# 3D Printing Human Noses: An Engineering Perspective


The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

Loughborough University

**Andrew Gleadall - andrew.gleadall@nottingham.ac.uk - Institute for Advanced Manufacturing, University of Nottingham**

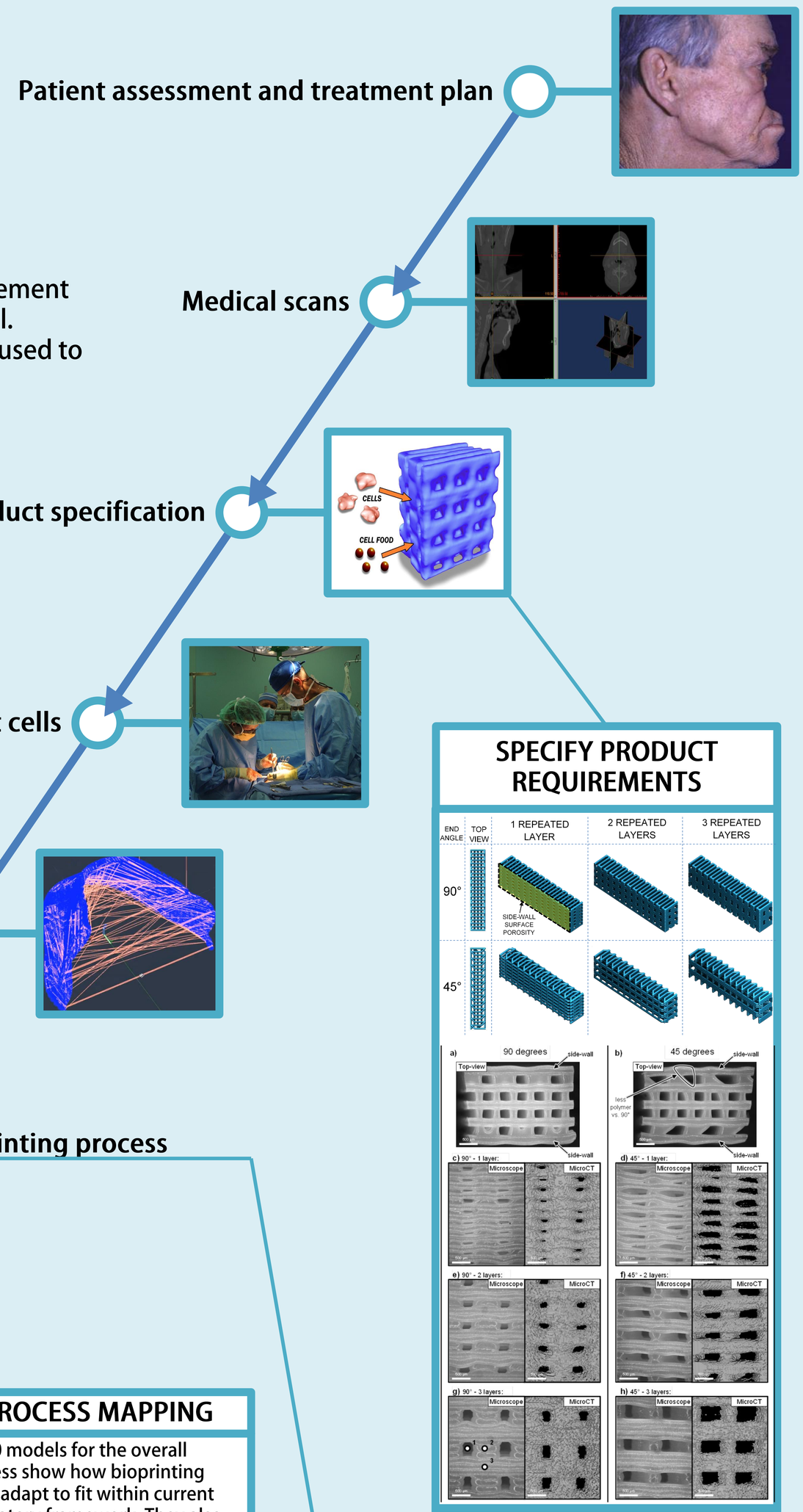
**Joel Segal, Laura Ruiz Cantu, Jing Yang and Kevin Shakesheff - University of Nottingham**
**Paul Hourd and Nick Medcalf - Loughborough university**


