First steps in redesign of Clamping Unit

Jules Verkade, Bachelor Industrial Design Engineering, University of Twente, the Netherlands

—

Public Summary

This bachelor assignment was carried out for VyCAP B.V., located in Enschede, the Netherlands. VyCAP is a biotech company, closely tied to the University of Twente, specialized in the imaging, enumeration, analysis and isolation of rare cells.

One of the markets VyCAP is innovating in is the usage of B-cells to produce therapeutic antibodies. They have developed a tool that can aid in the measurement of antibody production per single cell. The cells are divided with the microwell chip through a pumping process. After this process each “well” in the chip contains a single cell. When this filled microwell chip is clamped to an antibody-binding membrane and stored in an incubator, a part of the antibodies produced by the cells is captured on the membrane. This membrane can then be observed under a microscope to find out which cells produce which antibodies, and in what volume. Selected cells can then be isolated from the microwell chip using another device developed by VyCAP.

The clamping of the microwell chip and membrane is currently done with a device developed by VyCAP (Figure 1), in collaboration with the TCO department at the University of Twente. VyCAP has offered the opportunity to take the development of this clamping unit further. The assignment was formulated as taking the first steps in bringing the prototype device to a mass-produceable, user-friendly product.

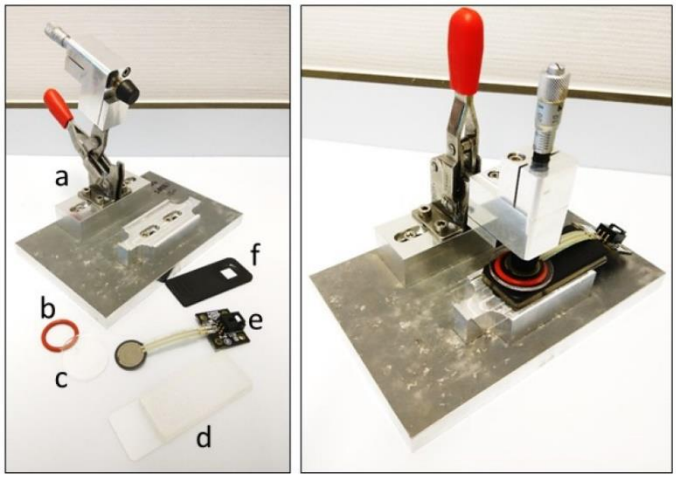

Figure 1: Left: a) Clamping unit, b) silicon o-ring, c) cover plate, d) PDMS press foot and microscope glass, e) force sensor, f) microwell slide. Right: Assembled Clamping Unit

To deconstruct the prototype into its core functions, the prototype was analyzed through a function analysis and observing a user use the prototype (Figure 2). Various interviews were also held with members of the company and researchers using the prototype. From this analysis a few conclusions were formulated, including: a) the parts in the clamped stack are all aligned by hand, this function could be taken over by

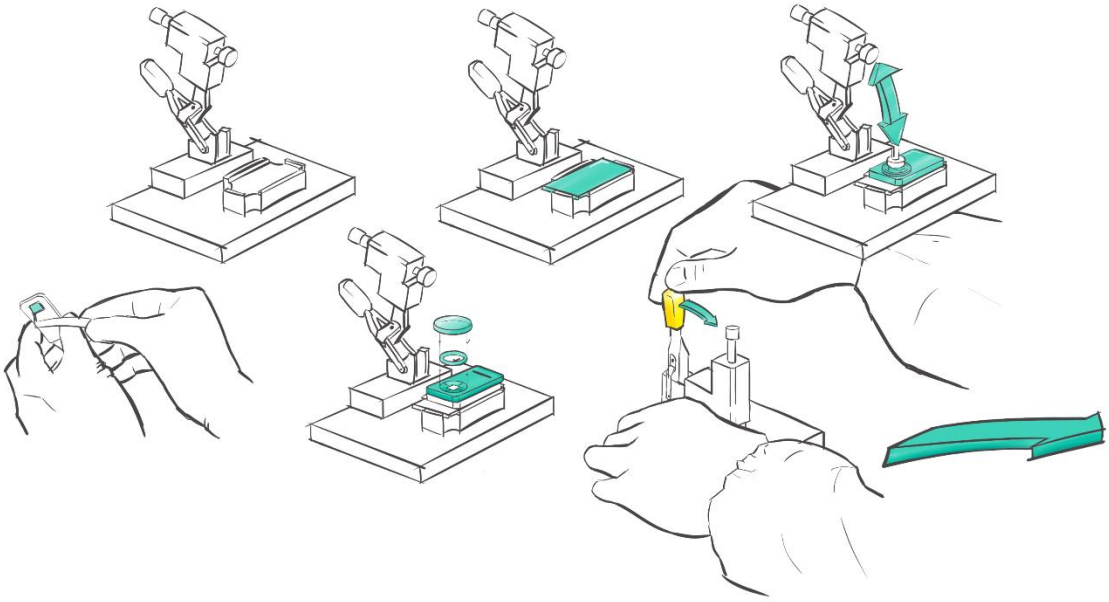

Figure 2: Simplified scenario of Clamping Unit prototype usage. From left to right, top to bottom: 1) Empty Clamping Unit, 2) Add microscope glass, 3) Add PDMS unit and align with press foot, 4) Install membrane in microwell slide, 5) Stack O-ring and cover plate, 6) Close Clamping Unit and set aside in incubator

the device to avoid mistakes. b) The number of parts in the clamped stack is high. The prototype counts 8 parts that must be assembled in the correct order, this could be reduced for higher ease of use and reliability. c) A square membrane is used, the user must remember the exact rotational alignment of the membrane, otherwise the antibody spots cannot be traced back to the cells that produced them. d) The device is not currently sterilizable. e) The device does not allow for filtered gas exchange between the environment and the cells, making longer-term sterile experiments unviable.

With these early conclusions a list of requirements was formulated, and the device was broken down into its core functions. The core functions and requirements were used to generate new mechanisms. Of these mechanisms two were selected and further developed in CAD in multiple design steps, keeping in mind the usability, production and assembly of the designs. Two concepts (Figure 3) were presented as general directions for further development. The concepts were evaluated with list of requirements formulated after the analysis phase. The concepts both satisfy most requirements, except for the material-related requirements, as a definitive material was not yet chosen. Ideas for the rotational alignment of the membrane and filtered gas exchange were also suggested, but not yet implemented. Other recommendations include testing the 3D-printed prototypes for ease of use and the measurement of the amount of force applied by the two clamping units.

Figure 3: Renders of the two designs. Top: The two designs together, in clamped position. Left: Plate Unit in exploded view. Right: Box Unit in exploded view.