

The OpenFlexure Microscope

Open hardware needs an open toolchain

Julian Stirling



The OpenFlexure Microscope



openflexure
microscope

Motorised, digital,
laboratory-grade microscope

Mechanical stage is 3D printed

Design optimised for plastic (not
a cheap imitation)

Anyone can reproduce the design,
all project information is open

Focus on medical, research, and
educational use.



Openness builds a research community

METHOD ARTICLE

Adapting the 3D-printed Openflexure microscope enables computational super-resolution imaging [version 1; peer review: 2 approved]

Stephen D. Grant , Gemma S. Cairns , Jordan Wistuba, Brian R. Patton 

Department of Physics and SUPA, University of Strathclyde, Glasgow, UK

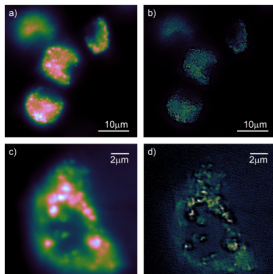


Figure 3. Fluorescence imaging of 90 nm nanodiamond in monocyte-derived macrophages. The nanodiamonds



Optical sectioning robotic microscopy for everyone: the structured illumination microscope with the OpenFlexure stages

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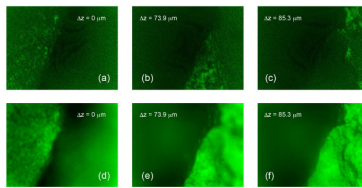
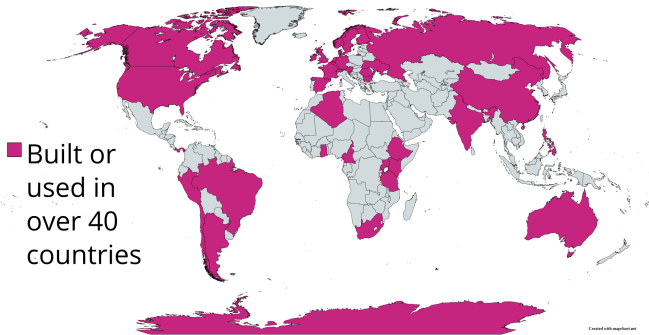


Fig. 4. (a)–(c) Optically sectioned and (d)–(f) conventional images obtained from corresponding images shown in Figs. 3(d)–3(f) by post-processing with Eqs. (1) and (2), respectively. These are at different axial positions of (a,d) $\Delta z = 0 \mu\text{m}$, (b,e) $\Delta z = 73.9 \mu\text{m}$, (c,f) $\Delta z = 85.3 \mu\text{m}$, where the axial position of $\Delta z = 0$ is at the plateau ground on the coin and a positive increase in Δz corresponds to going up to the hill of the numerical character of “0”. Scale bar 50 μm .

