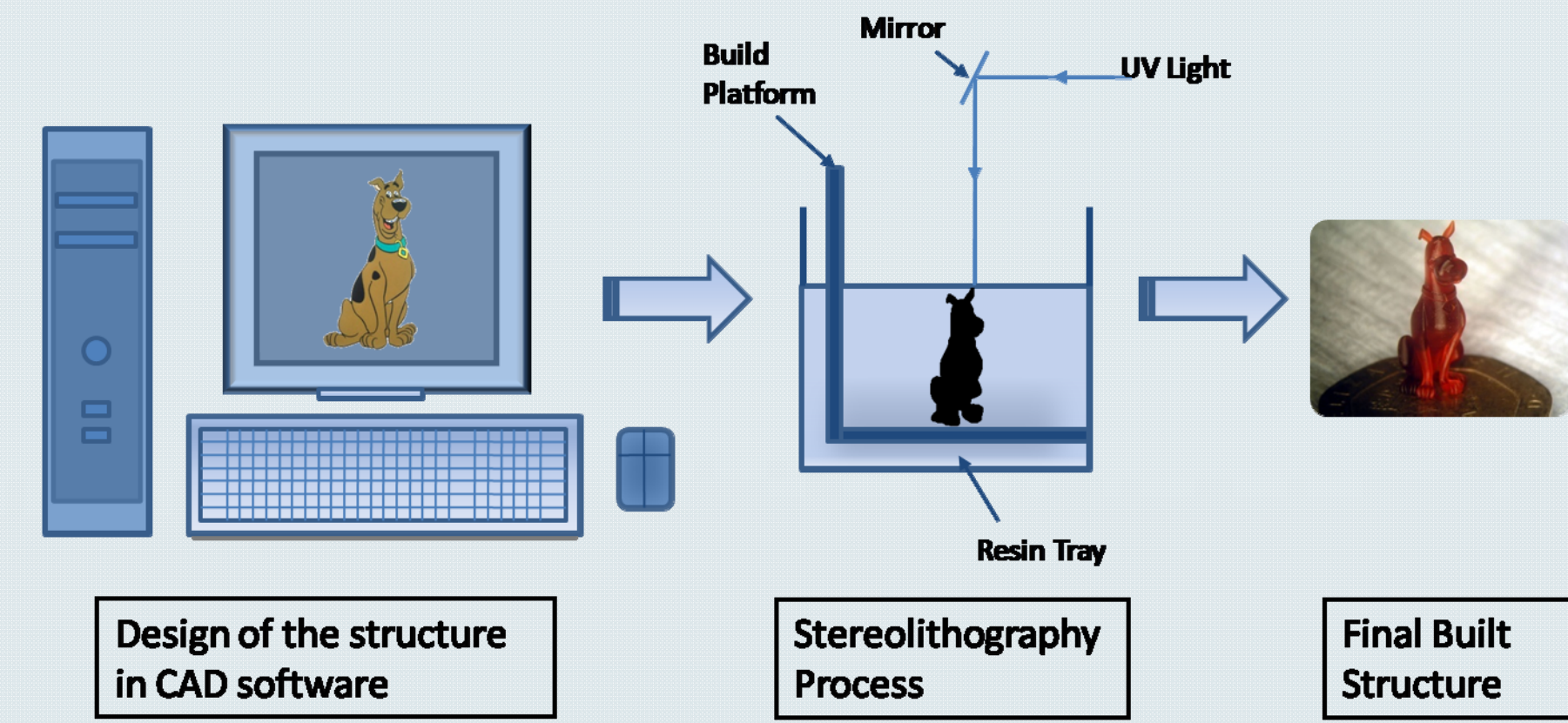


What is MSL?



Stereolithography (SL) was introduced in 1981 by different teams in the US (Hull 1984) and Japan (Kodama 1981) as a rapid prototyping and manufacturing technology that enables the generation of physical objects directly from computer aided design (CAD) data files. STL is the most common data format for transferring 3D models for a rapid prototyping machine.

