Pulse Pressure and Impedance Reutilization

Naren Chaudhry- Team Leader
Callie Mataczynski- BWIG
Cristian Naxi- BSAC
Yiqun Ma (马逸群)- Communications
Ian Baumgart- BPAG

Presentation Overview

I. Project Description - Cristian

II. Background - Ian

III. Inventory - Yiqun

IV. Instruments and Functions - Naren and Yiqun

V. Future Work and Timeline - Callie

I. Project Description

Dr. Naomi Chesler is requesting an assessment and reutilization of medical instruments

- Instruments left behind by Dr. Nancy Sweitzer
- Unused since Sweitzer's departure
- Provide inventory and schematic
- Reassemble for further experimentation

About the system:

- Will be used to accurately measure systemic vascular impedance

Problem Statement

Non invasive assessment of hemodynamics for diagnoses and prognoses is possible by measuring the pulse pressure with tonometry and blood flow with ultrasound. A system needs to be assembled to do so with healthy volunteers.

Primary goal:

- Reassemble a system of instruments

Secondary goal:

- Develop a protocol

II. Background

- Conducted by Dr. Nancy Sweitzer MD, PhD
  - Research at UW until 2014
  - Investigation focused around predictive biomarkers for heart failure
    - e.g. ejection fragment, central augmentation index, chemical therapies
  - Used instruments in conjunction to measure biomarkers
    - Mitral inflow
    - Arterial tonometry
    - Blood Pressure
    - Limb-lead echocardiogram

Impedance

"Pulmonary artery input impedance (PAII) expresses the opposition of pulmonary vessels to pulsatile blood flow, in the same way that vascular resistance expresses opposition to steady flow"

$$\text{Systemic Vascular Resistance} = \frac{\text{(mean arterial pressure - central venous pressure)}}{\text{cardiac output}}$$

$$\text{Systemic Vascular Impedance} = \frac{\text{(arterial pressure wave - venous pressure wave)}}{\text{blood flow wave}}$$

- Arterial and venous pressure waveforms measured by vascular tonometry
- Blood flow waveform measured by Doppler flowmeter