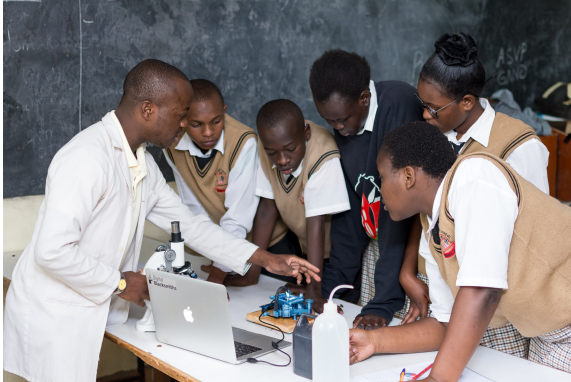
Openness builds a research community



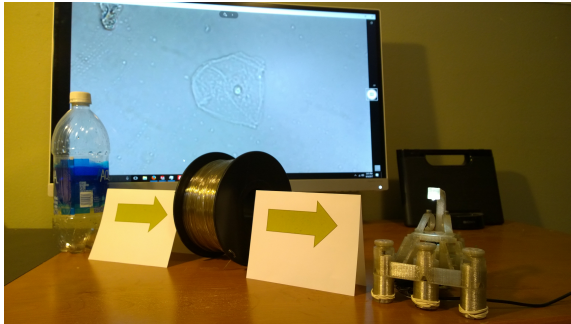
Use in education



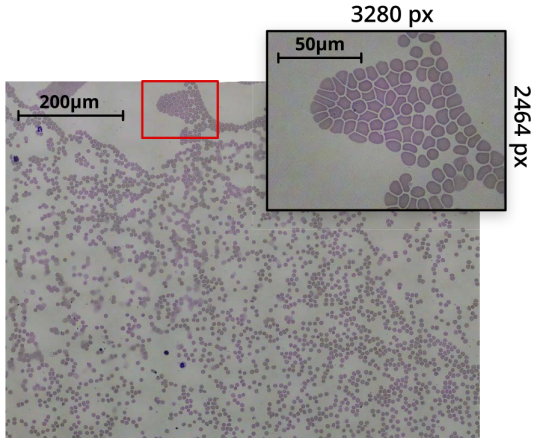
Use in education



Use in education



Why do we need a medical microscope?



Why do we need a medical microscope?



Why do we need a medical microscope?



Why build another medical microscope?

How much does a commercial microscope cost?



Purchase cost ~£20,000



Maintenance: Parts cost + engineer travel

Why build another medical microscope?

How much does a commercial microscope cost?



Purchase cost ~£20,000



Maintenance: Parts cost + **engineer travel**

Can we design a microscope that is:

- Understandable by many
- Community can suggest changes
- Has variations for different purposes
- Useful for hobbyists, researchers, and education
- Can be used in a medical product across the world

Medical device design requires:

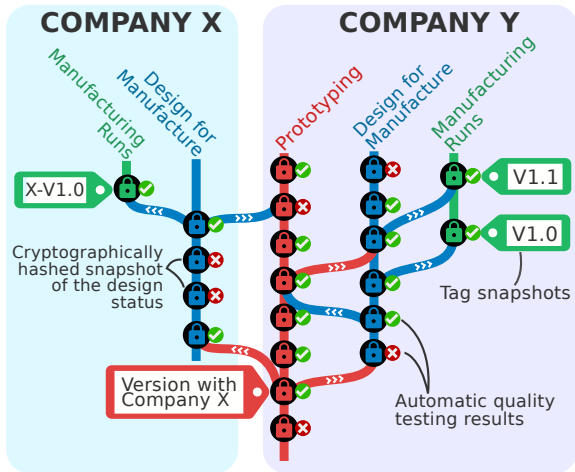
- Clear version control
- Control of what goes into the design
- Design risks assessed
- Clear, concise, up-to-date technical documentation

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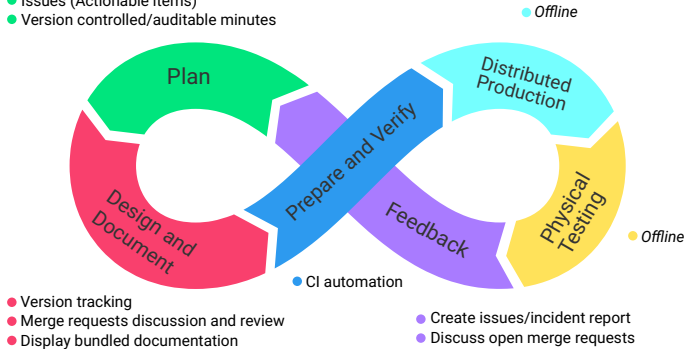
How hard is it to do this in the open?

Remote collaboration is hard!