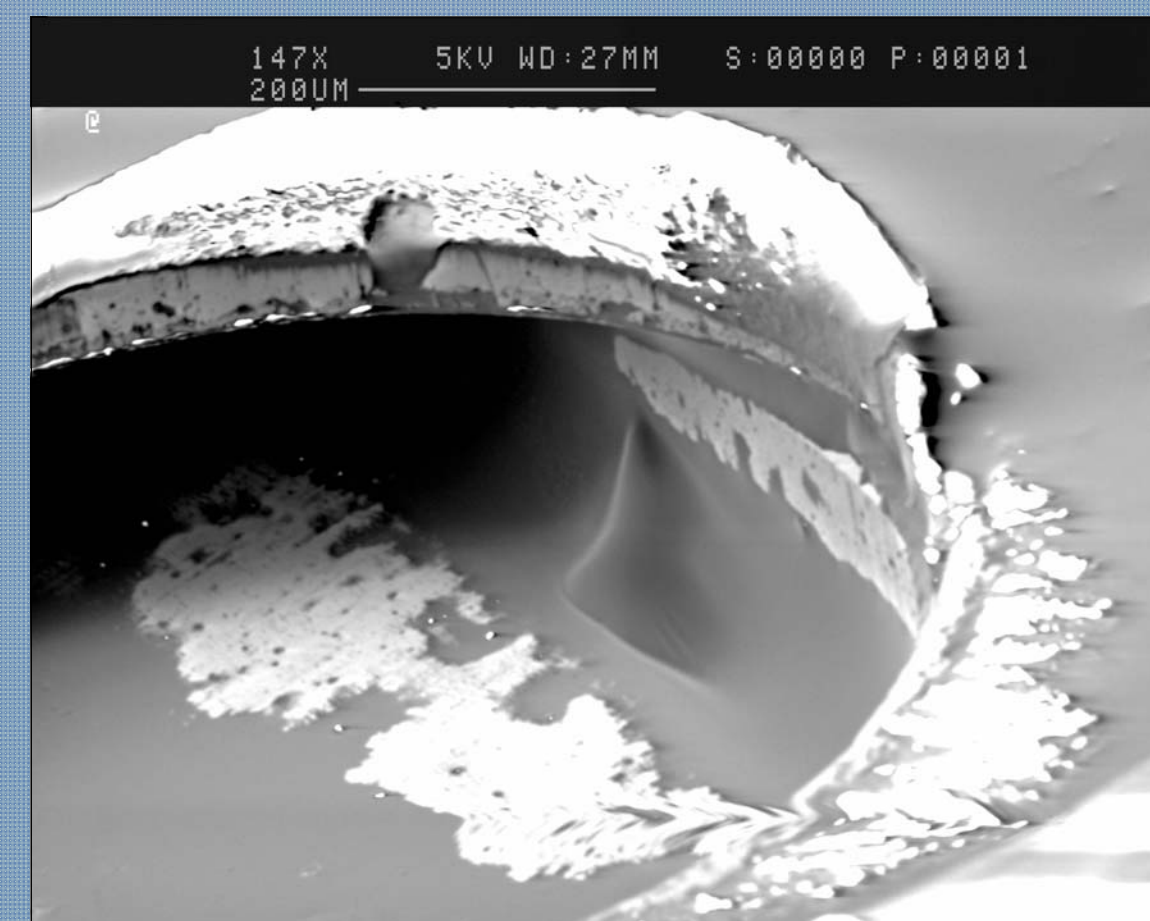


The stereolithographic process begins with the definition of a CAD model of the desired object, followed by a slicing of the three dimensional (3D) model into a series of a closely spaced horizontal planes that represent the X-Y cross-sections of the 3D object, each with a slightly different Z-coordinate value. As $\delta Z \rightarrow 0$, the resolution of the final structure increases.

