Design and Prototyping Group
Case Study

Customisable, optimised design for additive manufacturing and parameter driven CAD

The AMRC Design and Prototyping Group (DPG) has taken an existing spinal implant and reengineered it to ready it for a future of additive and subtractive manufacturing using the Symbionica machine; a reconfigurable machine for the new additive and subtractive manufacturing of next generation fully personalised bionics and smart prosthetics.

Using the technology being developed by the EU Horizon 2020 Symbionica project, DPG has reimagined the design of the implant to demonstrate how the machine can be used for the mass customisation of personalised medical implants.

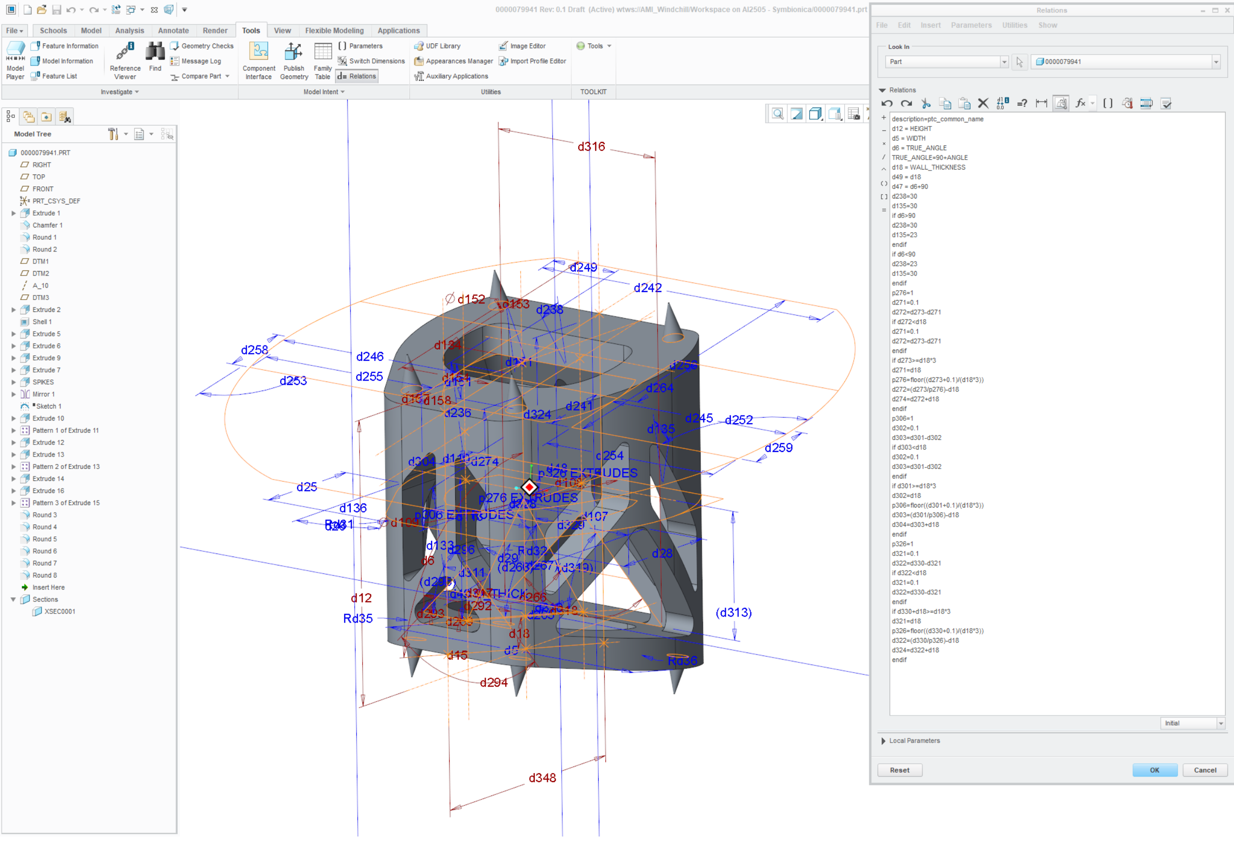
The current design of the spinal implant was a telescopic assembly of CNC machined components; the modular and telescopic design of the implant allowed it to be adjusted into a limited number of configurations to satisfy most clinical cases.

