

Marshall Aerospace & Defence Group

Marshall engineers address COVID-19 crisis with ventilators simulated using MSC Apex



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Pictured above: a negative pressure ventilator in the 1950's during the Polio crisis, commonly referred to as an "iron lung."

During the early-to-mid-1900's as Polio was ravaging the world, a need developed for an artificial breathing apparatus for patients who could no longer fully breathe on their own. Engineers at the time were able to help by developing a mechanical ventilator, which ended up being commonly referred to as the "Iron Lung."

Technology has changed a lot since then, but the existence of respiratory illness has not. The COVID-19 pandemic has brought this to the forefront and caused a similar need today, as some of the most severe cases require ventilators to help the patients breathe during the worst parts of their hospitalization.



Figure 2: An early artistic rendering of the “Exovent” negative pressure ventilator, which greatly simplifies the design and cost compared to the 1950’s

Challenge

The British Government challenged the Aerospace & Defence Industry to rapidly develop a modern version of the “iron lung” and develop respiratory ventilators that can help save lives around the world. Marshall Aerospace & Defence Group, located in Cambridge, UK, responded to the challenge and led a taskforce to do exactly that.

Due to the rapid nature of development that was needed, time was not on their side. Marshall’s engineers needed to design, analyze, and manufacture all on almost-parallel paths, so that a prototype could be delivered as quickly as possible. As such, the design was rapidly changing, sometimes changing daily, and the engineering simulation team needed to keep up with this rapid pace of development. MSC Apex was able to step up to the challenge and deliver rapid analysis results for Marshall’s engineers, allowing them to develop reliable and safe ventilators and deliver them quickly to save lives.

Solution/Validation

Marshall’s engineers first noticed the meshing capability of MSC Apex, and the speed of re-meshing and geometry cleanup. This allowed the stress analysis team to perform the simulation tasks needed in an environment where the design was changing rapidly.

“We had a simulation ready to run in 4 hours that would normally take a week. The model had fairly simple loading

and constraints, but all that time was saved on geometry clean up and meshing.” -Ian Debenham, Principal Stress Engineer at Marshall Aerospace & Defence Group

But then, after digging into the product a bit more, they realized that due to the connection Apex has between the CAD and the mesh, as well as the model validation Apex provided with first-run MSC Nastran solver success, quick design changes could be made without having to rebuild the simulation model from scratch for each design change.

“We were able to amend the simulation concurrently with both design and manufacture as we built a prototype ventilator so as to provide an almost instant response on product structural acceptance.” -Ian Debenham, Principal Stress Engineer at Marshall Aerospace & Defence Group

Thus, the reinvention of the iron lung was achieved, dubbed “The Exovent” and a prototype was delivered to the National Health Service (NHS) in an unprecedented amount of time.

Results

Prior to this development project, conventional Intermittent Positive Pressure Ventilators (IPPV’s) were used commonly, which require the patient to be intubated via their windpipes, meaning they have to be sedated, and sometimes even paralyzed, while their chest is squeezed to introduce and remove air into their lungs. The Negative Pressure Ventilator (NPV), developed by Marshall

Aerospace & Defence Group, did not require this invasive procedure, but instead patients remained conscious, could take medications and food by mouth (instead of drip), and continued to be able to speak after being put on the ventilator.

MADG are using the experience to increase their knowledge of medical device quality procedures to support future work relating to medical systems in Land and Aero domains (Medevac, CT scanners and field hospitals)

About Marshall Aerospace & Defence Group

Marshall Aerospace and Defence Group is one of the largest privately owned and independent aerospace and Defence companies that delivers innovation and excellence in engineering and support solutions in the air, on land and at sea. Marshall specializes in the conversion and modification of military, civil and business aircraft, alongside Defence vehicle engineering and shelter manufacturing. Our capabilities include engineering design, manufacture and test and the provision of personnel, training and advice, whilst providing maintenance, integration, manufacture and product support. Marshall Aerospace and Defence Group is a respected total solutions provider for the military and commercial sectors.

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Figure 3: The engineering prototype built by Marshall Aerospace & Defence Group

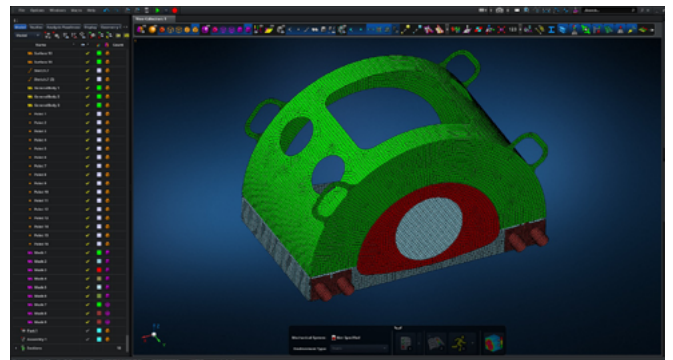


Figure 4: The MSC Apex structural analysis model of the Exovent prototype





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Our technologies are shaping urban and production ecosystems to become increasingly connected and autonomous – ensuring a scalable, sustainable future.

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