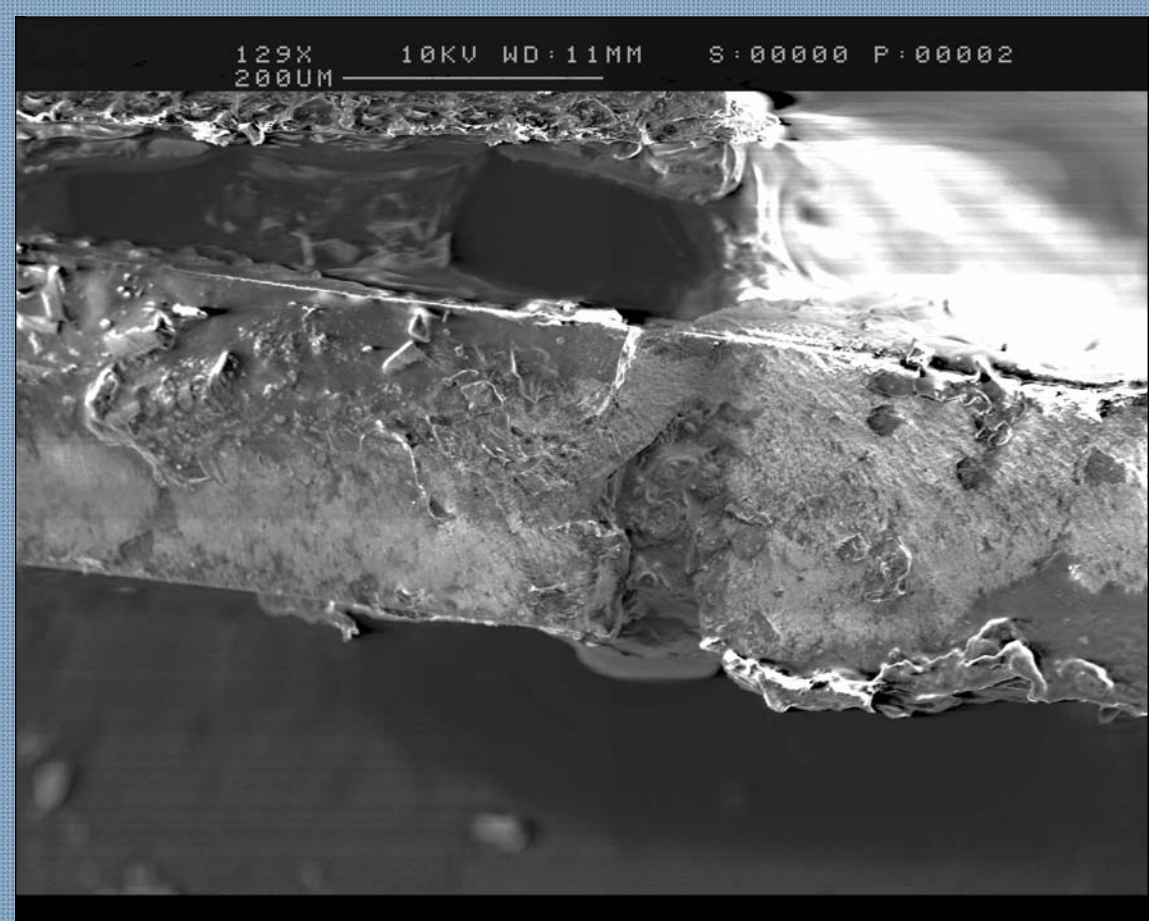
All the cross-sections are then translated into numerical control code and merged together into a final build file to control the ultraviolet light scanner and Z-axis translator. The desired polymer object is then written into the UV-curable resist, layer by layer, until the entire structure has been defined.



In 1993, a process capable of generating 3D structures at the micron scale was introduced. This was termed microstereolithography (MSL) and uses the same principles as SL. An example of the detail obtainable can be seen on the rook above which was produced using the EnvisionTec machine currently used by the university.

