Product Design Specifications – September 29, 2010

Project #42: Hemodynamic Analysis System

Team Members

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Problem Statement

Currently, Echocardiography and right-heart catheterization are used separately to screen for pulmonary hypertension (high blood pressure in the arteries of the lungs); however, better diagnostic techniques are needed. In order to accomplish this, it would be advantageous to measure flow and pressure from the echocardiogram and catheterization simultaneously. Therefore, the purpose of this project is to construct a data collection and analysis system that can synchronize and export time, flow, and pressure to a data file for interpretation.

Client Requirements

- Conversion of analog inputs from echocardiography and right heart catheterization to digital output
- Synchronization of output including time, blood velocity, pulmonary pressure, and arterial diameter
- Collection of several data points per cardiac cycle
- Capability to store data and recall it later
- Optimization for use on humans (i.e. does not need to be adaptable to for use on animals) during rest and exercise

Design Requirements

1. Physical and Operational Characteristics

a. *Performance Requirements:* The device should be able to withstand operation at least twice per week for 60 minutes at a time.

b. *Safety:* For safety of the operator, the device should have no sharp corners and all circuitry should be enclosed. Also, the unit should not emit excessive heat.

c. *Accuracy and Reliability:* Collection of time, velocity, and pressure data should occur 20 times per cardiac cycle at a maximum heart rate of 150 beats per minute. This gives a sampling rate of 50 Hz. Also, the device should include programming to compute velocity from the Doppler output of the echocardiogram.

d. *Life in Service:* The device should maintain function for at least 5 years.

e. *Operating Environment:* The final prototype of the device will be used in a clinical setting. As such, it should be able to sustain movement associated with transport without loss of function.

f. *Ergonomics:* The device should be portable. Thus, it should be easy to hold and lift. Additionally, data output files should be easily accessible with an intuitive user interface.

g. *Size:* The maximum size of the device can be 12 in x 12 in x 12 in.

h. *Weight:* The weight of the device should not exceed 10 pounds.

i. *Aesthetics:* The appearance of the unit should be professional, as it will be in clinical setting.

2. Production Characteristics

a. *Quantity:* Two functional prototypes should be constructed.

b. *Product Cost:* Total cost for materials and construction should not exceed $1000 per device.

3. Miscellaneous

a. *Customer:* The primary user of the device will be our client, Naomi Chesler. William Schrage, in the UW-Madison physiology department, would also benefit from the creation of our device and use it in his testing. Additionally, researchers at Northwestern University are interested in utilizing a successful prototype of our device.

b. *Competition:* A Doppler audio converter has recently been developed that calculates fluid flow velocity using ultrasound audio signals. Our device must perform this function and synchronize the flow to pulmonary pressure. There are no current devices that can perform this synchronization step.