops, this AM production method opens up a number of alternative manufacturing avenues that can reduce production lead times and alleviate pressure on machine shops.

CONTACT

Howmet Aerospace
5515 Ernest Cormier Street, Laval, Qc H7C 2S9
Benoît Pigeon, Bid, New Product Implementation & Engineering Project