

### Desired Needs

- **Low input impedance:** The main aim of the hydrogel electrode is to achieve an input impedance within 40 k $\Omega$ , outperforming many commercial dry EEG systems.
- **Low-cost manufacturing:** Since many commercial EEG systems cost upwards of \$10,000, the use of 3D-printable components aims to drive the effective production cost down as much as possible.

### Constraints

- **Safety:** Since the headset is an electronic device with direct skin contact, all precautions must be taken to avoid any risk of short circuiting, irritation, puncture wounding, and electrode contamination. This becomes additionally difficult with a low-cost design philosophy and a short project timeframe.
- **Manufacturability:** Since the hydrogel needs to be molded, the mold needs to be designed so that it can be made without compromising internal geometries; additionally, to maintain a low-cost profile, it must minimize financial, temporal, and laboral burdens.
- **Quality Control/Marketability:** Quality control is constrained by time, as it would require repeated impedance testing and mechanical testing of connectors.

### Engineering Standards

- **ISO 10993-1** → This is the flagship engineering standard for medical devices, which should be upheld by any devices with bodily interfaces aiming for commercialization.
- **ASTM D395** → Assesses the compressive behavior of elastomeric materials, which would be important in characterizing the performance of the hydrogel and TPU springs.
- **IEC 80601-2-26** → Specific safety standard for EEG systems in healthcare settings, which would be important for future clinical implementation.

### Concerns

- **Ethical:** There is a broad ethical concern surrounding products directly interfacing with the brain, as they can risk cognitive impacts with any electrical or mechanical damage.
- **Environmental:** Because the headset uses mostly 3D-printed elements, there is an environmental concern regarding the plastic and 3D-printing energy consumed.

### Teamwork

- Though two sub-projects were formed, there was consistent cross-communication to keep everyone up to date. Additionally, there were multiple open brainstorming sessions where everyone was able to freely express their ideas.
- To meet all expected deadlines, we worked immediately when assigned tasks, and would reconvene ahead of any major deadlines to finalize our work.

### Motivation

- The gap between current EEG systems and what many users actually need
- Since our project combined knowledge from many disciplines and fields, each member was able to focus on an area that interested them while still learning from the other subprojects

### Innovation

- The comb-like hydrogel electrode is a novel prototype, bridging the design gap between current wet and dry EEG systems.
- The modularity and ease of assembly would allow for this to be commercialized as “EEG kits” with minimal fabrication cost.