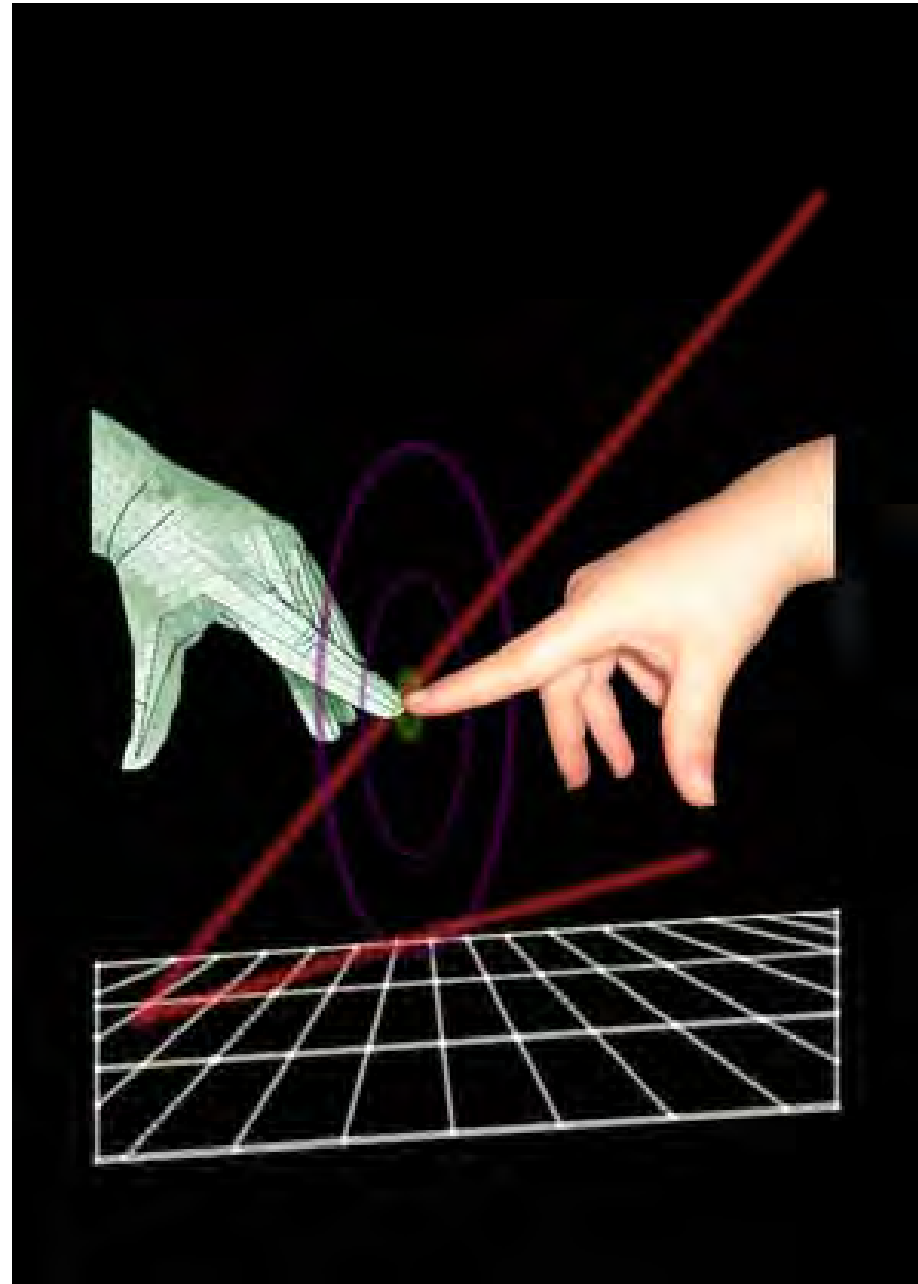


Tactile Displays

Mark
Ansermino

Visual Displays

Auditory Displays





The Tactile Display of Physiological Information

Department of Electrical & Computer Engineering

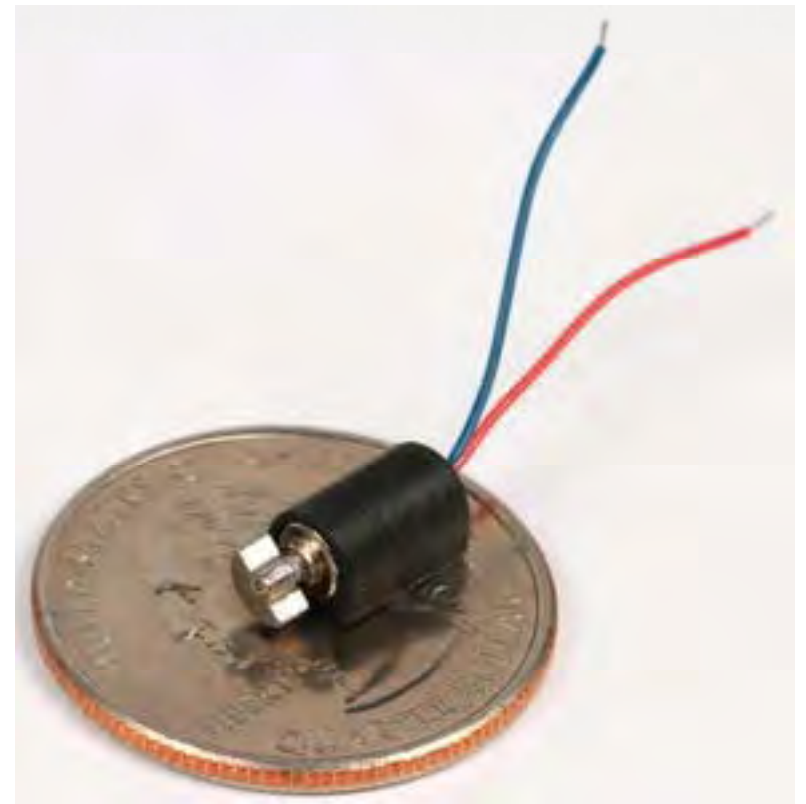
Department of Anesthesiology, Pharmacology & Therapeutics

The University of British Columbia, Vancouver, British Columbia, CANADA

Products & Process Applied Research Team

British Columbia Institute of Technology, Burnaby, British Columbia, CANADA

Vibration Mode





Affordances of Touch

'tap on the shoulder'

