Tubeless Monopolar Smoke Pencil Attachment

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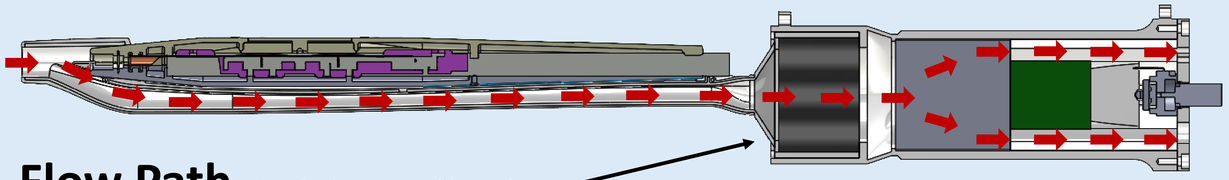
Mission

Evacuate harmful surgical smoke generated by electrosurgical pencils using a handheld device, eliminating the need for external filtration systems.

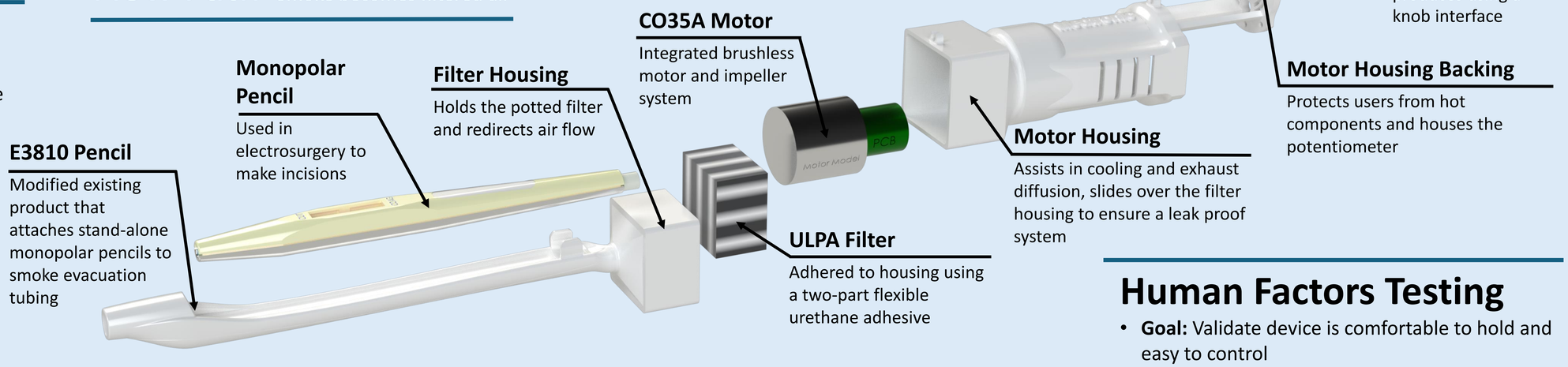
Specifications

- ✓ Conform to ISO Standard 16571
  - Achieves at least 90% smoke plume capture during active use
  - Implement ULPA filtration
- ✓ Cost of materials for disposable unit < $20
- ✓ Optimize form factor
  - Minimize weight and size
  - Consider human factors
- ✓ Shield device from EMC interference
- ❑ Meet all requirements for 15-minutes of activation time