## Introduction

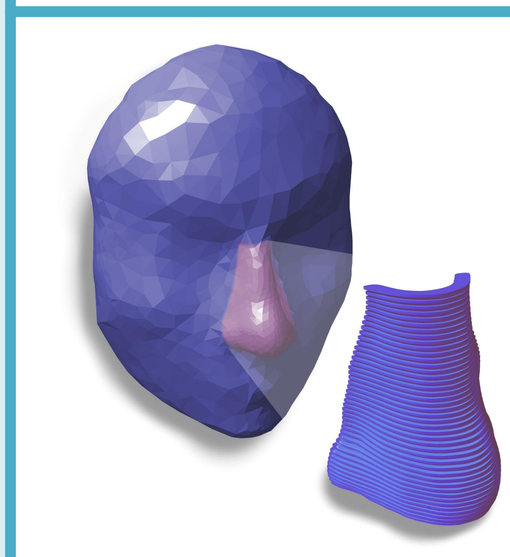
Bioprinting tissue engineering scaffolds is an active research area. A large portion of the current research focusses on biological characterisation but there are also opportunities for engineering research, which will ultimately help ensure bioprinting scaffolds can be printing consistently to the required level of quality.

## Our approach

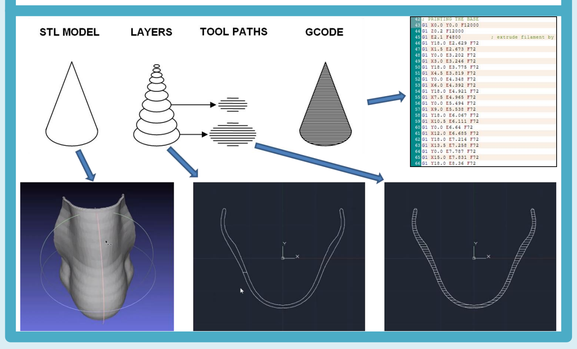
We're integrating engineering research into the overall process of 3D printing a replacement nose for a patient who has been subject to facial trauma or undergone tumour removal.
We've developed new printer control software and new 3D modelling tools. These are used to control and simulate the bioprinting process in novel ways.



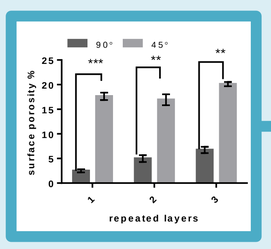

### NEW SOFTWARE TO SET UP AND CONTROL THE 3D PRINTER

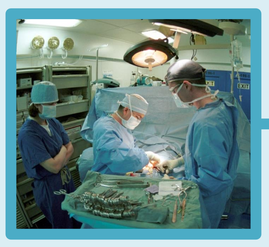


New software has been written that takes a 3D model of the nose and generates machine code to control the 3D printer. The nose is 3D printed layer-by-layer. The software code can be adapted freely so enables novel print paths and allows fine control over scaffold porosity or similar properties.



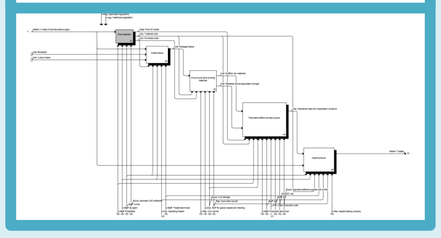

### PRINTED NOSE



### PROCESS MAPPING

IDEF0 models for the overall process show how bioprinting must adapt to fit within current regulatory framework. They also helped identify important research questions for future work.



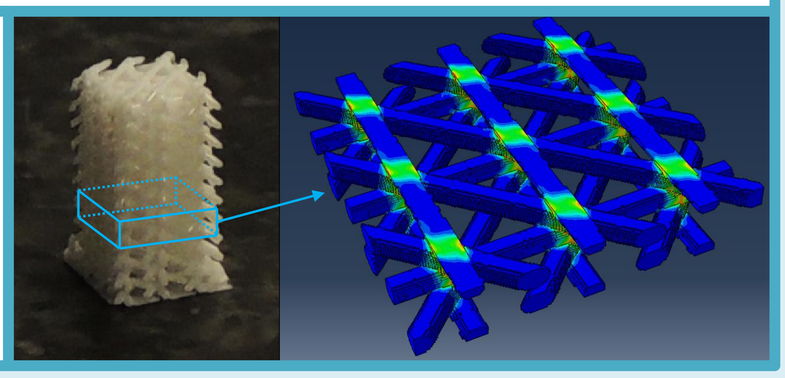
### SPECIFY PRODUCT REQUIREMENTS




New software was used to achieve a range of different surface porosities for 3D printed scaffolds.
The surface porosity was found to have a significant effect on cell seeding and proliferation.
It is important to specify properties such as porosity and to develop the bioprinting capability to achieve them.

### SIMULATION OF A 3D PRINTED SCAFFOLD

We have developed a model to simulate the 3D printing process and it has been used to predict the geometry of printed scaffolds.
Finite Element Analysis simulations of the modelled structures successfully predicted mechanical properties.



## Conclusion

**We have developed novel engineering methods to support the 3D printing process for tissue engineering scaffolds and to simulate scaffold properties. We've also analysed how the process can fit within the current regulatory framework. This field presents interesting challenges for engineering that must be investigated.**