SIMULIA

ROYAL ENFIELD

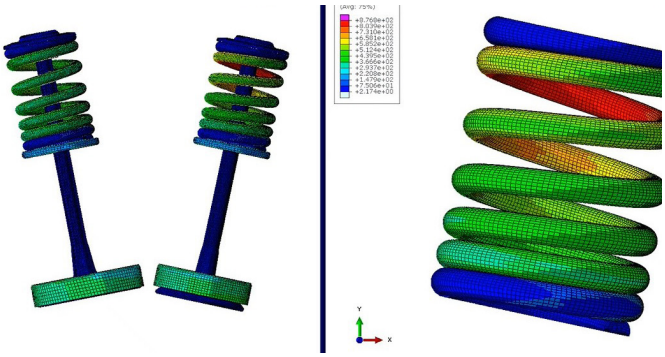
Case Study

DASSAULT SYSTEMES

Challenge:
Royal Enfield, the oldest global motorcycle brand in continuous production, needed to find better ways to continue producing the bike models that have long made them famous, while also incorporating the technology and performance that modern customers demand.

Solution:
By leveraging the SIMULIA portfolio throughout the design process of the engine and chassis, Royal Enfield engineers are able to rapidly improve performance and safety while reducing weight.

Results:
Royal Enfield customers enjoy motorcycles that have the classic look of yesterday, and the comfort and safety innovations of today.



Dynamic Implicit Analysis of Valvetrain

The oldest motorcycle brand in the world in continuous production, Royal Enfield has thrived by combining classic styling with modern performance. Headquartered in Chennai, the company currently enjoys 95% market share in the mid-size segment of the Indian motorcycle market and is expanding across the world.

Part of the brand's appeal comes from its heritage – the Royal Enfield Interceptor from the 1960s is now considered a classic racing bike – but at the same time, customer desires and regulatory requirements in the motorcycle sector have changed dramatically in the decades since. Environmental and safety devices such as ABS and catalytic converters are now a must, while at the same time improvements to roads mean that riders put even more value on speed and acceleration. To integrate modern technology without compromising on style, Royal Enfield turned to Dassault Systèmes SIMULIA tools.

REDUCING WEIGHT, OPTIMIZING THE EXPERIENCE

The balance between durability and weight—and therefore speed—is present in all areas of transportation, but it is especially crucial in motorcycle design. Motorcycles are very compact, and a small weight reduction in one component can represent a significant change to the total vehicle weight, particularly as decreasing the size of one part can allow others to be made smaller as well.

According to Rod Giles, Head of CAD & CAE at Royal Enfield, "only a few grams difference to the piston can have a massive knock on effect to all of the other components in the engine. So if you could save, say, 10 grams in the piston that would potentially result in perhaps 1 or 2 kg saving in the whole engine because you can then make all the other components lighter, bearings smaller, a more compact package, less material in the crankcase and so forth.

"We went through a very extensive simulation of the piston including all of the thermal effects and the structural effects going through and simulating the durability cycle of the piston and then optimizing the thickness of the piston to make sure that we got the right answer. That included how the piston moves in the cylinder: all the thermal expansion effects, all of the clearance effects, the oil film thickness and how that interacts.

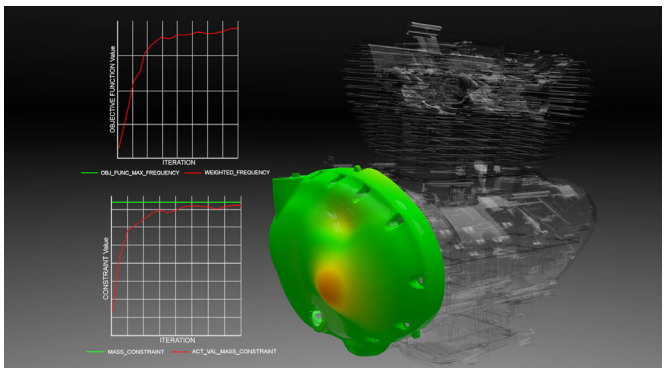
"There are a lot of difficult and important effects that needs to be captured ,so all of the SIMULIA tools are used. Simpack to look at what's called the piston secondary motion – how the piston behaves in the cylinder with all of the bore distortion and thermal expansion. We then imported that Simpack results along with the thermal data to Abaqus, to understand how piston stresses were varying during the cycle. The Abaqus results are then taken to fe-safe for a piston durability analysis"

Another way that Royal Enfield increases the strength of parts while minimizing weight is to add ribbed patterns to the inside of panels. Nabeel T K, CAE Engineer, in the powertrain CAE team describes how they use the Dassault Systèmes SIMULIA optimization tool Tosca to design these ribs: "It shows us how the ribs should be aligned based on a frequency based sizing optimization, which gives an optimized shape for the ribs and all the covers.

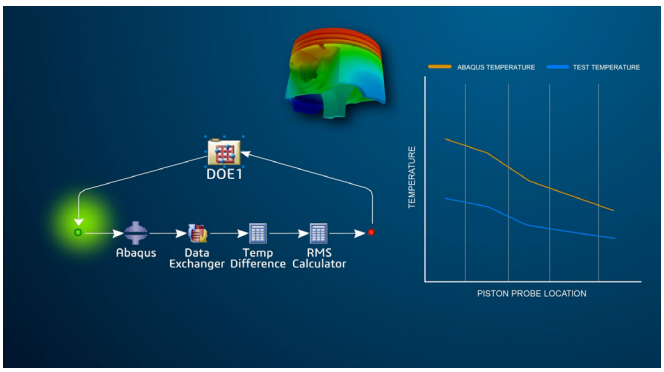
"In the Interceptor 650 , rib patterns of the clutch cover, magneto cover , oil-pan and also the head cover are based on the suggestions coming from Tosca."