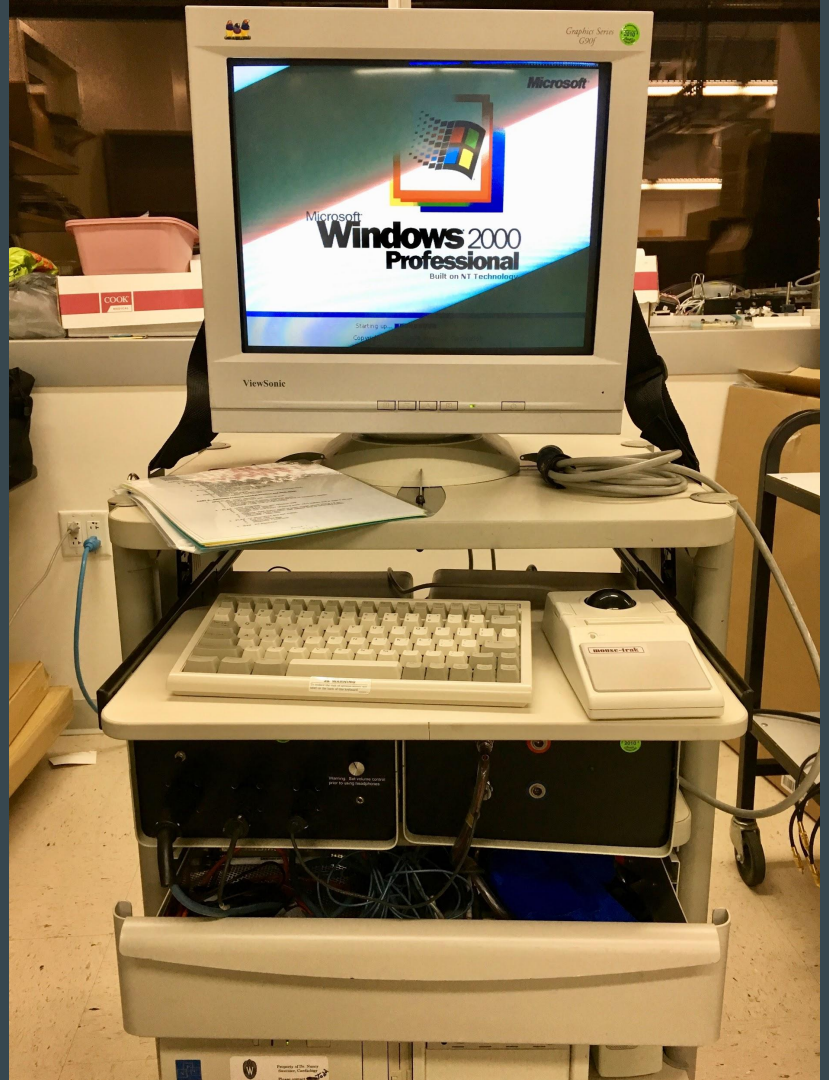
III. Inventory

Manufacturer	Part	Description	Serial Number	Notes
Hokanson	Rapid cuff inflator	Controls amount of pressure delivered to the cuff	E20 Rapid Cuff Inflator	Missing one power cord (found)
Hokanson	Cuff Inflator Air Source	Provides source of air	AG101 Air Source	Missing an air tube to connect the air source and the inflator
NiHem	Black laptop	A computer for data acquisition. Has ports for inputs and outputs.	P017 (not sure)	Missing a power cord
Acuson Sequoia	Echo machine & computer	Collecting tonometry data	C512	Don't know the password
Tronics		Appears to be an air blower	456873	Missing power cord. Don't know the function
N/A		No idea	01684-1 or 12OVACRMS	Missing power cord. Don't know the function
Carolina Medical Electronics Inc.	Cliniflow II	Model FM701D Electromagnetic Blood Flowmeter	004801A	Manual found
Manufacturer	**System**	**System Parts**	**Description of parts**	**Notes**
Hokanson	Rapid cuff inflator	Output hose	Gray tube with blue Y connector	Missing one power cord
		Power cords (2)		
		Plug adapter set		

IV. Instruments and Functions

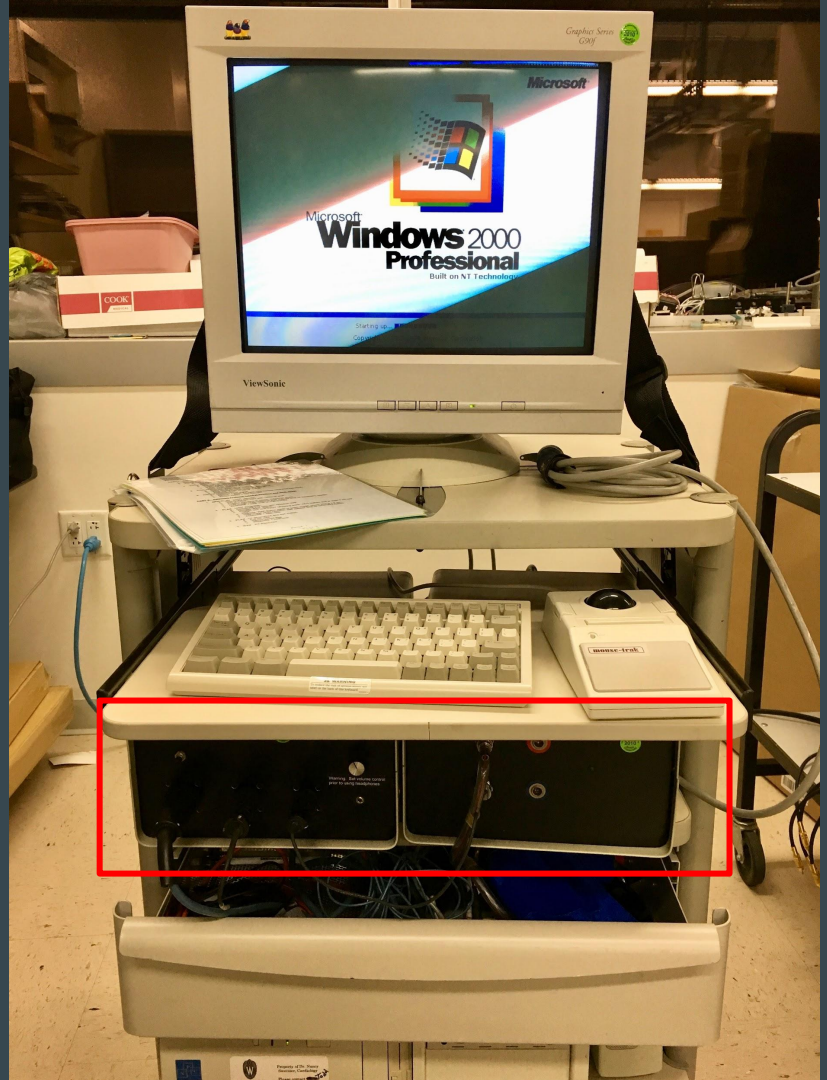
A. Sequoia C512 (Echo Machine)