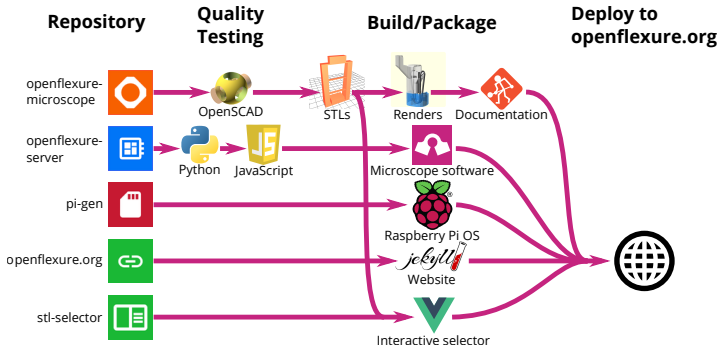


HardOps

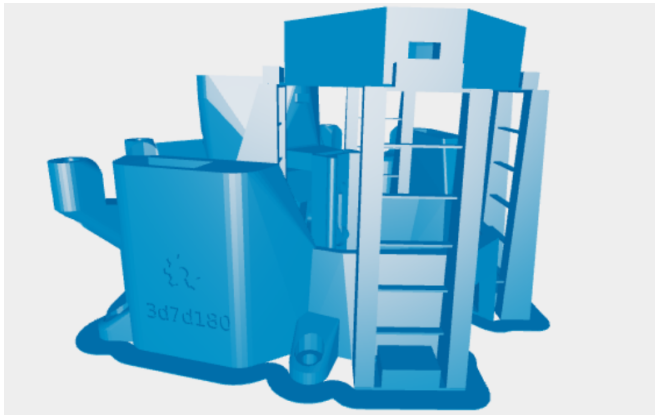
- Project management (Milestones, Assingees, etc)
- Issues (Actionable items)
- Version controlled/auditable minutes



Automation helps!



Automation helps!



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Assemble the actuators

There is one "actuator column" for each of the three axes of the OpenFlexure Microscope stage. These allow you to move the sample in X and Y, or focus the microscope by moving in Z.

For this section you will need:

Printed Parts

- 3 [feet](#) - Each actuator has its own labelled foot.
- 3 [large gears](#)

Printed Tools

- 1 [band tool](#)
- 1 [band tool cover](#)
- 1 [nut tool](#)

Sub-Assemblies

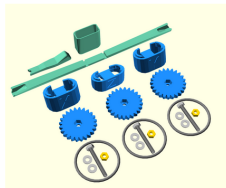
- 1 [prepared main body](#)

Consumables

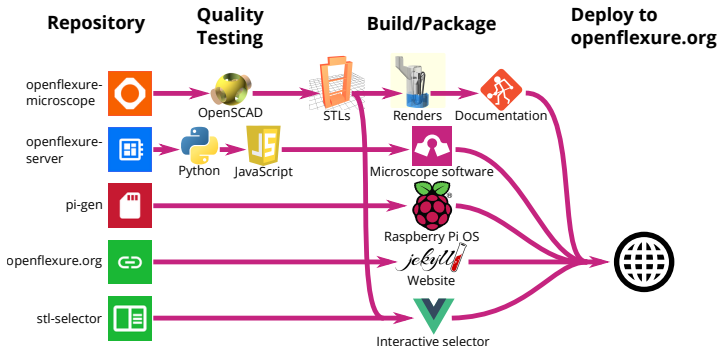
- 3 drops of [light oil](#) - Don't skip this or you will damage the screws

Mechanical Components

- 3 [M3 brass nut](#)
- 6 [M3 stainless steel washers](#)
- 3 [M3x25mm stainless steel hex bolt](#)
- 3 [Viton O-ring \(30mmx2mm\)](#) - "Viton band"



Writing our own toolchain



So much time was “wasted” developing software

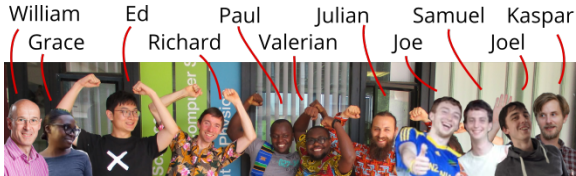
If only there was a Foundation for that!



Open Toolchain
FOUNDATION

Acknowledgments

OpenFlexure team:



Our clinical collaborators (Catherine Mkindi, Joram Mduda, Daniel Rosen)

And our growing community