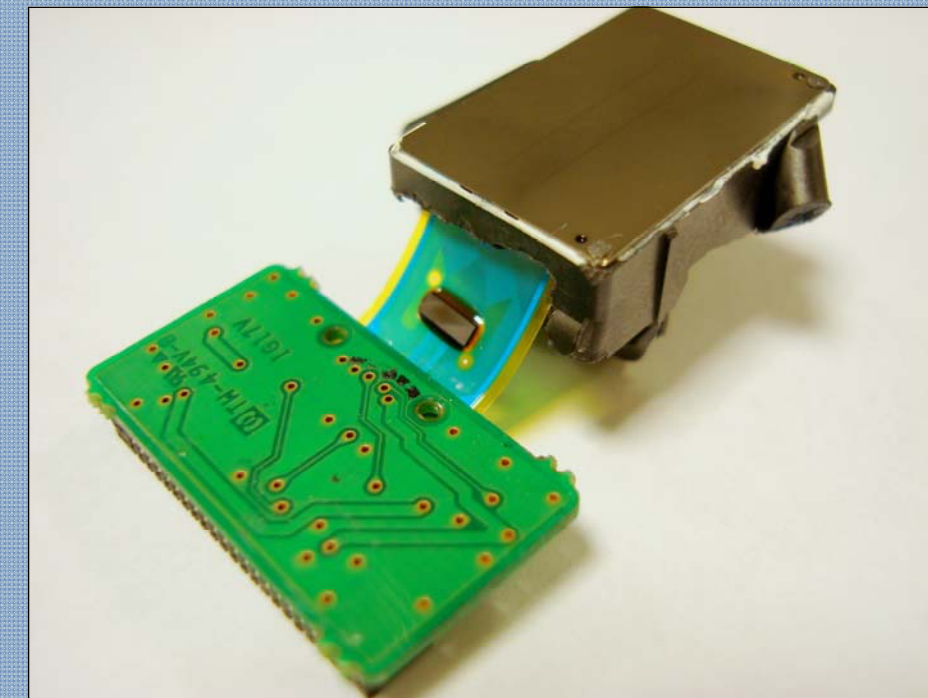


An SEM image showing a close-up of an ink entry point inside the print head.

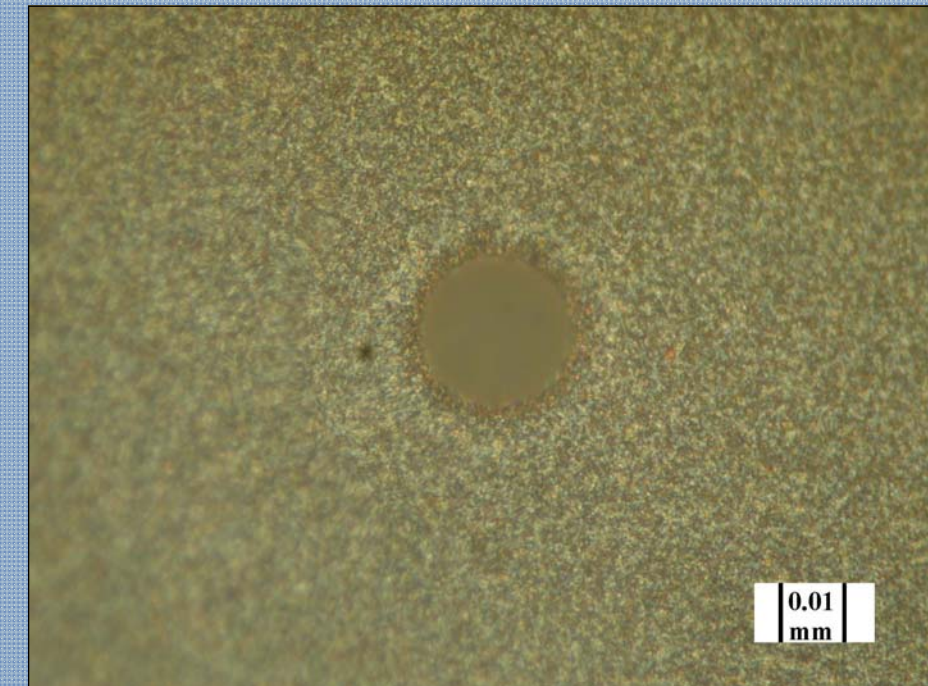


An SEM image showing a cross-section of a single ink ejection hole

Printer Module



The dismantled EPSON print head



An individual outlet nozzle (size $\approx 15\mu\text{m}$)

The printer module is comprised of a reverse engineered Epson printer head with the attached continuous ink supply system (CISS); this will be used to spray the chosen material (i.e. Resin) onto the build platform.

The CISS has a reservoir of ink, located separately from the cartridge, which gives it the advantage of a larger capacity and a simpler refill process in comparison to standard cartridges alone. It can also be refilled without interrupting the build process.

Progress:

- A suitable interface to drive the piezoelectric actuators is being developed via probing the operation of the printer, analysing the signals sent to the onboard logic in a normal printing mode.

Future:

- To complete this interface and test its functionality.
- Improvement by further probing and better replication of the signals sent to the print head.
- Enable the ejection and successful curing of a range of materials.
- The feasibility of using a thermal print head may be investigated as an alternative method.

Optical System

The optical system is used to cure the resin sprayed by the printer module.