- Temporal and spacial discrimination
- Capturing attention
- Large area (2m²)
- Underutilized
- Proximal
- Bidirectional
- Private

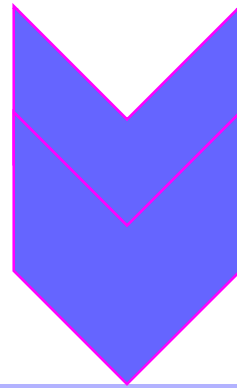
Geldard 1957

Tactile Display or Haptic Display

Tactile Cues

Kinesthetic Cues

position, weight, movement

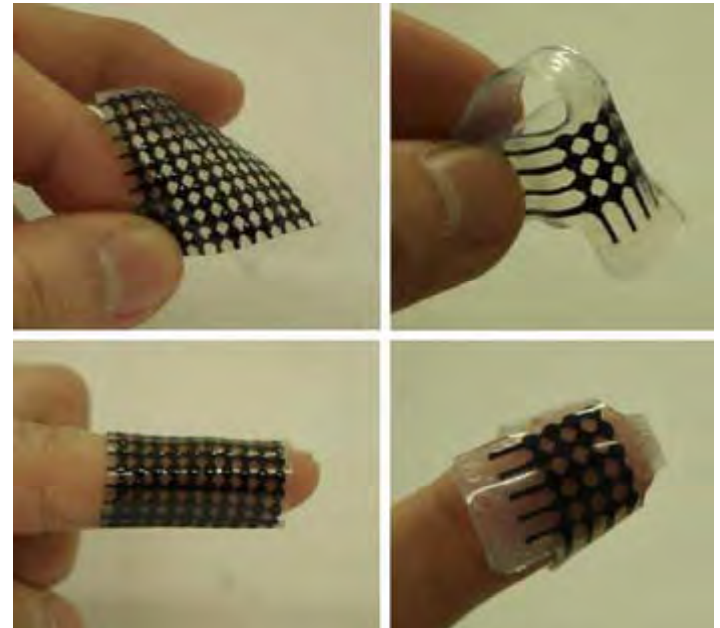


Haptic Display

augmented interactive touch



Sensory Substitution



Augmented Virtual Reality



Spacial orientation





Communication/ Messaging

- Tactons (tactile icons) *Brewster 2004*

- *Easy to learn*
- *Have meaning or emotional content*
- *Universal and intuitive*