- Multifunctional ultrasonic machine
- Color Doppler
- Tonometry data



IV. Instruments and Functions

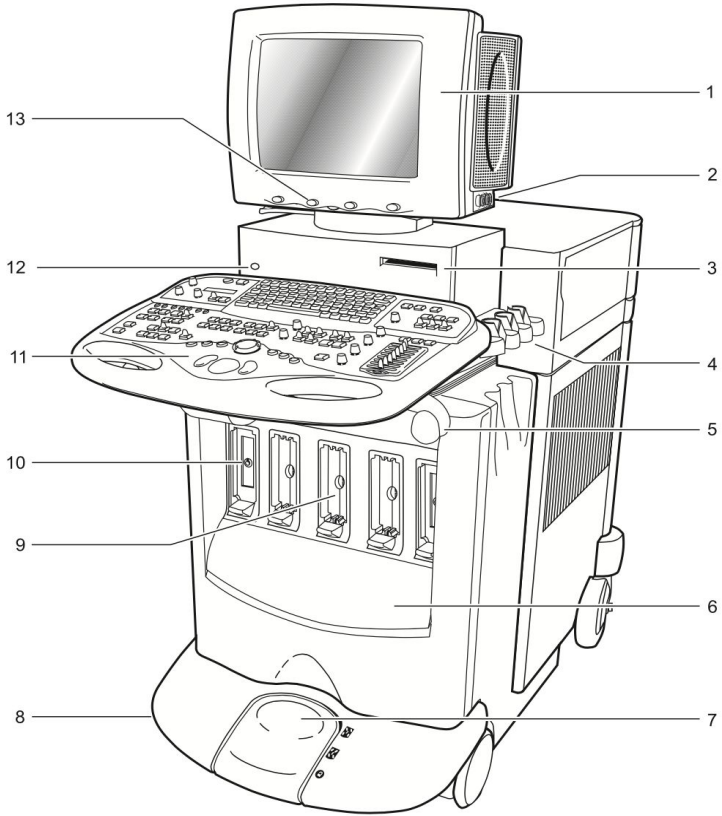
A. Sequoia C512 (Echo Machine)



IV. Instruments and Functions

A. Echo Machine

1. Monitor and Speakers
2. Monitor Controls
3. MO Disk Drive
4. Transducer Holders
5. Cable Holder
6. Storage Compartment
7. Wheel Lock/Steering Controller
8. Footswitch Connector
9. MP Transducer Ports
10. MP Storage Port
11. Control Panel/Keyboard
12. Power Button
13. Soft Keys (4)



IV. Instruments and Functions

B. Cuff Inflator

IV. Instruments and Functions

B. Cuff Inflator Airsource

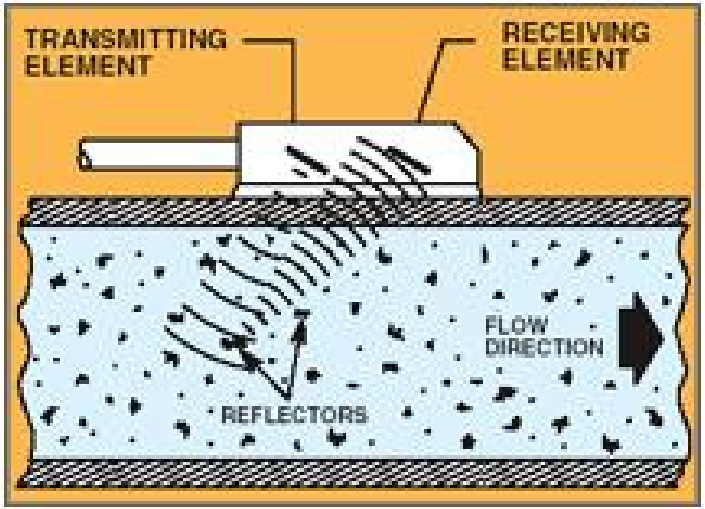
IV. Instruments and Functions

C. Blood Flowmeter (non-invasive)

"single-channel laser Doppler flow meter used with a specialized fiber optic probe to measure blood cell perfusion in the microvasculature of tissues and organs."
-ADInstruments
(https://www.adinstruments.com/products/blood-flowmeter)

IV. Instruments and Functions

B. Blood Flowmeter (non-invasive)



http://www.omega.com/prodinfo/ultrasonicflowmeters.html

- Uses Doppler Effect to measure average velocity in mass or volumetric flow rates (kg/s or L/s) (http://www.omega.com/prodinfo/ultrasonicflowmeters.html)
- Requires particulate/ non-homogenous solution.
- Change in frequency of sound-waves directly proportional to the flow rate.

