COMPETENCE
INDUSTRY
MANUFACTURING
4.0

RM FORUM 25|26 SEPT 2024
THE 'ADDITIVE' COORDINATES TOWARDS THE FUTURE

Reverse engineering and optimization of spare parts for historic vehicles

Andrea Manassi
Additive Manufacturing Product Engineer

CIM4.0

Consortium & Partnership

Politecnico di Torino | Università di Torino | Camera di Commercio Industria Artigianato e Agricoltura di Torino | api Torino | Unione Industriali Torino

4D Engineering | Agilent Technologies | aizoOn Technology Consulting | Alten | Avio Aero | CEMAS elettra

Dumarey | eni | FEV | iren | Italdesign | Leonardo

Merlo | Michelin | Prima Additive | Reply | Siemens | SKF

Stellantis | Thales Alenia Space | TIM

3 PA (1% share)
2 INDUSTRIAL ASSOCIATIONS (4.2% share)

21 COMPANIES (94,8% share, 4.31% each)

26 FULL MEMBERS

accenture | Always | APTIV | aws | Dylog Tesar | FANUC

Google Cloud | Intesa Sanpaolo | Iveco Group | Mimete Metal Powders | Roboze | Tecnocad

12 ACTIVITY PARTNERS

CIM4.0 assets
Our resources

People

40	**CIM4.0 specialised people**
138	**People from consortium members**
82	Senior professionals
34	Junior professionals
7	Associated professors
15	Full Professor

Assets

2	Open spaces
4	Areas for education, training and co-working
1	**Additive Manufacturing Pilot Line**
1	**Digital Factory Pilot Line**
1	**Hub** (Michelin Innovation Center - Cuneo)

AGENDA

Scenario

+CIM4.0

During the restoration of many **historic cars**, some **spare parts** are required, which are difficult to be found.
For these components **original drawings and tooling**, with which they were made, are **often unavailable**.
In order to replicate them, **traditional manufacturing** deals with **high production costs**, if a demand of only **few units per year** is needed.

Additive manufacturing is proposed as an effective solution to this problem, because it can optimize costs for medium to **low production volumes** and needs only a **3D model** to produce final parts, without any tooling.