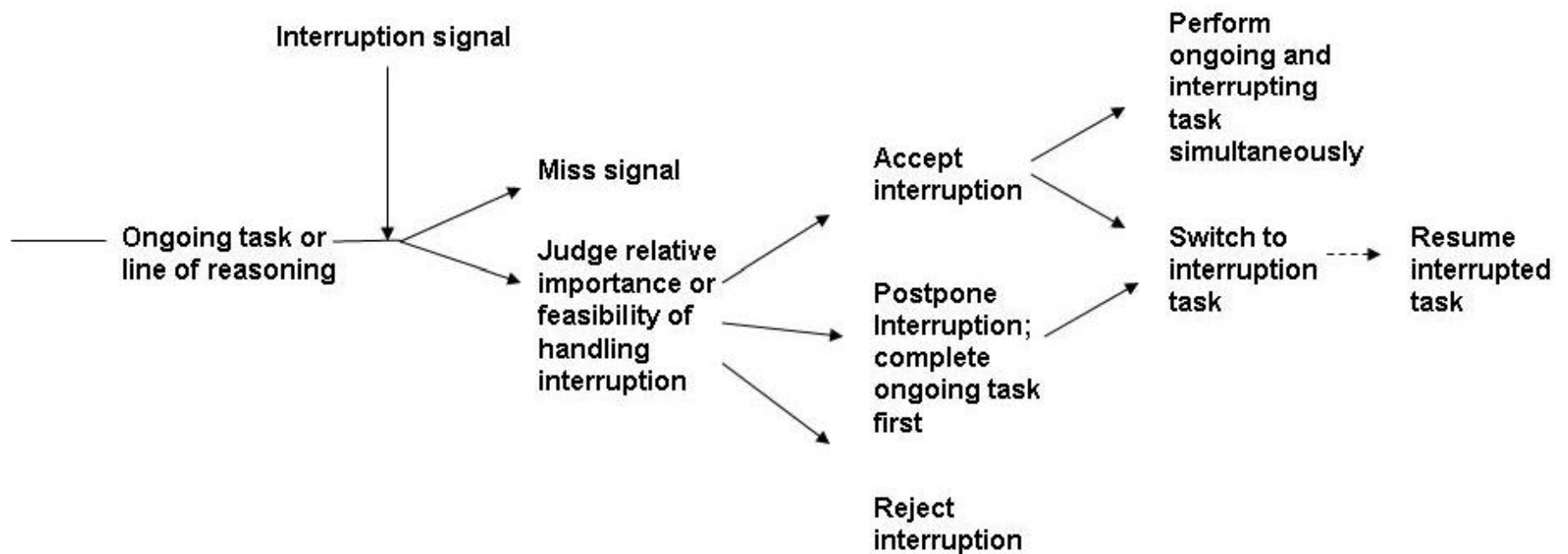
Pasquero 2006



What can we do in anesthesia?

- Interrupt (alert)
- Non visual/ auditory communication
- Multimodal augmentation
- Attention management

Pre-attentive reference



Interruptive cueing (*Sarter 2005*)

