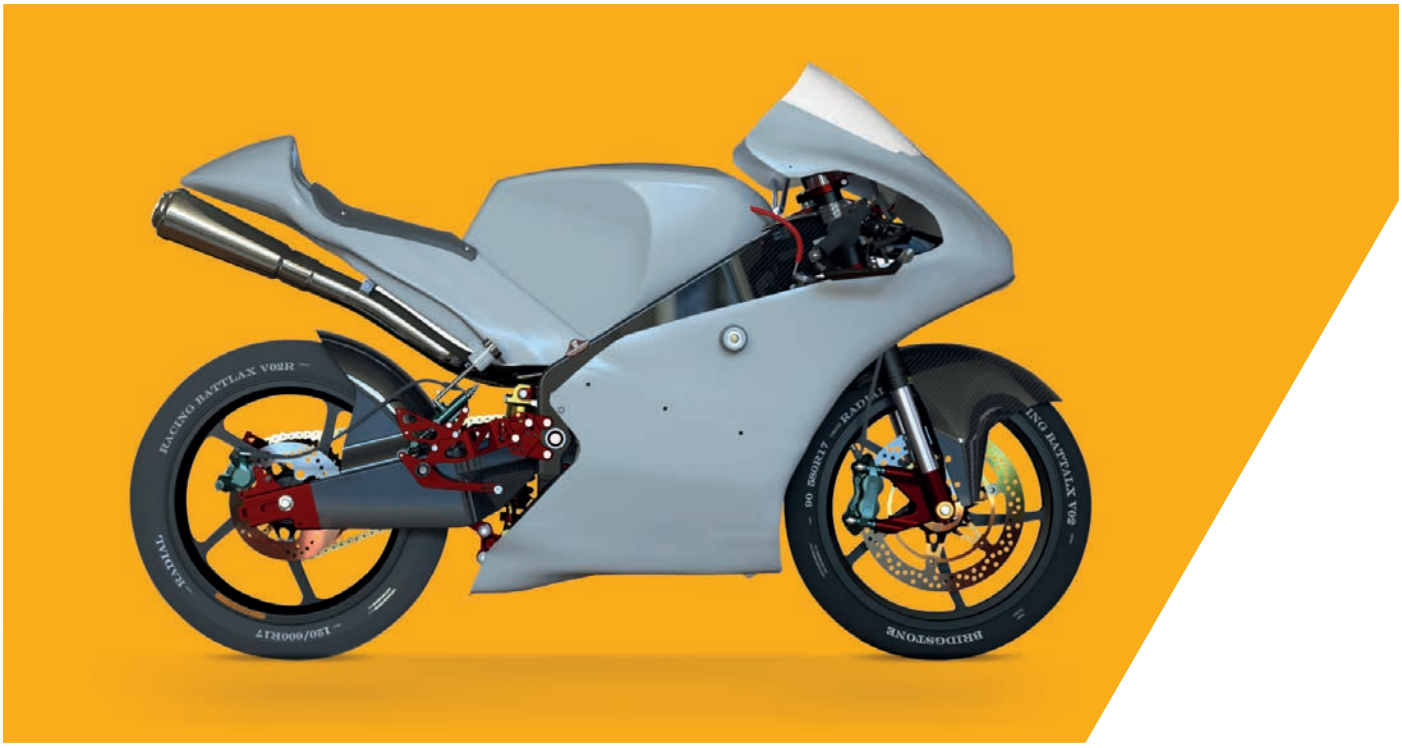
CASE STUDY



OPTIMIZING FOR MOTORCYCLE SUCCESS

IMPROVING DESIGN PERFORMANCE OF PRINTED COMPOSITE PARTS

About the Team

MOTO-MAQLAB-UC3M was founded in 2010 by students at Carlos III University in Madrid, Spain, to develop a racing motorcycle for the international MotoStudent competition. MotoStudent is an international event held every two years at the MotorLand, Aragon circuit and welcomes university teams from all over the world. The MOTO-MAQLAB-UC3M team won awards in several categories of the fourth MotoStudent edition including first prize for best industrial design and second places for best innovation and best industrial project. Inspired by their successful participation, the students wanted to further develop and improve their race bike designs to repeat or exceed these results. Team members come from various university faculties covering the different projects areas such as design, simulation, manufacturing, electronics, marketing, and operations.