Source: Quattroruote.it

Objective

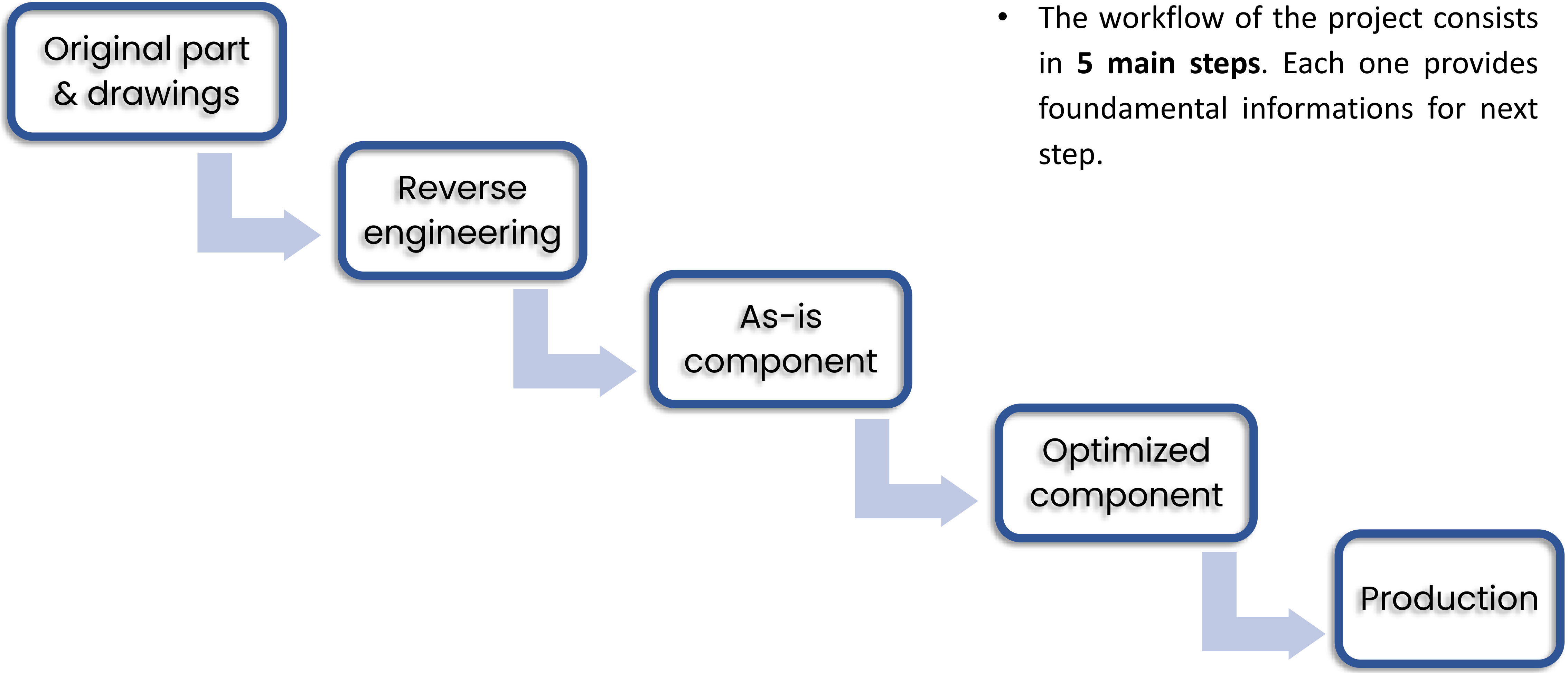
+CIM4.0

The main goal of the project is to highlight the potential advantages of Additive Manufacturing in the proposed application field through the **production** of an **optimized component** taken from an **historic vehicle**.

Imposed requirements:

- **Preserve** the **external geometry** as close to the original as possible. Inner geometry is less constrained because is not visible (Aesthetic requirement)
- **Maintain** component **performance** (Performance requirement)
- Optimize production **costs** (Economic requirement)

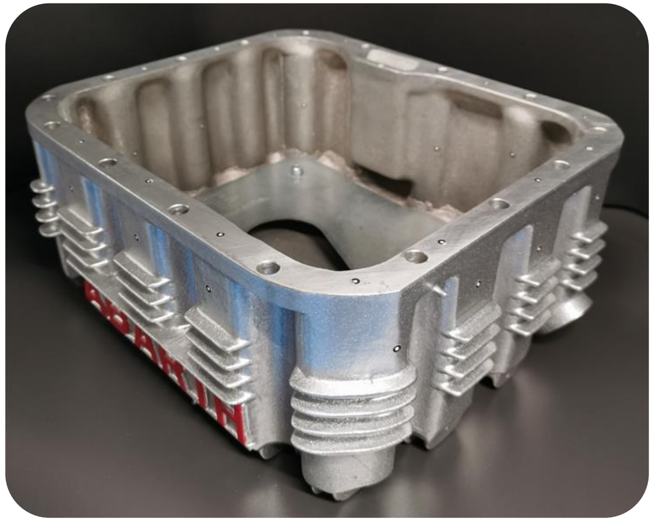
Workflow



- The workflow of the project consists in **5 main steps**. Each one provides foundamental informations for next step.

