



Teton
Simulation

CASE STUDY

CarbotechLtd

**OPTIMIZING 3D PRINT PARAMETERS
FOR PERFORMANCE DEMANDS AND
MANUFACTURING EFFICIENCY**



SmartSlice

Carbotech Ltd was formed in the UK in 2018 as an independent one-stop-shop to fulfill 3D printing, scanning, and the reverse engineering of parts. These services give their customers the best options to succeed with their design. Carbotech Ltd scans a part if required, then produces an editable model, and finally 3D prints the part. This gives the customer complete flexibility in design alterations and is ideal for prototyping, whether it is for tooling for engineering, automotive, aerospace components, and even medical parts. From polymers to metals, rubbers to carbon filled, Carbotech Ltd caters for a majority of the materials currently available for additive manufacturing.

David Smith, 59 years old, engineer and lifelong motorsport enthusiast, who has owned competition cars for over 25 years came to Carbotech Ltd with a problem. He was having temperature issues on his high-performance Westfield and needed Carbotech Ltd to engineer and deliver a custom 3D printed part to meet a quickly approaching deadline.



"The Westfield will probably be my last car and as so has been built with the best components that money can buy. The engine is from a Ford Focus ST and last year was producing 280 bhp but I was having temperature problems on the air intake side which wasn't helped by running the turbo at 100%." said David Smith "The solution was to change to a Ford Mustang 2.3 inlet plenum which has the throttle body mounting in a different position. This reduced the cold air pipework from around 900mm in length down to 100mm. The 3D printed adaptor was required to get the orientation of the throttle body to line up with the charge cooler. With a new turbo for this year, the car is now producing 380 bhp and the estimate is that 450 bhp would be feasible."

Rob Ellis at Carbotech Ltd immediately realized there were several factors to be considered, including temperature, load, stress, and torsion of the part that was to be used in precision motorsport racing.

The previous version of the part was a flexible pipe that was secured on both ends by jubilee clips. Carbotech Ltd's brief was to manufacture a pipe that would allow smooth airflow and incorporate a sensor that would be easily accessible with a firmer fixing directly onto each mating face. A pipe that would meet these criteria was not available on the open market so this would be the first of its kind to be manufactured. Being able to include the sensor directly into the pipe allows for the best reading to be achieved by the sensor and aids in better engine performance. The new pipe would also lend itself to being more aesthetically pleasing with firm fixing locations.

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Knowing this was a project that would be engineered practically from scratch due to its not yet being commercially available, and with only the flange face details being provided, a traditionally designed and manufactured component would require several weeks to complete. However, time was of the essence as the slot for the engine test was only 10 days away!

There was a further day to be taken into account which included getting the car to the test site which made the deadline even tighter! If they were late, this would put testing back at least 3 weeks and there was no guarantee at that time, that another slot would be available.

Carbotech Ltd began by designing the part around the data which was provided and ensuring that the client's requirements had been met before sending over the model to the client for approval. Once approved, it was over to Ultimaker Cura and SmartSlice software.

SmartSlice is a plug-in for Cura that makes smart decisions by optimizing print parameters for performance demands and manufacturing efficiency to reduce print time and material use. In just seconds, SmartSlice can validate the as-printed performance of the part, which allowed Carbotech Ltd to evaluate whether it was under or over-designed by comparing simulated part deflection and safety factors to limits they defined.

Rank	Print Time	Mass	Factor of Safety	Max Displacement
1	09h 54min	115.0g	3.23	0.22 mm
2	10h 57min	132.0g	3.34	0.18 mm
3	12h 04min	135.0g	3.36	0.18 mm
4	11h 25min	133.0g	3.34	0.18 mm
5	10h 59min	132.0g	3.33	0.18 mm

REQUIREMENTS		
Objective	Computed	Target
Factor of Safety:	3.23	3.00
Max Displacement:	0.22	1.00

TIME ESTIMATION		
Print time:	09:54	100 %

MATERIAL ESTIMATION			
	15.28 m	115.03 g	0.00 €

9 hours 54 minutes
115.03g · 15.28m

"We've been using Cura Slicer for some time now on our Ultimaker 3D printers and when Teton Simulation's SmartSlice was added as a plugin, we just needed to try it." said Rob Ellis, Owner, Carbotech Ltd.

"As we manufacture a variety of jigs and fixtures it can take some time to run those through simulators, which in turn would provide the optimum print profile for manufacture. Choosing the correct material is only part of the process when 3D printing. It is the building of the layers providing strength where needed that is paramount when producing a part to carry out its correct function.

