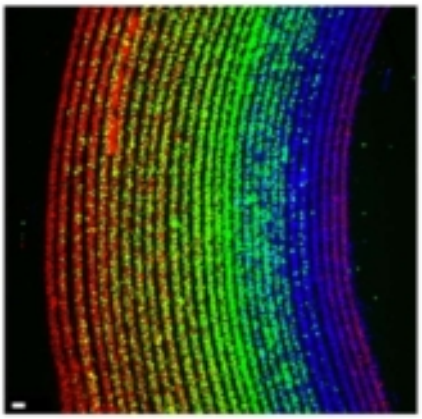
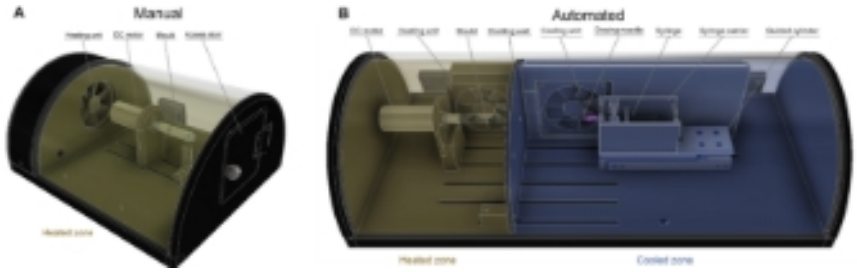
Gwyneth builds a semi-automatic RIFLE.

Regular readers of this blog will have met Ian Holland's RIFLE system for bioengineering layered tubes that consist of mixtures of living cells and the extracellular matrix in which they are embedded (see http://golgi.ana.ed.ac.uk/Davieslab/blog/2023-07-RIFLE.pdf). The image to the right of this text is intended to act as a reminder of what this system can achieve; it shows a section of tube wall with the layers filled with different mixtures of cells labelled with primary colours, to create a rainbow effect. RIFLE has a lot of potential as a technique for tissue engineering (at least, we think it does!), but in its original form, it is very manual and takes a great deal of an experimenter's time. Essentially, someone has to sit by the machine and drip small drops of cell/ matrix suspension into a spinning mould, a drip every few minutes in a process that can take a few hours.



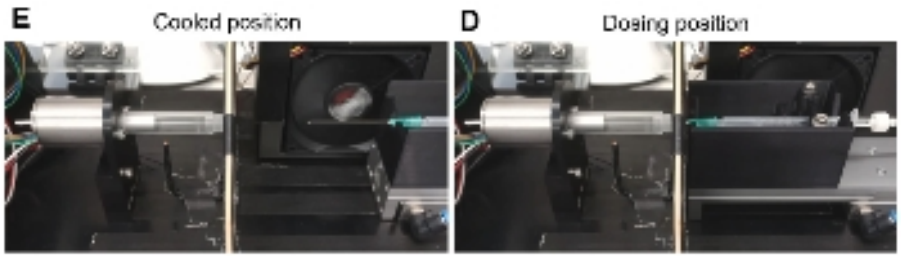
In any walk of life, dull, repetitive tasks are ripe candidates for automation. By a happy coincidence, Gwyneth West, an MSc student, came to the lab to express an interest in doing a research project on tissue engineering machinery and ways to improve it. She and Ian set about designing hardware and software that would see the process of dripping in cells and matrix done automatically, with any temperature changes needed to control gelling also done automatically. Human intervention would still be needed, but mainly at the beginning and end of the process.

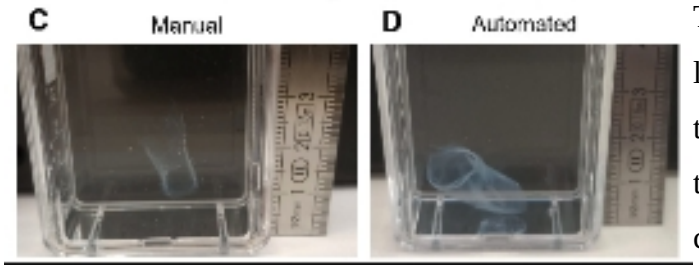
The RIFLE machine itself had a rebuild, to accommodate warm and cool zones so that collagen gels could be kept cool until dripped into the warm spinning mould. This made the machine somewhat longer than it had been, and a little more complex in terms of needing fans and heating elements, and heat sensors to maintain temperatures.



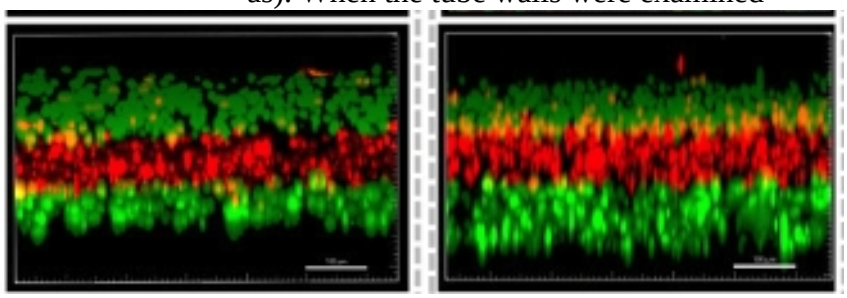
The carrier of the dispensing needle (a perfectly ordinary hypodermic needle) also had to be mounted on something that could be moved accurately along a slot, to align perfectly with the

centre of a narrow tube spinning at up to 9000 revolutions per minute. The two pairs of photographs to the right show the needle away from the spinning mould, and advanced so that it enters the mould ready to drip in some cells and matrix.





The tubes formed by the automated method look just like those made manually they are the ghostly grey things suspended in saline in the photographs to the left). Viability of the cells was as good as it was with the manual system (not significantly better, just as good as). When the tube walls were examined at high magnification, they looked very similar; green and red cells loaded into different layers stayed in those layers, and the layers were clear. In both cases the cells at the top show poor contrast; this is just an imaging issue due to the thickness of the sample, and if the samples are turned the other way up the new 'bottom' cells now look fine.



Manual Automated

Gwyneth and Ian published a nice paper to describe the work (see 'Links' below), and everyone in the lab using RIFLE can spend less of their time sitting at a bench dripping liquids every minute or so, and more time doing other things. Each of them has now left my lab, Gwyneth to study medicine and Ian to continue developing RIFLE within the department of Engineering, in another campus in Edinburgh.

Links

- West G, Ravi S, Davies JA, Holland I. Semi-automated layer-by-layer biofabrication using rotational internal flow layer engineering technology. SLAS Technol. 2025 Feb 21;31:100256. doi: 10.1016/j.slast.2025.100256. Epub ahead of print. PMID: 39988116.