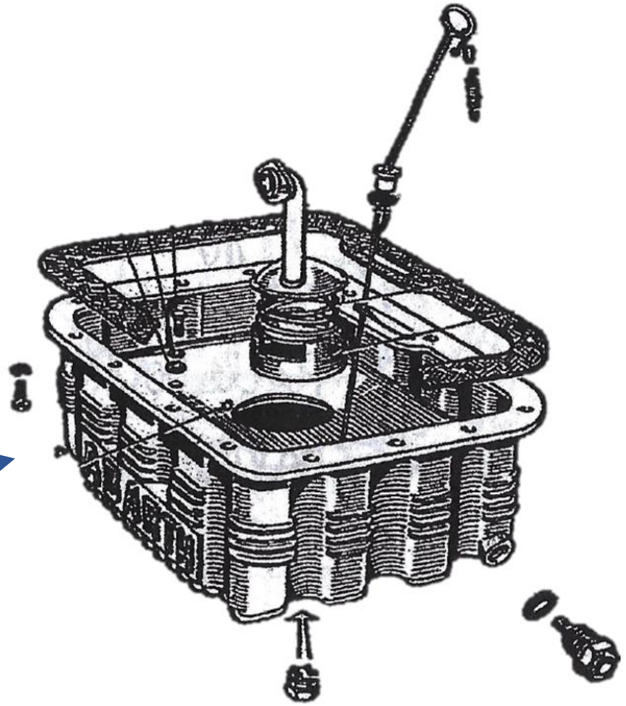
Original component

The chosen component is the **oil pan** from a FIAT 500 Abarth of the 1960s. As input data for the project work, the **physical component** and some **original notes and drawings** were provided by the FCA Heritage Hub.



Physical component

Original drawings



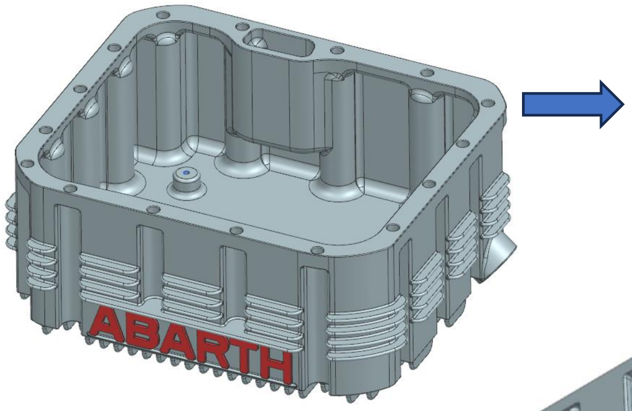
Original part data:

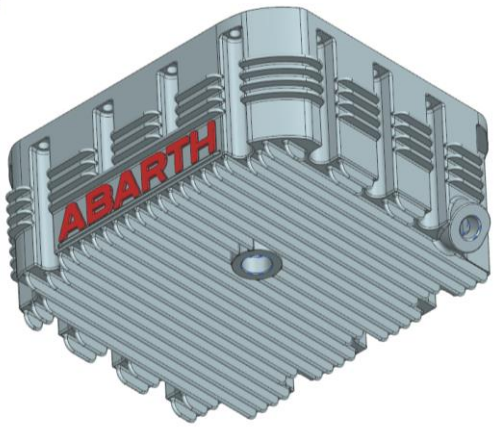
Part mass(g)	3314
Inner plate mass(g)	188
Total mass (g)	3502
Material	AlSi9MnMg
Fabrication process	Casting
Wall thickness (mm)	4

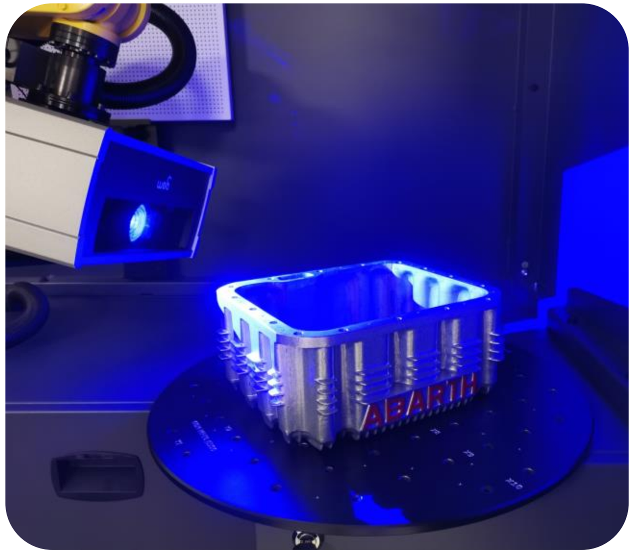
Original component

Reverse engineering:

- The first step to produce an AM component is to obtain a **3D model** from input data. **3D scanning** captures a point cloud of the original geometry and generates a virtual model with a fine discretization of the outer surfaces (STL file).