Dr. Sweitzers blood flowmeter is actually an electromagnetic blood flowmeter. The velocity of the particle moving at a right angle through the magnetic field can be determined (Faraday's law)

- http://www.omega.com/prodinfo/magmeter.html

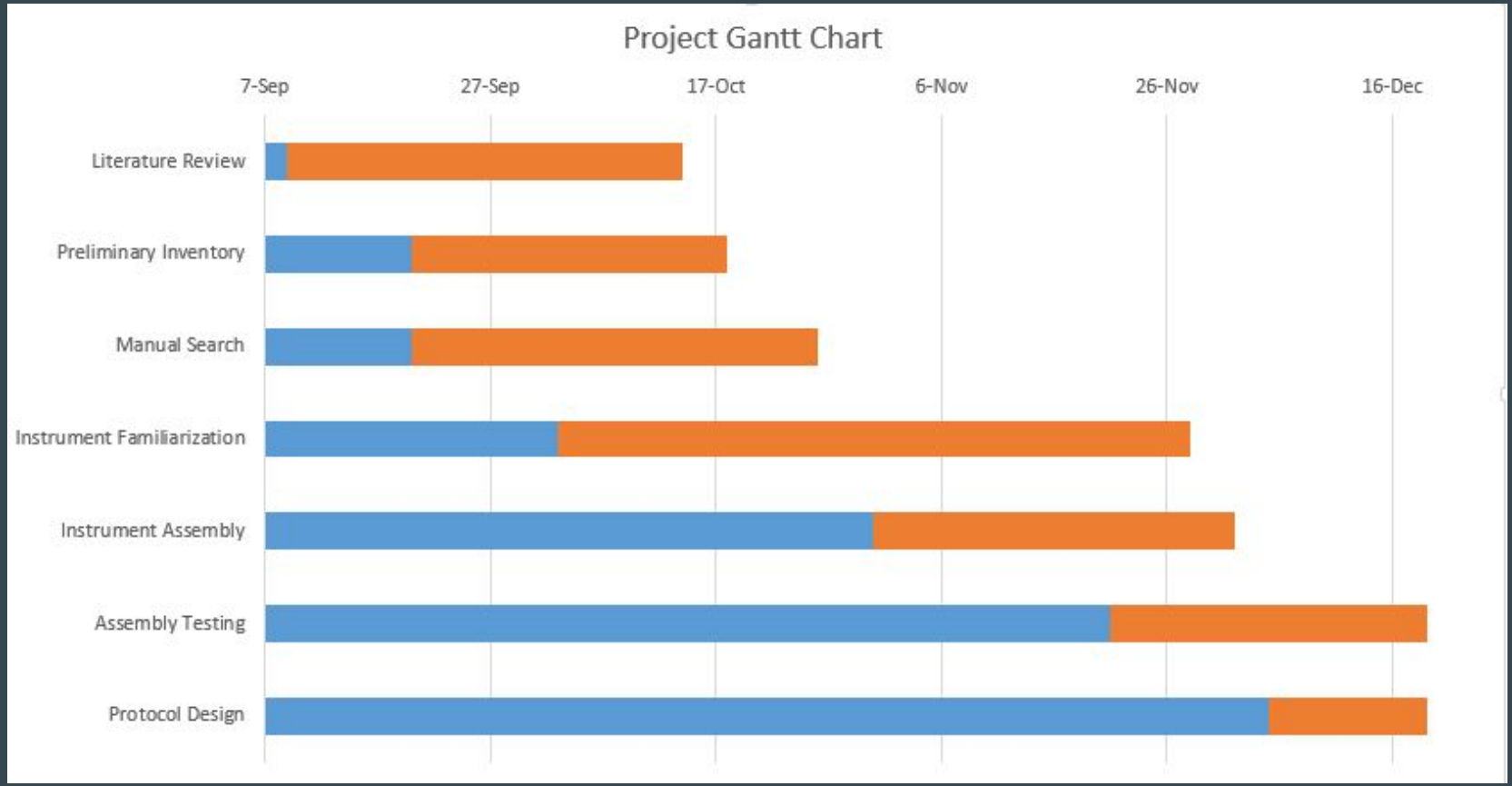
E is proportional to V x B x D where:

E = The voltage generated in a conductor
V = The velocity of the conductor
B = The magnetic field strength
D = The length of the conductor

V. Future Work

- Continue to decipher machine function
- Order missing parts
- Combine all subunits into one or two working units
- Design protocol

Timeline of Events



References and Acknowledgements

Acknowledgments:
Prof. Willis Tompkins
Prof. Naomi Chesler
Diana Tabima
Mark Golob

References:

1. Sweitzer, Nancy K. et. al., "Left Ventricular Responses to Acute Changes in Late Systolic Pressure Augmentation in Older Adults," *American Journal of Hypertension*, 26(7) 866-871, March 2013, DOI: 10.1093/ajh/hpt043
2. Morpurgo M. et. al., “Pulmonary input impedance or pulmonary vascular resistance?,” *Monaldi Archives for Chest Disease* 50(4): 282-285, August 1995
3. Acuson_Sequoia_C512_Echocardiography_Systems_Operator_s_Manual
4. http://www.omega.com/prodinfo/ultrasonicflowmeters.html
5. http://www.omega.com/prodinfo/magmeter.html
6. https://www.adinstruments.com/products/blood-flowmeter