The Challenge

To be successful in motorcycle competitions, race teams have to rely above all on the performance of their motorcycles, which have to be lightweight, powerful, and innovative. Since one important factor in race bike engineering is a high stiffness of the motorcycle frame, motorcycle designers are employing advanced tools and engineering to find the optimal design.

In order to improve their results in the competition, the MOTO-MAQLAB-UC3M team needed to reduce the mass in the cycle parts of the bike. To reduce weight, they wanted to introduce additive technology and replace several components made of traditional materials with parts made of composite materials while maintaining the same stiffness level of the replaced part.

30% ▼
WEIGHT & MASS REDUCTION

100%
PERFORMANCE

REDUCED
DEVELOPMENT TIME

In this case, the main challenge was to provide a rigidity equivalent to one of the previous (award-winning) models and maintain the dynamic properties while simultaneously achieving a much lighter design. Additionally, the team had to face a tight schedule to be ready for the upcoming competition.

Our Solution

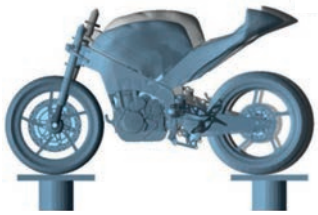
The team first created a finite element (FE) model of the part they wanted to additively manufacture. This model included insights on the rigidity of both the wall of the printed part and the rigidity provided by the additive manufacturing plastic fillings. To obtain the necessary forces of the occurring load cases, the team built a multibody model using Altair simulation solutions Altair MotionSolve™ and Altair HyperWorks™ while considering maximum acceleration, maximum braking and cornering, thermal behavior, competition regulations (horizontal and vertical compression), and total, lateral, and torsional rigidity of the model.

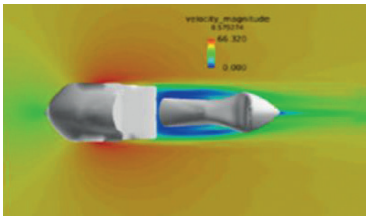
The resulting forces were then used for the analysis of the FE model. For the FE simulation, the students simplified the bushings and bearings using 1D elements, and the 3D printed fill part was modeled using a mat9-ORT material card assigned to the geometry of the printed part. Composite materials and isotropic material inserts were created using 1D, 2D, and 3D elements. Analytical formulations were then used to obtain the applying forces from the load cases in the multibody model and to obtain the properties of the anisotropic model.

Since the entire design and production of the bike is a multidisciplinary project, several departments including simulation, design, and manufacturing were involved in the process. In addition to the Altair solutions, which allowed the calculations and optimization, the team also relied on Altair's technical support, which was critical for the project's success.

Results

Altair solutions enabled the MOTO-MAQLAB-UC3M team to approximate the ideal number of layers, their shape, order, and direction. Thanks to the Altair tools, the team achieved a mass reduction of 30% which contributed massively to the achievement of the weight goal while maintaining the stiffness of the original part. Altair solutions not only solved all calculations but also saved preparation time and improved productivity. Three-point carbon fiber testing ensured that the manufactured part will be within a very small deviation of the results obtained from the simulation. Satisfied with the results of the project, the MOTO-MAQLAB-UC3M team looks forward to competing in the next race.





TOP: The multibody model built in Altair MotionSolve and Altair HyperWorks enabled the team to determine the occurring dynamic loads. **MIDDLE:** Aerodynamic simulation of the model in a virtual wind tunnel to assess the aerodynamic forces on the bracket. **BOTTOM:** Using the Altair solutions, a mass reduction of 30% was achieved while maintaining the stiffness of the original part.