- Scanning result and original drawings provided all the elements to perform the **model reconstruction** (CAD file).

  To ensure proper **assembly**, special attention was paid to the **upper flange**.

As-is component

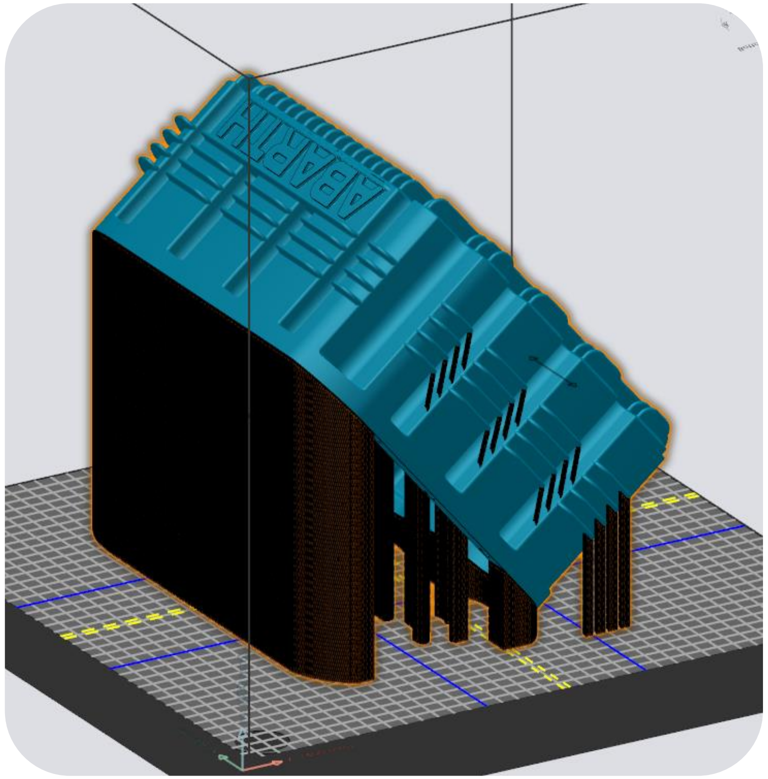
+CIM4.0

The CAD model is modified by adding **extra material** on those surfaces requiring post-machining (flange and holes). Build preparation is then carried out after the **orientation choice** and **support generation**.

The orientation aims to fulfill requirements on outer surfaces and avoid supports on critical surfaces.

- **Estimation results**:

