DEPARTMENT OF MECHANICAL & AEROSPACE ENGINEERING

University of Strathclyde Engineering

Statement of Work (SoW) Contract

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1 Problem Statement

The conception, design, iteration, and operation of a High-Performance Pressure-Based Microfluidic pump, control system, and software.

2 Project Objectives & Scope

This work will provide the James Weir Fluid Lab (JWFL, or *client*) a pressure-based pump for use in microfluidic research. The apparatus and user interface (UI) will be built in-house, and be used by researchers of the JWFL for the foreseeable future, providing a significantly cheaper alternative to commercial options. The group will aim to achieve an acceptable, and potentially competitive performance, particularly in comparison to the currently used syringe pump.

The project will be governed by an evolving scope. This is to ensure that basic functionality is first acquired before increasing the complexity and features of the system. By adopting this philosophy, we can ensure that regardless of how successful the later stages of the project is, the group can still deliver a working system for JWFL.

This project will not look at alternative pumping approaches, and will solely focus on applying pressure generated from compressed-air. For the prospective applications of the pump, the fluids in use will not be particularly corrosive or flow-impeding. The design limitations are summarised in Table 1.

Table 1: Pump Performance Criteria

Property	Requirement
Pressure Range	Due to component availability, the design will allow for up to 1-2 bar.
Flow frequency	Based on indsutry typical, and previous research, the design will range up to 5 Hz.
Scalability	The design will initially focus on 1 channel, then adapted to allow up to 3 channels.
Control Type	The design will initially control a steady flow rate to validate the design setup. Following this, an attempt will be made to produce different waveforms, such as square and sinusoidal.
Fluid Capability	The design will not accomodate overly-corrosive fluids, but some consideration will be taken into common materials used in laboratory and industrial applications. The design will also not (initially) accomodate flow-impeding liquids, such as rheological liquids and viscoelastic fluids.

3 Project structure

The project will be divided into 5 phases, described by Table 2.

Table 2: Project Structure

Stage	Activities
Phase 1	Literature review, component comparison, and Bill of Materials (BOM) creation
Phase 2	System design and component costing and sourcing
Phase 3	System prototyping, assembly and software development
Phase 4	Testing, evaluation, and expansion
Phase 5	Final product benchmarking, analysis, and report writing

4 Work Breakdown Structure

The work breakdown can be seen in Figure 1, following the key phases laid out in the previous section.

