

Product Design Specification

Hands-free Ventilator Project

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Team Members:

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Function:

The product function is to modify the disposable manual ventilator (AMBU bag) to allow hands-free operation. The prototype consists of a modified foot bellow that is equipped with an oxygen reservoir. The bellow base is also connected to ventilation tubing that is connected to a mouthpiece with PEEP valve capabilities. The hands-free ventilator or bellow apparatus mimics the AMBU bag and provides a respirator resource to patients in need.

Client Requirements:

The project will allow for hands-free operation of the manual ventilator (AMBU bag), using the client's legs. Traditionally, AMBU bags operate as an inflatable bag by hand. To allow for the AMBU bag to be operated using legs, an extension piece (ventilation tubing) was engineered to reach the patient and provide oxygen. The extension piece maintains the current capabilities of the manual ventilator and provides adequate assistance in respiration (adequate exchange of oxygen and carbon dioxide).

Failure of the extension piece to adequately replicate the respiratory function of the traditional AMBU bag would cause the patient to suffer from oxygen deprivation. The oxygen reservoir attaches to an oxygen source which pumps pure oxygen into the ventilation system.

Design Requirements:

1) Physical and Operational Characteristics

- a. *Performance Requirements:* Product maintains the current capabilities of the AMBU manual ventilator and assists in respiration (adequate exchange of oxygen and carbon dioxide). Product provides pure oxygen to the patient at an air pressure ranging from 20-45 cpm, which is the designated pressure range of trauma victims.
- b. *Safety:* Product adequately replicates the respiratory function of the traditional AMBU bag to prevent patients from becoming overexposed to harmful carbon dioxide and also suffering from oxygen deprivation. The oxygen reservoir provides the bellow with a pure oxygen source that eliminates dead space (often containing harmful toxins such as carbon dioxide) in the prototype.
- c. *Accuracy and Reliability:* Mouthpiece sufficiently allows for oxygen-carbon dioxide transmission. Product provides adequate oxygen to the patient while eliminating carbon dioxide buildup in the tubing. Product has PEEP valve capability which controls the end respiratory pressure in the lungs.

- d. *Life in Service:* Product should be able to tolerate traditional helicopter conditions. Damage and wear can be repaired by tubing and plastic repair. Product is repairable. No disposable model is being made.
- e. *Shelf Life:* Shelf life should last the same length of the traditional AMBU bag which traditionally last 1-2 years without leaks.
- f. *Operating Environment:* Since Medflight operation takes place year round, the device will be able to endure a variety of weather conditions including moisture, high and low temperatures. Traditional AMBU Bag is operable in temperatures ranging from 0°F to 122°F.
- g. *Ergonomics:* Product is designed to comfortably fit at client's feet or on his leg and stretch to the patient. Product will feature traditional bag base and tubular extension. Tubular extension has been measured and modified to adequately stretch to the patient. Oxygen reservoir is equipped with a reservoir bag that maintains a constant supply of oxygen in the bellow and ventilation tubing.
- h. *Size:* Extension piece will stretch from bellow to patient. Extension piece will be in tubular shape to allow for oxygen-carbon dioxide transmission. Bellow piece fits on the floor of the helicopter to allow for easy-operation by Medflight personnel.
- i. *Weight:* Final weight of the prototype is 2.5 lbs, approx. Traditional AMBU bag weight is .92 lbs (without oxygen), approx.
- j. *Materials:* Ventilator extension was crafted using tubing material and plastic that was provided by the client and is common in medical

ventilation devices. Bellow piece was engineered from a traditional camping bellow to allow for an oxygen-source attachment and bag reservoir. Mouthpiece was provided by the client and is identical to those found on the AMBU ventilation device.

k. *Aesthetics, Appearance, and Finish:* Product is free from excess appendages that take up excess space. Product has red paint detail and functions as a one-piece compact model.

2) Production Characteristics

a. *Quantity:* 1, with the possibility of further replication.

b. *Target Product Cost:* Cost: \$35.00, which is comparable to the price of traditional AMBU bag. Target Product Cost includes the cost of disposable AMBU bag, extension materials (crafted with similar materials used in AMBU products), oxygen reservoir and bellow instrument.

3) Miscellaneous

a. *Standards and Specifications:* none.

b. *Customer:* Product needs to be free from “dead-space” that could develop in extension piece and become contaminated with carbon dioxide. Oxygen source believed to eliminate dead space by maintaining continuous supply of oxygen in the prototype. Traditional AMBU bags contain less than 5 mL dead space.

c. *Patient-related concerns:* Product needs to be free from harmful materials (i.e. carbon dioxide) and have all performance capabilities as

original AMBU bag. Product needs to adequately replicate respiratory function of the AMBU bag.

d. *Competition:* AMBU hand-operated ventilator