Project Summary

June 2022

NWCAM

North West Centre for Advanced Manufacturing

Axial3D

Company overview

Axial3D is an award-winning Belfast-based start-up founded in 2014. It specialises in converting 2D medical data (such as CT or MRI scans) into 3D printable volumetric models. Axial3D's service is predominantly used to advance pre-operative planning techniques resulting in surgery that is faster for surgeons, cheaper for hospitals and safer for patients. Axial3D has based its existing business on developing proprietary algorithms to automate the company's unique services. Utilising machine learning and artificial intelligence has enabled Axial3D to develop a fully-automated approach to creating accurate and detailed 3D models.

The project

- Characterisation of additive manufacturing polymers for use in advancing surgical practice

Industry focus

Medical 3D printing has the potential to be applied in a wide range of areas. Axial3D identified two such areas to be explored through a NWCAM project - point of care surgical guides, and cranial implants.

Surgical guides are templates used to assist orthopaedic surgeons in precise surgical placement and angulation of implants. These patient-specific tools (derived from the patient's CT scan data) are designed prior to surgery to minimise risk of error and improve surgical outcome. The project aimed to develop superior (i.e. convenient and straightforward to use at point of care) and low-cost guides for scalable manufacture.

Cranial implants, used to replace damaged bone, have tended to be constructed of metal materials. The project investigated the use of an alternative material - polyetheretherketone (PEEK) – in the 3D printing of a cranial implant. PEEK is a biocompatible and chemically stable polymer (with mechanical properties like that of human cortical bone). It is lighter than metal and less responsive to temperature increases. The project explored the potential application of thermoplastic PEEK in 3D printing of a cranial implant prototype which would be commercially scalable.

Research partnership

Axial3D was partnered with Ulster University's Advanced Future Materials & Manufacturing group in the School of Engineering at Jordanstown. The extensive polymers expertise and research experience within Ulster University provided the appropriate partnering arrangement to meet the research challenges set by Axial3D. The project research team included eight co-investigators, one research assistant, and one PhD researcher.

Project outputs

The project provided Axial3D with validation data and working prototypes of the 3D printed surgical guides and cranial implants. In doing so, the technology has been moved from Technology Readiness Level (TRL) 3 (Experimental proof of concept) to TRL 5 (Technology validated in relevant environment)[1]. The important data resulting from the project is vital for future stages of the product development journey and advancement of new value propositions which will facilitate diversification into new markets.

[1] Héder, M. (2017) 'From NASA to EU: the evolution of the TRL scale in public sector innovation', The Innovation Journal: The Public Sector Innovation Journal, 22(2), p. 11, [Online]. Available at: https://www.innovation.cc/discussion-papers/2017_22_2_3_heder_nasa-to-eu-trl-scale.pdf Accessed 13 June 2022.

Dan Crawford, founder and CSO of Axial3D, commented that: "Participation in NWCAM provided us with access to a PhD student, a research assistant and Ulster University's wealth of knowledge and experience in the area of advanced polymers and additive manufacturing. This has been invaluable to Axial3D and has enabled us to focus more on R&D while maintaining a lean company structure. The learning gained from the project has been pivotal in enabling us to prepare for future R&D activities, and propose business strategies which will diversify our product portfolio beyond anatomical modelling."

Project benefits

- Increased competitiveness of the life and health sciences sector through innovation
- Industry-related skills development of academic researchers (including through the award of an Industrial Fellowship by the Royal Academy of Engineering)
- Intensification of R&D activities at Axial3D whilst maintaining a lean and efficient business model
- Knowledge dissemination to the wider life and health sciences sector through academic publications and conference presentations
- Provided evidence of Axial3D's research capabilities. Such evidence supported successful funding applications and private investment into the company
- Technology transfer from Ulster University to Axial3D
- Upskilling of Axial3D staff with regards to advanced polymers materials and additive manufacturing techniques

Project legacy

Dr Adrian Boyd (Ulster University) commented: "As engineers we strive to deliver new and exciting innovations that make a positive difference to society. At Ulster University's School of Engineering, we work hand in hand with industry through our teaching and research. Thanks to the Royal Academy of Engineering Industrial Fellowship I will have the opportunity to be embedded into Axial3D, working in close partnership with clinicians and the medical device industry, to help develop new innovative products for the company that can enhance patient outcomes and their quality of life. This fellowship will also allow me to cultivate new digital skills and create new teaching resources that can inspire and educate the next generation of engineers. The NWCAM project was the important foundation that provided a platform to enable me to develop new ideas, build collaborations with companies and apply for this fellowship."