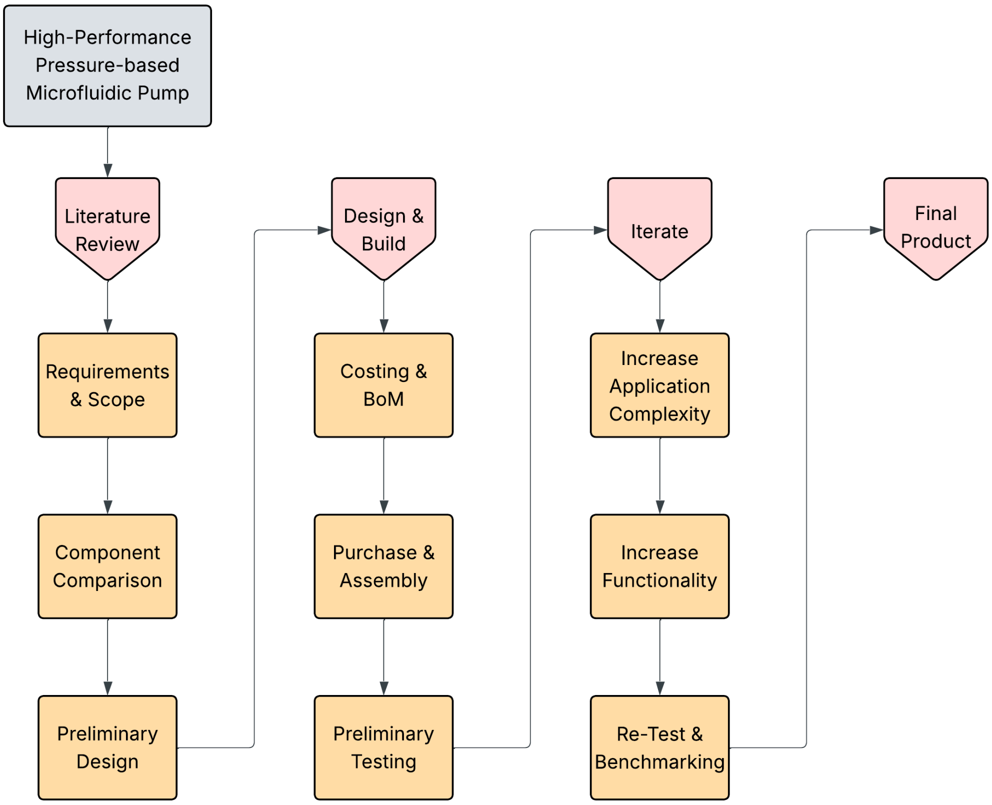

Figure 1: Work Breakdown Roadmap

5 Proposed Methodology

Initial product conception and design to be based on client requirements, as well as commercial options and researchers' own creations (with papers attached). This will take the group through to the costing of the first proposed system. In tandem with the hardware, software conception will also take place. This will focus on utilising the sensors already used by the client to facilitate data acquisition, resulting in a dashboard to monitor and calibrate pressure. This will also be utilised for the final product. Simulation of the velocity profile and flow kinematics can be undertaken to help with system design and validation. Hardware will be chosen in order to accommodate all levels of potential iteration, as well as different forms of control systems, in order to assure optimum performance.

Key parameters to meet include fast response time, adequate pressure capabilities, replicability, adequate reservoir capacity, cost-effectiveness, flow stability, and scalability.

Once costed and above parameters are met, components can be bought and assembled. Pump can then be integrated with developed software, and preliminary testing can begin. Once appropriate adjustments have been made, and desired parameters met (in a simple application scenario), the group can begin to evolve the complexity of the project down two paths: one being increased channels (3), and the other being product features (reversibility, flow rate sensor, etc).

Product validation will mainly involve the use of pressure sensors, velocity profiles, and flow rate. Comparison against the existing syringe pump (bad response time) is not a necessary feature of the final deliverable. Once system has been benchmarked and is sufficient, the final product will be encased to be as compact as possible, and the UI will be made to be user friendly. A full bill of materials, manual of operations, and risk assessment must be provided at this point, as the product will be passed over to the client.

6 Project Schedule & Milestones

Key deliverables throughout the project are laid out in Figure 2.