Part (g)	3140
Support (g)	328
Total building time (h)	16,6

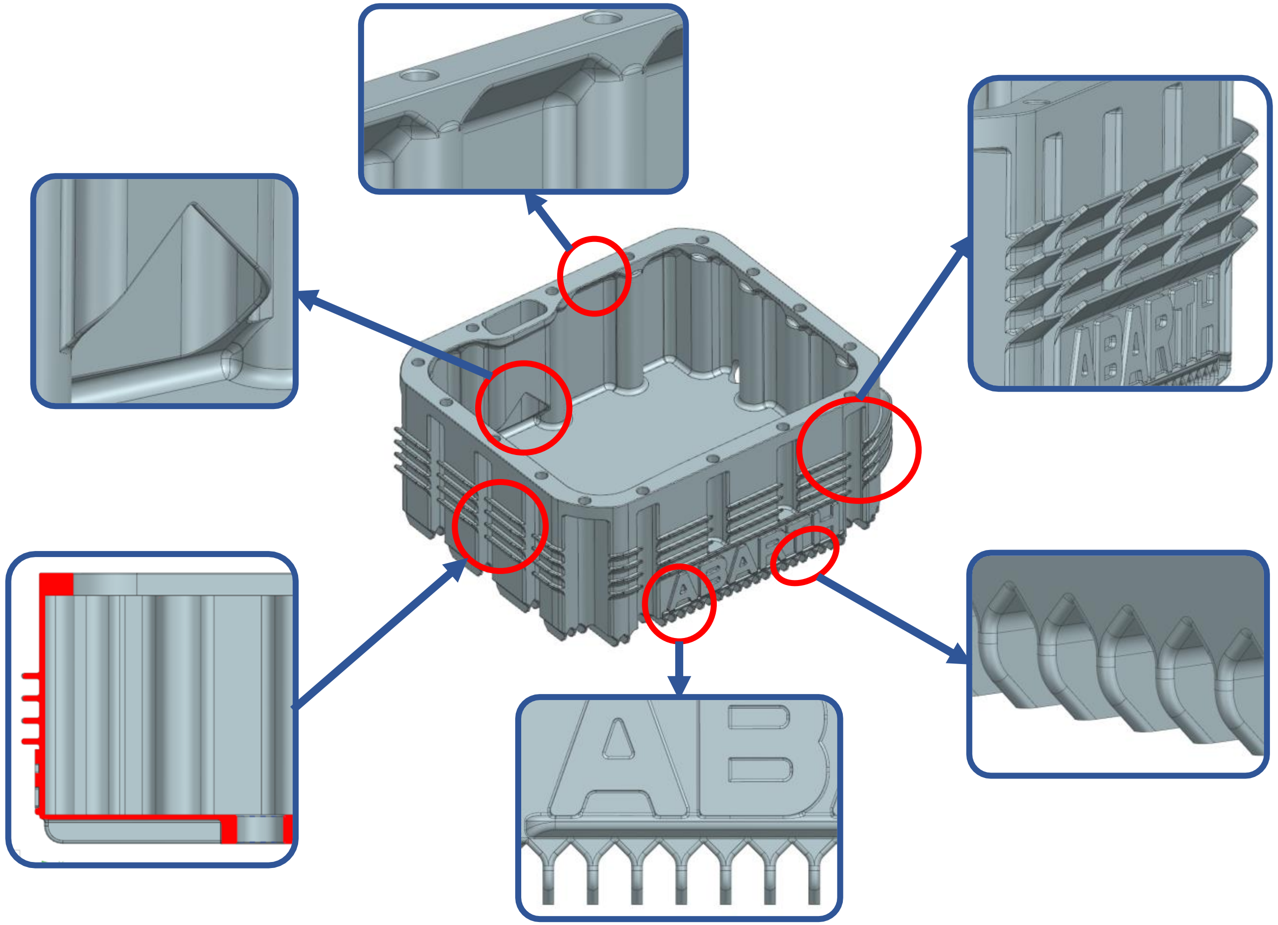


- AlSi10Mg
- 80-microns layer with double recoating

Optimized component

+CIM4.0

During re-design phase the **main driver** was **building time reduction**; a **new orientation** was then defined with **minimum Z height**. In this phase, DfAM rules were followed to reduce as much as possible support structure.



DfAM and upgrades:

- 2 mm wall thickness
- Bottom oil inlet duct cutted with 45° planes
- 45°chamfer on flange inner overhanging surfaces
- Fins extruded on build platform
- Support-free structure for oil pan bottom face
- Side fins tilted at 45°angle

