Product Design Specifications:
Liquid Controller

Team Roles:
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Function: Currently, reagents are added manually when testing cell signal functioning under a microscope. This leads to problems regarding accuracy of timing and amount. To resolve this issue, an automatic system is desired. This system will use valves controlled by a computer interface to precisely deliver required reagents.

Client Requirements:

- Must be user friendly
- Must have replaceable parts
- Must be automated
- Must have quick setup time
- Must not interfere with the experiment

Design Requirements:

- Must be resistant to corrosion
- Cannot leak toxic material
- Plug into USB
- Can be externally powered via wall outlet
- Must fit within limited table space
- Must have a computer interface
- Must have ability to switch fluids because of time
- Must have ability to control the flow rate

1. **Physical and Operational Characteristics**
    a. **Performance Requirements:** The liquid controller must be able to run on a daily basis for sessions lasting over 30 minutes. The limiting factor here is the performance of the valves, which can only have current passing through them for short periods of time before overheating.

    b. **Safety:** Product must be free from risk of electrical shock.

    c. **Accuracy and Reliability:** A high degree of repeatability is required. The liquid controller must be capable of producing the same exact output each time that it is used

in order to be able to repeat experiments. Time controls must be accurate to within one millisecond. Flow rates must be constant, controllable, and under 5 milliliters per minute.

d. Life in Service: Parts should be made replaceable, increasing the service life indefinitely. The liquid controller will be used daily for at least 30 minutes. Each component must be reliable for at least one year before replacement is needed.

e. Shelf Life: If properly cleaned, the liquid controller should last in storage as long as the shelf life of the commercially available parts used (the valves, pumps, etc.).

f. Operating Environment: The liquid controller will be used in an ordinary lab environment. Internally, several potentially corrosive materials will be used as reagents, including salts and organic solvents. The valves and tubing must be able to withstand this exposure. Additionally, the internal circuitry used in the hardware must be resistant to overheating. If this proves to be a problem, a fan must be used for cooling and ventilation.

g. Ergonomics: The liquid controller should require as little human interaction as possible while still remaining reliable and user friendly. The users should be able to quickly enter in the desired timings, then proceed with the experiment.

h. Size: The liquid controller minus the laptop should fit within the client's available desk space (approximately 1/3 square meter). It must be easily transportable, and should be no higher in height than 1/3 meter.

i. Weight: The liquid controller must be light enough to be carried up and down seven stories by an average person. This means a weight under 5 kg.

j. Materials: Materials must not corrode with repeated exposure to salt solutions. Materials must also not leak or be biologically incompatible.

k. Aesthetics, Appearance, and Finish: The liquid controller should be designed with functionality in mind, aesthetics is of secondary concern.

2. Product Characteristics

a. Quantity: One unit will be needed.

b. Production Cost:

Estimated budget:

Item	Cost (est.) ($)	Qty	Total ($)
Two-way isolation NO Teflon valve	60.00	1	60.00
Two-way isolation NC Teflon valve	60.00	7	420.00
Power relay	50.00	1	50.00
LabJack U12 LabVIEW interface	130.00	1	130.00
External power supply	20.00	1	20.00
Miscellaneous*	100.00	-	100.00
Total (est.)	-	-	**780.00**

*Miscellaneous expenses includes tubing, building supplies for stand, electrical wiring, and other necessities.

3. Miscellaneous

a. **Standards and Specifications:** No standards or specifications are required.

b. **Customer:** The liquid controller will be used by faculty members in the department of obstetrics and gynecology. The customer has limited programming knowledge. The customer prefers LabVIEW for easy integration into already existing programs. A gravity pressure system will drive the solutions (as opposed to using pressure delivered through a pump). The valves must separable from the case by at least five feet.

c. **Competition:** To the best of our knowledge, no device currently exists that meets all of the client's requirements.