Teton Simulation's SmartSlice has allowed Carbotech Ltd to carry out those layer variations providing 10 iterations concerning the safety factor, which is ultimately the strength and stress of the part running through the software."

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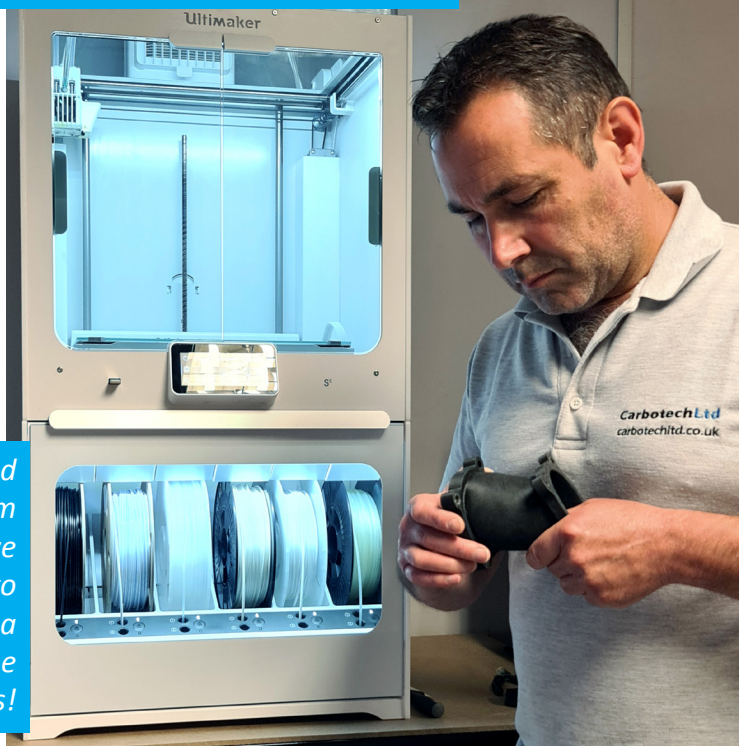
Carbotech Ltd knew the location of the part in the engine and was able to provide its fixed surfaces and its loaded surfaces which would be applied in service. They then ran the part through SmartSlice to generate the 10 print setting configurations from which they were able to choose the preferred configuration which would encompass all the requirements for a strong and structurally sound part. This process took only 32 minutes to perform with SmartSlice, which using their current software would take 7-8 hours to carry out the same number of iterations on this part as each part iteration would have been carried out individually. Utilizing SmartSlice not only for this component but also throughout the year, it has been calculated that Carbotech Ltd can save more than 360 hours in labor time and over 2,016 hours in print time, which frees both personnel and 3D printers up considerably for other projects. On this project alone Carbotech saved 50.4 hours of print time (due to reduced validation prints) and 9 hours in labor time (due to the reduced consumption of software time).

Carbotech Ltd's Rob Ellis added, "SmartSlice has proven to give substantial savings which are already showing benefits both for us and for our clients."

SmartSlice took into account all the requested variables and Carbotech Ltd was able to select the factor of safety which they wanted to be applied to the part.

SmartSlice allowed them to execute and view slices of each configuration before actually printing any parts. Being able to perform this all within only 32 minutes has saved what is in effect a complete day before 3D printing.

Once sliced, Carbotech was confident that the first build would meet performance requirements. SmartSlice delivered the part on the first 3D print and most importantly, on time.



Commenting on Carbotech Ltd's success Rob Ellis concluded "Knowing that we only had 10 days to provide a part from design, through software test, and to final part would have been a tall order and one that would have been hard to keep using our standard software. Using SmartSlice was a real game-changer here and it enabled us to carry out the complete package 2 days ahead of the client's requirements!"

The cost saving of 67% compared to the manufacture and design of the part when not utilizing SmartSlice again has been instrumental in Carbotech Ltd now using SmartSlice regularly with the confidence knowing that it provides a solid result enabling us to go straight to print.

Just looking over the breakdown it is easy to see that without the use of SmartSlice the cost of the part would have been so much more. Being able to reduce that we have been able to pass that cost saving on to our client."

This satisfaction was emphasized by Carbotech Ltd's customer, David Smith "The commitment of Rob Ellis at Carbotech Ltd to understand what I needed and produce at a realistic cost in the time frame required was second to none."



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