Flow Path



Smoke becomes filtered air



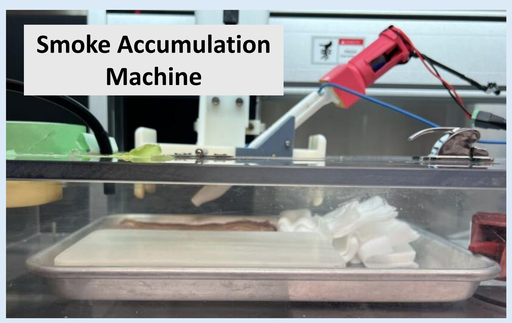
Design Methodology

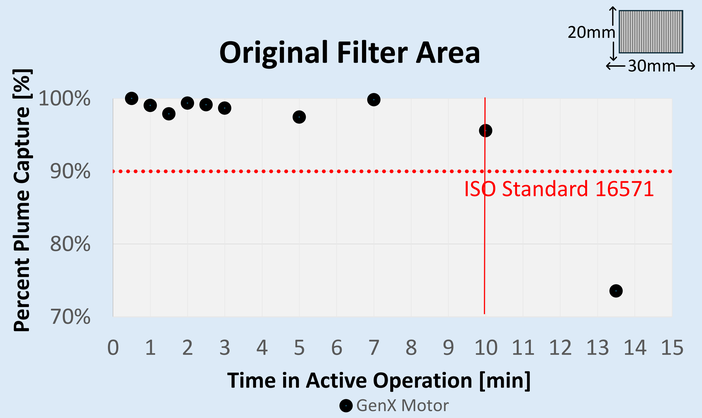
Multi-pass prototype design process

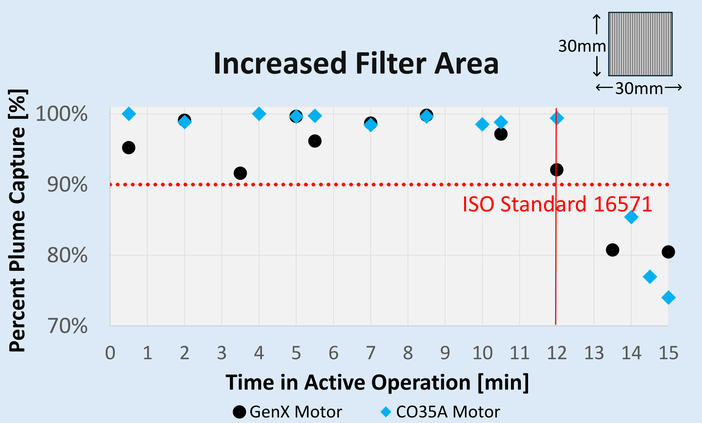
Round & Purpose	Knowledge Gained
Round 1: Validate test setups and get baseline measurements	1. Design of experiment 2. Possible sources of error 3. Need for new filter potting procedure
Round 2: Motor selection and optimize flow path	1. Selection of CO35A motor 2. Filter is a larger flow resistor than originally thought
Round 3: Full integration and smoke plume capture testing	1. Heat can be dissipated from air flowing over the motor 2. Increased filter area improves device use time

Functional Testing

1. **Perforated Plate Model**
   - Designed and manufactured a standardized flow resistor using Darcy's Law
   - Used in motor selection process
2. **Leak Proof Filters**
   - Developed a procedure to install filters in house to mimic the manufacturing methodology of a preexisting Medtronic laparoscopic smoke plume capture device
   - Proved leak free using soapy water and compressed air
3. **Smoke Plume Capture**
   - Conducted using Medtronic's Smoke Accumulation Machine (S.A.M)
     - Generated surgical smoke
     - Measured % smoke plume captured
     - Compared to ISO 90% standard







Human Factors Testing

- **Goal:** Validate device is comfortable to hold and easy to control
- **Methods:** Two rounds of testing where 20 people were asked to draw 6 lines with the motor on and off
- **Takeaways:** Vibration had minimal impact on use, inverted pendulum is undesirable

Results:
Percentage of Participants Who Responded "Yes"

Question	Round 1	Round 2	Difference
Is the required force to complete testing acceptable?	94%	100%	+6%
Is it easy to maintain control of the device?	89%	95%	+6%
Does the device feel evenly weighted?	67%	55%	-12%
Does the device feel comfortable to hold?	72%	75%	+3%

Future Work

- Integrate an adjustable angle smoke exhaust system
- Eliminate power cord through integration with existing generator or onboard battery
- Continue testing

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