The typical photosensitive resin utilised in traditional MSL processes is cured by UV light. Curing may be achieved by two alternatives:

- UV-LEDs are a widely available source but provide a challenge in terms of low power output. An array of LEDs may overcome this.
- UV Halogen lamps are another option as focusing the light beam is not essential. Each layer of resin may be cured individually rather than each point as it is placed.

Another option is to change the material so that it either absorbs a different wavelength of light, or that it requires a thermal input to initiate the curing process. This will be limited by the materials that are compatible with the printer module (in terms of viscosity and density).

Progress:

- So far these different directions have been researched.

Future:

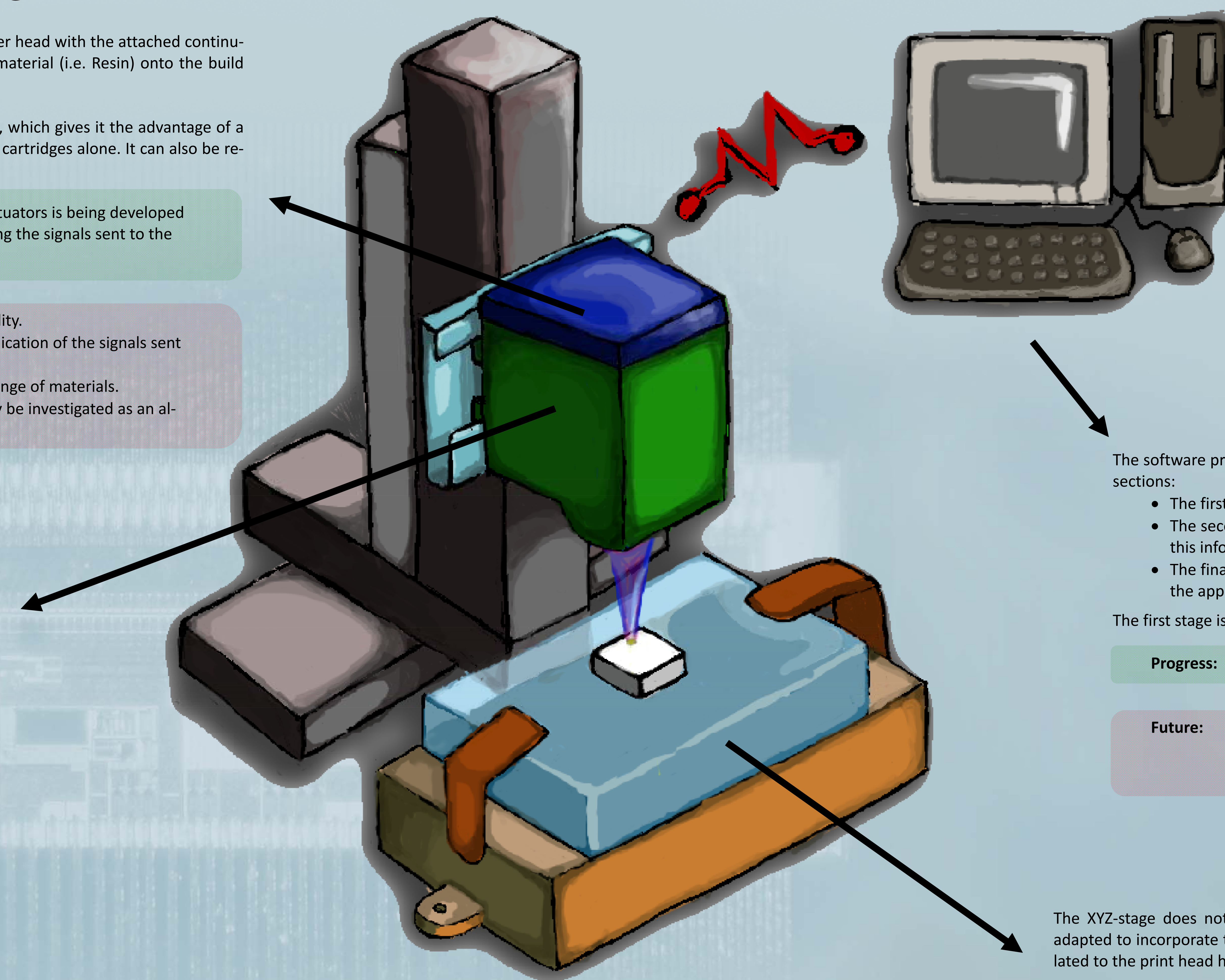
- To compare the different methods and make a final system that will be compatible to cure the modified resin.