"The best part about SIMULIA products is the correlation we are getting with test results. We can do an initial DOE study, an optimization, approximation if needed, a six sigma analysis, all those things for reliability."

— Nabeel T K, CAE Engineer, Royal Enfield



Rib Pattern Optimization



Piston Temperature Matching

Not only do the ribs strengthen the panels, they also improve the sound of the bike by controlling where vibrations occur in the vehicle. Rod Giles adds that "Royal Enfield is really famous, particularly in India, for the sound of the motorcycle. When people are riding or when they are in the street, they can hear the sound of the motorcycle and they go "That's a Royal Enfield", and that then helps with building our brand and our cachet because it's an aspirational vehicle."

DURABILITY MEANS RELIABILITY

Customers expect reliability, especially from a quality brand like Royal Enfield. One crucial application of simulation tools at the company is to analyze the fatigue life of components and optimize their durability.

Nabeel explains "Simpack has excellent tools to assess the piston secondary loads, which is very important these days because if you just simulate a piston with just a combustion load that's not going to be enough because there's all sorts of other side loads. Simpack does a very good job of assessing the piston secondary loads and on top of it again, you can use a flexible body and get the stresses and do a fatigue analysis in fe-safe.

"The Dassault Systèmes SIMULIA portfolio has become mainly the one which I use: I use Abaqus. I use Isight. I use fe-safe all the time. For multi-body dynamics capabilities we use SIMPACK. I think we use most of the products in the SIMULIA portfolio."

"The best part about SIMULIA products is the correlation we are getting with test results. We can do an initial DOE study, an optimization, approximation if needed, a six sigma analysis, all those things for reliability."

Giles adds "The real key value of the simulation is that we have much more confidence in our design and this reduces the risk that we've got something wrong. So we can be very confident that our prototype will perform correctly. We can also reduce the time to market because we have that confidence so it's very much a risk mitigation type of exercise. Simulation is insurance, that we know that we're going to get the right product."

CLASSIC DESIGN, MODERN TECHNOLOGY

Royal Enfield is a long established name in the industry, and the company's Bullet line has had the longest production run of any motorcycle. The brand's heritage and cachet is a crucial part of its image and sets it apart in a crowded market.

However, as times have changed, Royal Enfield has changed with them. Improvements in technology and new environmental and safety standards have all made their mark on Royal Enfield's products. As Giles puts it, "we have to offer ABS as standard, we have to have fuel injection, and we have to have catalytic converters. All of these things would never have been on a classic bike in the 50s and 60s. So what we have to do is to be very smart about the packaging of all of those components so it's not really obvious that they're there."

Simulation helps to integrate these components into the limited space and achieve modern levels of performance, but without compromising that classic 1950s and 1960s style. "You still want to have a bike that looks like that, but it needs to perform in a modern way, particularly if we want to achieve higher speeds of modern traffic. One of the challenges is to make sure that the frame and engine have the correct stiffness in various directions to make sure that we get the stability that we need. And so we can do a lot of analysis using tools like Simpack to understand what factors are affecting the stability of the motorcycle."

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— Rod Giles, Head CAD & CAE, Royal Enfield

GOING GLOBAL

Although Royal Enfield's largest market is India, the company is targeting a worldwide market. Especially across Asia and South America, there are many potential targets for expansion. To avoid splintering their product range, they need to develop motorcycles that are suitable for different terrains and climates and meet all the different regulatory requirements.

Giles explains, "With the simulation tools from Dassault Systèmes, we can do a lot more testing virtually for different conditions and different marketplaces and so forth. The cost of shipping a motorcycle, to Brazil or so forth, with holdups and customs, makes it really expensive and very time consuming to do physical testing in various markets. But what we can do is take data from those markets, and then apply them in the simulation realm to make sure that we have a motorcycle which will meet the conditions of the local market. With the Dassault Systèmes software, we can look at all of the aspects all together to get an overall picture of how the component is going to actually work in the intended environment."

The ability to analyze many different designs and scenarios also offers significant time savings in design and allows a wider range of concepts to be tried. As Nabeel explains, "Without simulation, we wouldn't be able to do as many iterations at different stages of the product development phase."

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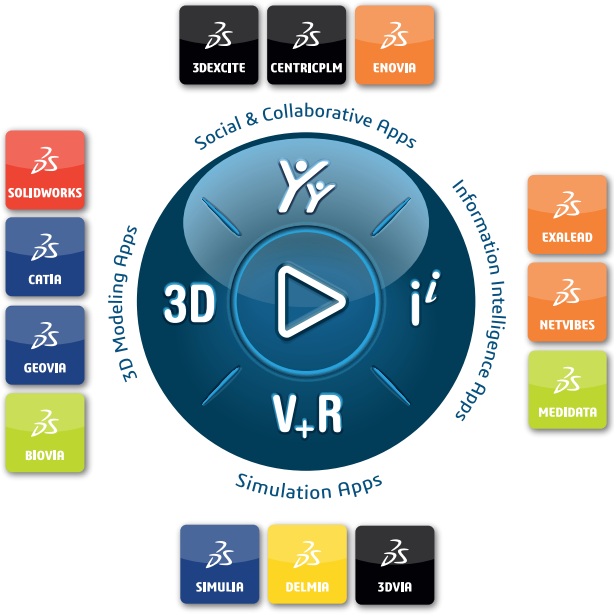

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