1. Physical and Operational Characteristics
    a. Performance requirements: The device should be able to be used repeatedly with minimal degradation. Since it is a training device, it should be able to last at least five years without needing to have any parts replaced. It will most likely be used several times a month depending on when the procedure is being practiced.
    b. Safety: The device will involve an electrical circuit and therefore all wiring must be properly insulated. The voltage supplied will be 5 volts in order to ensure proper function from the Arduino while avoiding overheating [1]. This device will contain a sharp tipped needle that presents its own safety hazards. This will be labeled and expressed clearly as a potential safety hazard.
    c. Accuracy and Reliability: The device should be able to determine that it is in the lumen of the vein 95% of the time.
    d. Life in Service: The device will be able to withstand bi-weekly use for two years. Expected use will consist of repeated vessel punctures for roughly 15 minutes. Replacement of the vessel and conductive gel is expected once every two months.
    e. Shelf Life: Copper wiring would be a cheap and effective wire, as the life-span could be anywhere from 50-100 years.(4) With typical wear and tear this could drop down to 20-25, but this time frame still does not create a problem. The plastic tubing that replicates the vain would need to be replaced after about 350 injections, to be careful. The environment should not affect the model while in storage. Depending on the battery size, but if we use a nickel cadmium battery the shelf life, that is without use, should be around 18 months. If we were to use a typical lithium double A battery, the shelf life would be upwards of 5 years.
    f. Operating Environment: Device will be operated at room temperature in a classroom environment. May be exposed to potential damage from gel leakage and needle puncturing
    g. Ergonomics: Uses should be restricted to supervised classrooms only. The needle should never be inserted towards the user.

h. Size: the maximum size of the leg and total model will not be any larger than a 2 foot by 1.5 foot
i. Weight: The device should be portable. The model should be under 15 pounds. There are no problems with a model that is too light.
j. Materials: Materials are intended to mimic the real feel of a dogs leg while being able to withstand repeated puncture.

Material	**Source**	**Cost**
Arduino Microcontroller	Arduino.com	$22.00
22 Gauge Catheter	Client	$0.00
Imitation Fur (20x30cm)	Hobby Lobby [10]	$16.99
Imitation Skin (Chamois Cloth)	Amazon [11]	$12.95
0.5 cm Diameter Rubber Tubing	Amazon [12]	$6.07
3 cm Diameter Wooden Dowel	Team Lab	$0.00
Wires and LEDs	Personal Supplies	$0.00
Coaxial Needle or Equivalent	Unknown	~$100.00
Memory Foam	Amazon [13]	$17.96
Conductive Gel	Parker Labs [14]	$7.50
Total:		$183.47

k. Aesthetics, Appearance, and Finish: Resembles the leg of a dog. Potential fur-like finishing outside of blood vessel region.

2. Production Characteristics:
    a. Quantity: Only one prototype is required.
    b. Target Product Cost: The expected total product cost is $183.47 if all expected materials are purchased. In general we would like to keep costs below $350.
3. Miscellaneous
    a. Standards and Specifications: The imitation vein that is used should comply with the size provided with a 0.5 cm outer diameter.
    b. Customer: Dislikes the use of fluid as a positive indicator within the tube that models the blood vessel since it dyes the operators hands.
    c. Patient-related Concerns: The device should not need to be sterilized, as the needles will not be used on humans. The people using the device must be careful when using the needle, or when they put the needle away as to not poke themselves.
    d. Competition: There are a few models that use a fluid solution to replicate blood but only one that uses an electrical system we are proposing and that is by the game operation(2).

Sources

[1] “Arduino Uno Rev3.” [Online]. Available: https://store.arduino.cc/usa/arduino-uno-rev3. [Accessed: 09-Oct-2019].

[2] “Life/form® Canine IV Leg.” [Online]. Available: https://www.gtsimulators.com/Nasco-Lifeform-Canine-IV-Leg-p/lf01016u.htm. [Accessed: 06-Oct-2019].

[3] D. J. Hernandez *et al.*, “Measurement of bio-impedance with a smart needle to confirm percutaneous kidney access,” *J. Urol.*, vol. 166, no. 4, pp. 1520–1523, Oct. 2001.

[4]“Your home electrical system: how long can it last?” [Online]. Available: http://www.improvementcenter.com/electrical/home-electrical-system-how-long-can-it-last.html. [Accessed: 06-Oct-2019].