Aims and Objectives

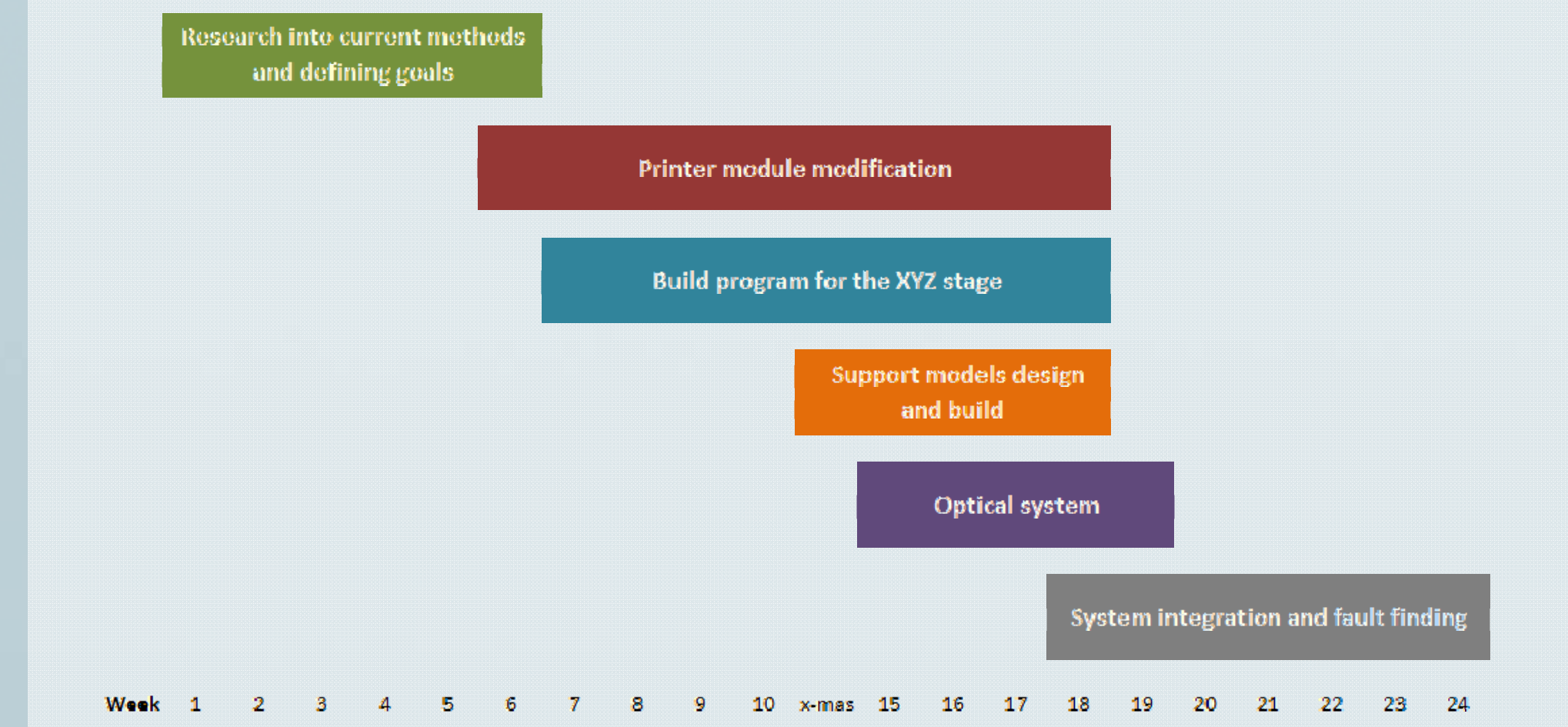
The **aim** of the project is to design and build a system capable of producing 3D structures using current inkjet printing technology.

Objectives:

- The proposed technology will ideally be superior to current methods in resolution and also the cost of fabrication.
- The expected resolution will be in the order of $10\mu\text{m}$.
- The system will enable the user to make structures using multiple materials.