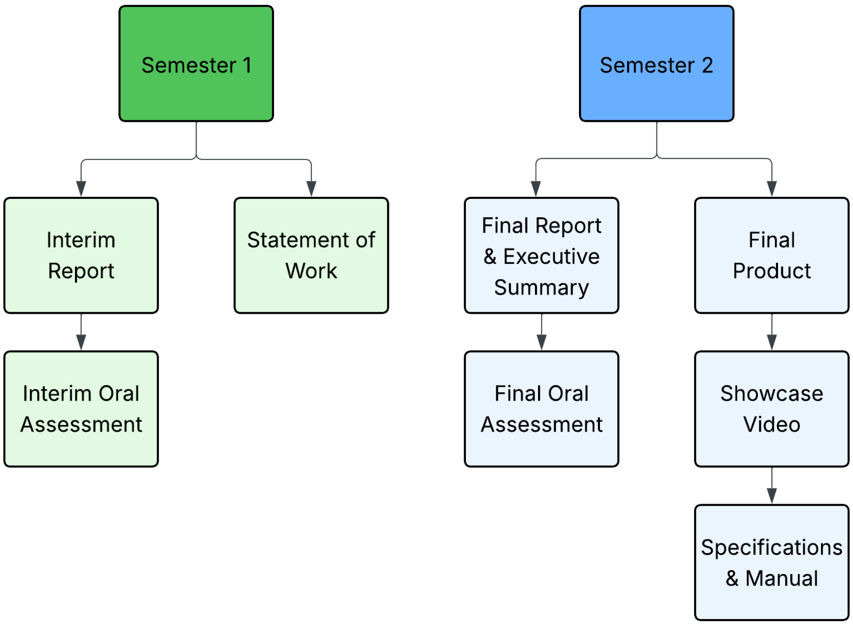

Figure 2: Semester Milestones

The projected timeline of our project has been laid out in a Gantt Chart, seen in Figure 3. Tasks seen in red are an estimate based of component lead times and other unknown factors.

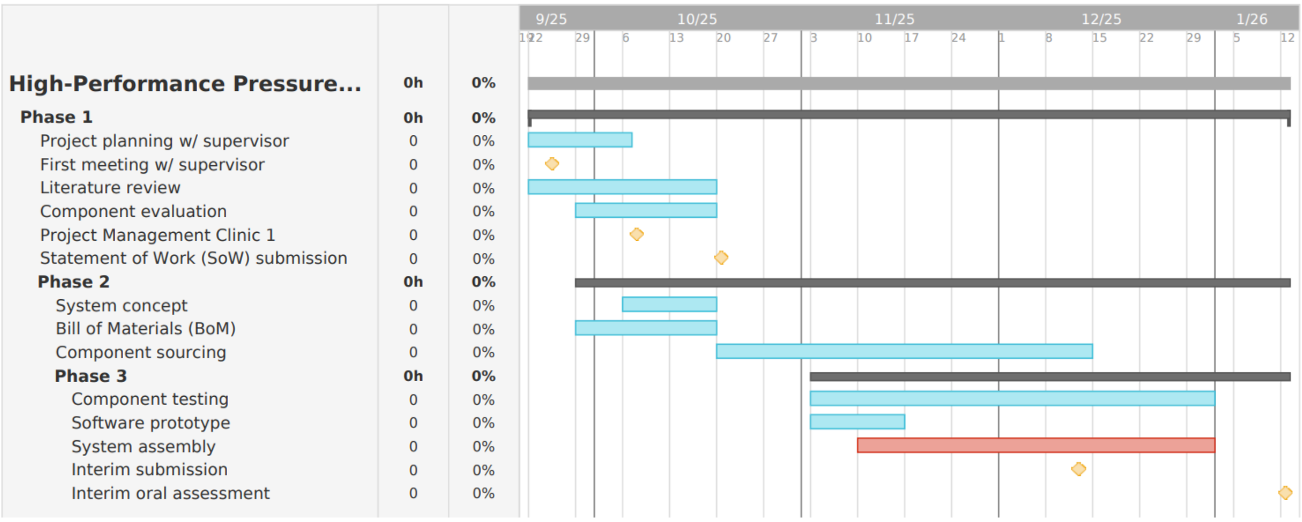

Figure 3: Gantt Chart

In order to make the set deadlines and function succesfuly, the group will follow the proposed Gantt chart in Figure 3. The key milestones throughout the project, as seen above, shall include:

- M0: First supervisor meeting and project approval
- M1: Statement of Work (SoW)
- M2: Interim Report + Product prototype
- M3: Improved iteration of product
- M4: Final Report + Product delivery
- M5: Relevant Documentation and Operation & Use (O&M) Manual

7 Project Deliverables

In line with the semester deliverables in Figure 2, the project shall deliver the following.

Sem 1:

- A completed Statement of Work (M1)
- Interim report detailing literature review and design progress to date (M2).
- The first iteration of a functioning product with software and UI (M2).
- A 10 minute presentation & allocated oral discussion.