Optimized component

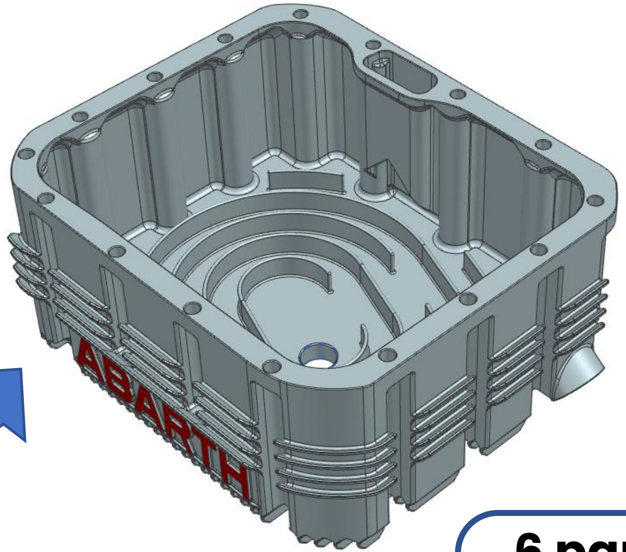
Original oil pan has an inner plate as **oil anti-slosh system**; its function is to **prevent** the **oil pump to run out of oil**, with the risk of damaging the engine. **Two** different **variants are** studied and **integrated** into the main body, to reduce assembly operations.