Project Plan



Control Software

The software program helps the user to control the XYZ-stage movement. It will be comprised of three sections:

- The first section controls the movement.
- The second section parses image files produced by the Envision Tec STL slicer, and passes this information to the third section.
- The final section will control the piezoelectric actuators in the print head to spray resin at the appropriate times.

The first stage is written in C, whilst the graphical user interface and later sections are in C#.

Progress:

- The test code for the first stage and the graphical interface has been produced.

Future:

- The current program needs to be tested on the XYZ stage.
- Upon its successful completion, control of the image parsing and actuation of the printer module needs to be added.

Support Models

The XYZ-stage does not include support for the printer module. Hence, the printer module must be adapted to incorporate the print head such that it is securely held by the XYZ-stage. Any vibrations translated to the print head have the possibility of having a major affect at the micron scale.

The platform on which the resin will be sprayed must be perfectly horizontal and have a surface that does not greatly adhere with the resin model. This will allow it to be removed with a reduced risk of model damage post-manufacture.

Progress:

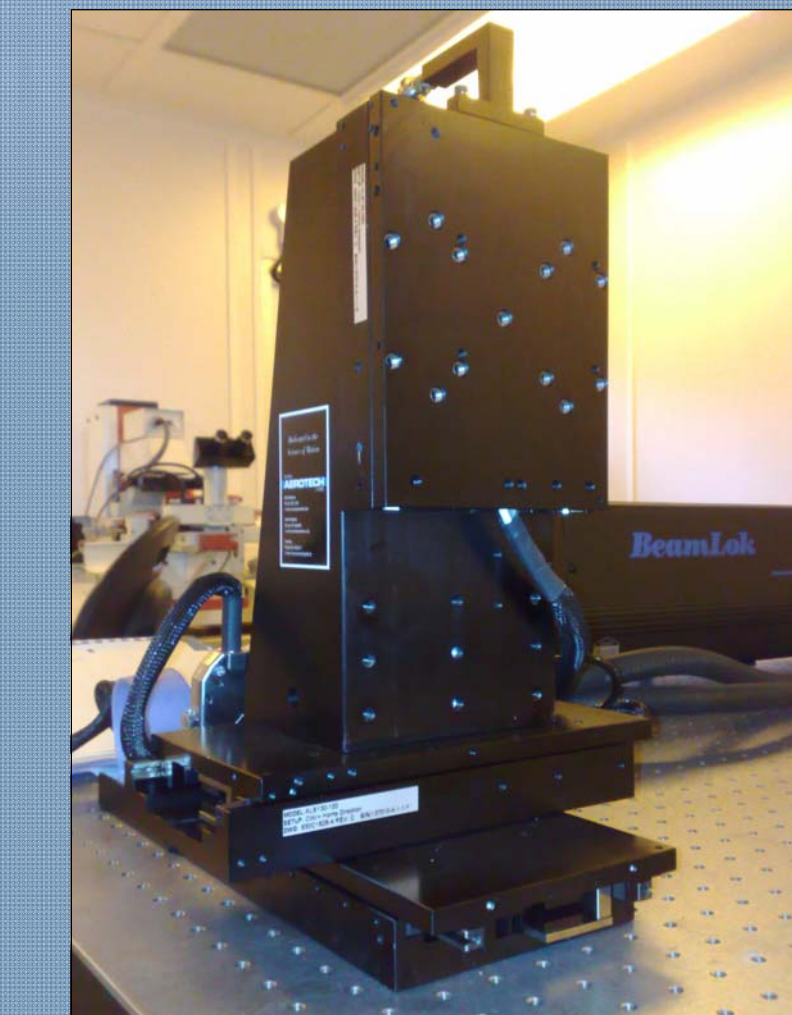
- It was decided the print module would be affixed to the XYZ-stage using either FDM (Fused Deposition Modeling) of ABS (Acrylonitrile Butadiene Styrene) plastic and incorporating parts of the original printer due to the print head's irregular shape.
- The EnvisionTec machine utilises a removable glass block as the build platform. This same platform will also be incorporated to our design.

Future:

- To attach the end effector to the XYZ stage by means of the adapted the support structure.
- Upon completion its mechanical stability will be tested and modified as required.



Current EnvisionTec Machine



XYZ-stage being used in this project