Sem 2:

- A final report detailing the review of (M4):
  - relevant literature
  - critique of current solutions
  - chosen components
  - costing breakdown
  - detail of design
  - build methodology
  - software and electronic configuration
  - final results
  - suggestions for improvements
- Presentation & final oral discussion (M4).
- Executive summary (M5).
- Archive of supporting files, including a manual and product specifications (M5).

8 Risks & Mitigation

Table 3: Risk & Mitigation Table

Risk	Mitigation
Deliverables: Understanding client requirements	Clear communication, note taking, and general understanding of the problem. Benchmarking and feedback to client to ensure progress is on track.
Purchasing components: Delivery time	Ensuring the projected delivery time for components is within the project schedule, looking for alternative paths to potentially reduce waiting times.
Purchasing components: Unreliable suppliers	Ensuring purchase from reliable retailers, and brands that are trusted by the industry. Not going for cheapest items.
Laboratory work: Compressed air	Appropriate safety training will be undertaken by every member of the group, and certificates obtained.
Laboratory work: General safety	Same as above.
Deliverables: Product damage	High pressures can be mitigated through a relief valve. Electronic and liquid mix can be mitigated through proper UK/EU specified connections. General lab etiquette and safety procedures are to be followed.
Software: Loss of data	Utilising backups, as well as OneDrive to help keep files safe. Multiple versions for the group in case one has an issue.
Lab access	Can potentially ensure electronics/UI integration works out-of-lab, only use lab when pressure is required. Multiple cards will be purchased in case one person cannot make it in.

9 Stakeholders Map

This project is under direct supervision from Dr Monica Oliveira and Mr Drew Irvine, however, it aims to directly benefit the James Weir Fluid Laboratory (JWFL). A representative diagram of the persons who have influence over the project is shown in Figure 4.

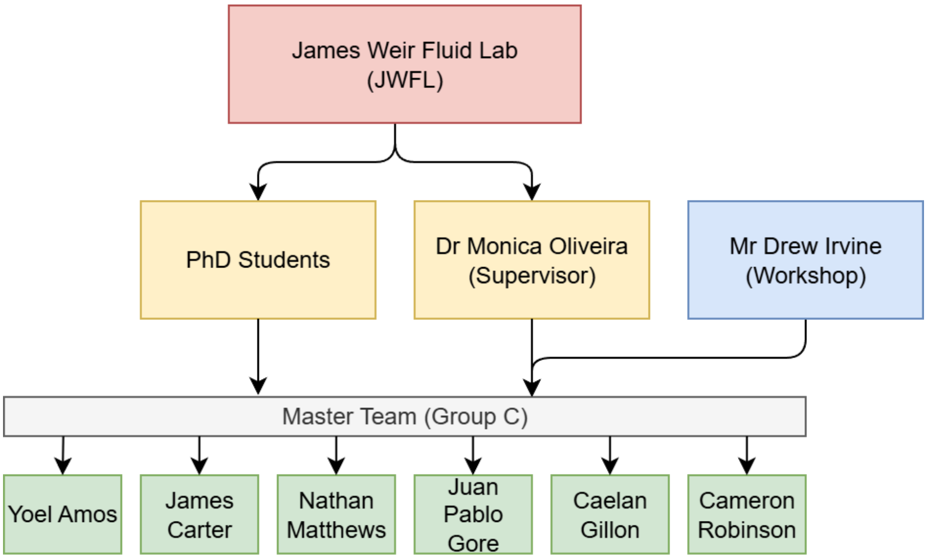

Figure 4: Stakeholder Structure

10 Communication Plan

Weekly group meetings, Weekly supervisor meetings to begin with, can change depending on requirement/availability. Daily group communication through multiple channels (Notion, WhatsApp, Teams, Emails).

Group 'Notion' project, to ensure all research, meeting minutes, and Gantt chart are all kept in one easily accessibly place.

Team member designated as communications manager, whom will be in charge of contacting client/ supervisor(s) as required, and relaying any necessary information to the rest of the team.