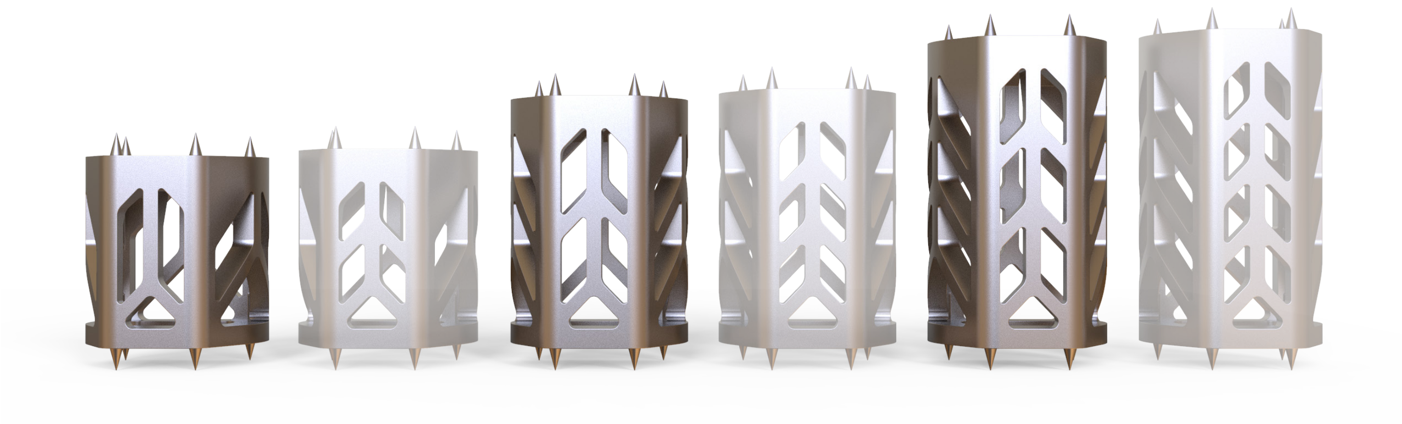
The new optimal design of the same product is a single component customised to the individual patient. The new design enables practically infinite customisation within the predefined range.

For comparison, the end plate angle choices of the existing modular spinal implant are limited to the five options: -10, -5, 0, +5 and +10 degrees. If using the additive and subtractive manufacturing process of the Symbionica machine, the angle of the end plate can be anything within the range of -10 to +10 degrees and this

Symbionica
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 678144

European Union
European Regional Development Fund





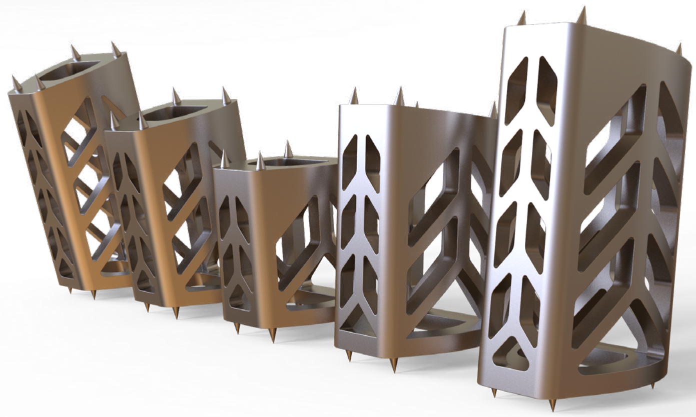
does not require any additional work from the machine operator. This can be applied to all of the size range options in the particular product.

An individual STL file is needed for each of these variants to send these to a machine. The most practical way of implementing this is the use of parameter driven CAD files. This works well for components where no additional features must be introduced in different variants. In this example, as the spinal implant is elongated, more support ribs are introduced after certain lengths and to achieve this scripting is required.

Current CAD packages allow for building parameter and script driven CAD models which regenerate themselves and introduce additional features according to the rules defined in the script. The optimisation for AM with use of self-supporting features can also be incorporated at this stage by ensuring that the self-support angles are maintained in all the customisation range.

This approach requires a strategic modelling and building of the script to achieve the desired behaviour. Once the script is finished it is extremely easy to automatically generate an infinite number of variations just by modifying the key parameters.

Angle of end plates	-10	-6	0	6	10
Height	51	40	30	40	51



As example, the set of models shown above was automatically generated just by altering 2 parameters.

As shown in this example complex self-regenerating CAD files can be created using current CAD modelling software capabilities.

The ability to customise every single component manufactured is a major strength of AM. The benefit of this approach becomes especially apparent with complex models which would otherwise require a significant amount of time to modify manually in order to generate every single configuration on-demand. As a result just by modifying a numerical value of the key parameters a designed for a particular manufacturing process, in this case AM, CAD files can be generated instantly on-demand.

This case study highlights the benefit of using AM manufacturing for easy personalisation of generic designs, so an implant can be optimised as a single component, saving programming and fixturing time over CNC machining methods.

The EU Horizon 2020 Symbionica project aims to develop new types of AM processes to allow the rapid manufacture of personalised smart prosthetics, including personalised hip, knee and spinal implants, as well as a foot exoprosthesis.

The new design enables practically infinite customisation within the predefined range.

For further information please contact Valdis Krumins:

0114 222 6312 | v.krumins@amrc.co.uk | amrc.co.uk