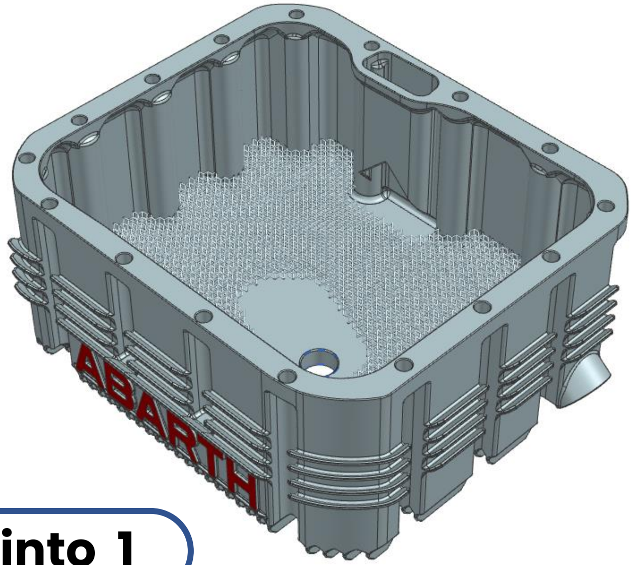
Labyrinth variant

A series of concentric partition walls

Lattice variant

A wide lattice structure





6 parts into 1

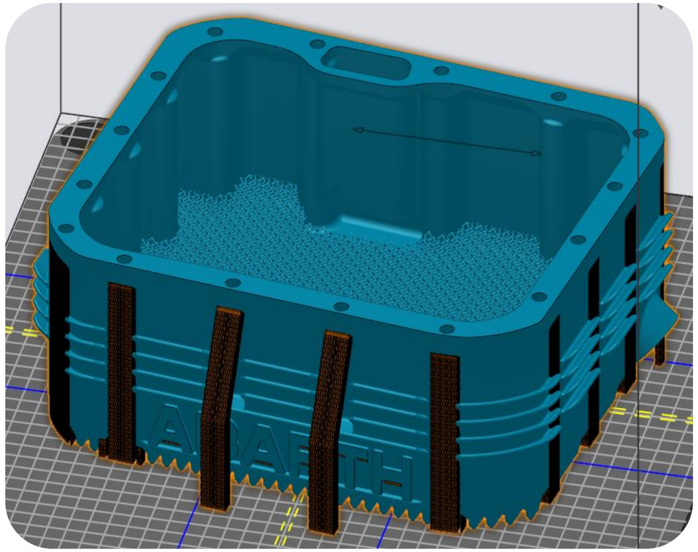
Optimized component

+CIM4.0

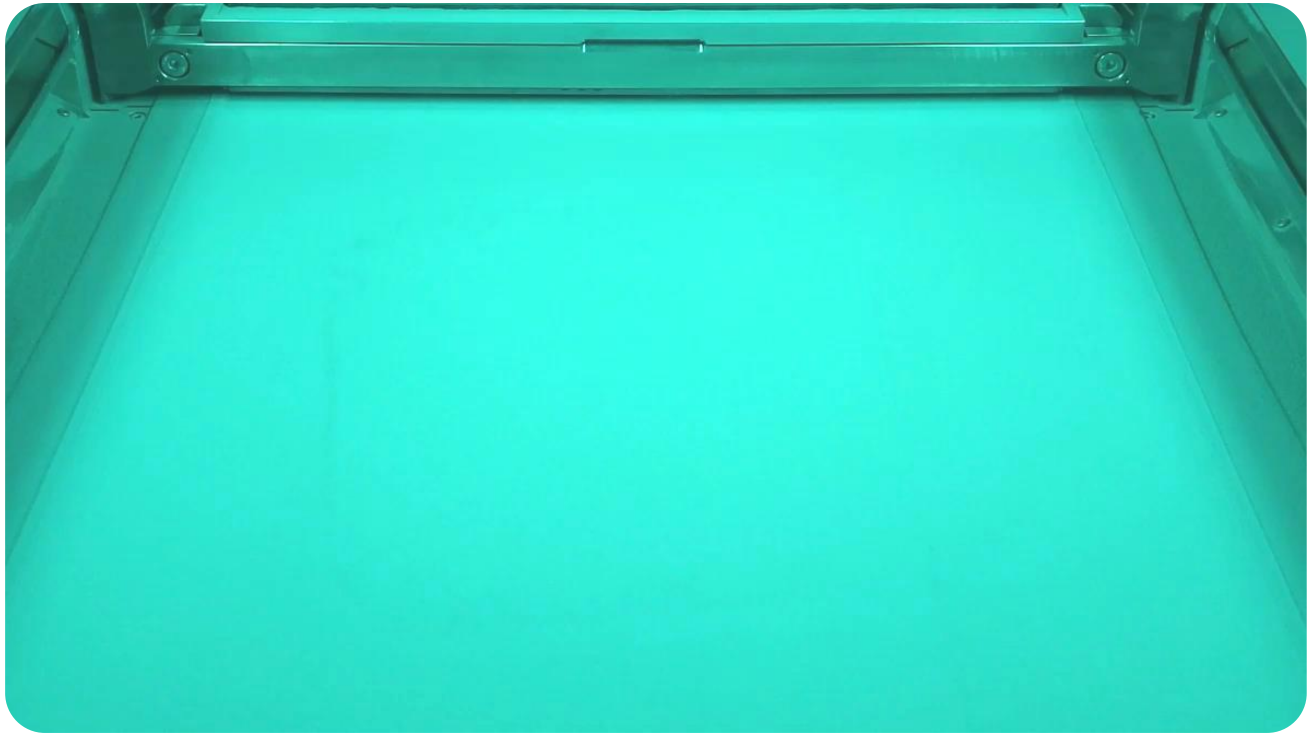
The production of lattice configuration is evaluated. Extra material for surfaces to be machined was added and supports were generated.

- **Estimation results**:

Part (g)	2472
Support (g)	83
Total building time (h)	8,9



- **The production:**



Conclusions and next steps

+CIM4.0

Optimized component presents several improvements, in terms of performance and costs, compared with the evaluation of the as-is/original part.

Final results:

- Optimized component is **30% lighter**
- Optimized component has **75% less waste material** (supports) than as-is version
- A **building time reduction of 45%** is achieved
- Assembly operations are simplified thanks to integration of the oil anti-slosh system (**6 parts into 1**)
- Increased heat exchange/oil cooling performance (**wall thickness reduced by 50% and 7 fins** were **added**)

Next steps:

- Install the component on the vehicle and carry out the **testing phase**
- **Identify other components** with higher production costs

Thanks for your attention!

+CIM 4.0

CONTATTI

cristina.cibrario@cim40.com

andrea.manassi@cim40.com

Registrati alla nostra newsletter per ricevere aggiornamenti

www.cim40.com