The Touch Receptors

Meissner corpuscles

- pressure change
- rough texture
- vibrotactile patterns
- slip detection

Merkel disks

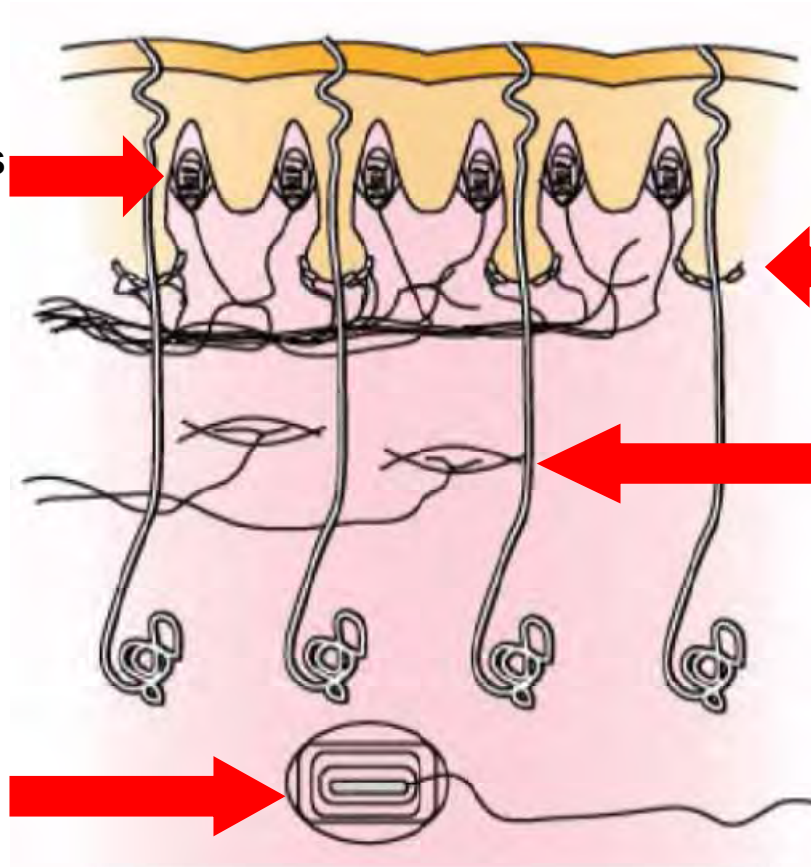
- finest details

Ruffini endings

- warmth
- direction of stretch

Pacinian corpuscles

- Vibration (250Hz)





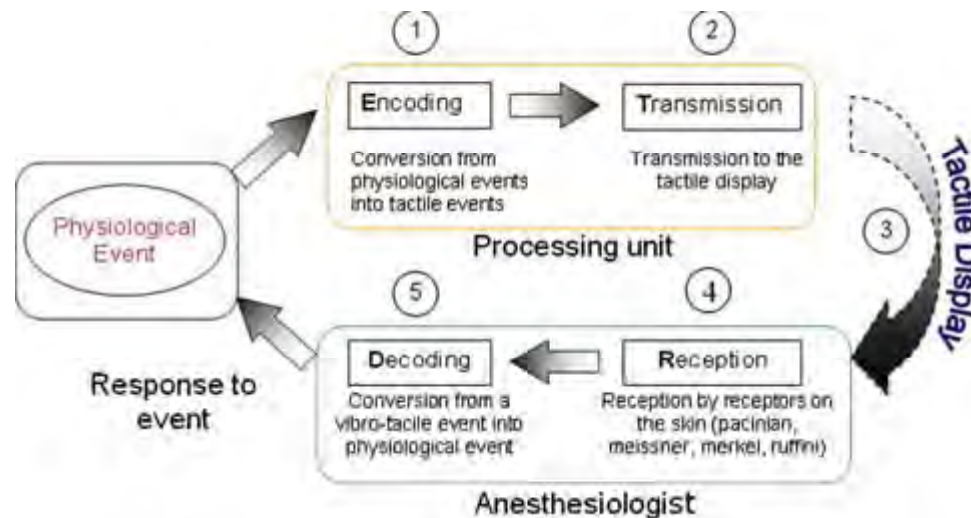
Tactile Sensations

- Location
- Duration
- Frequency
- Amplitude
- Pressure
 - mechanical deformation
- Vibration
 - roughness or texture
- Temperature
 - hot or cold
- Pain

What works?

- Frequency and amplitude interfere
- Ideal frequency 250Hz
- Two point discrimination – location dependant
- Duration 700msec
- Rhythm has high Information Transfer (IT)

Barralon 2009, Ng 2008

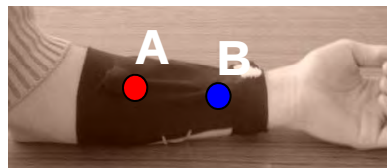


Multi-tasking in the O.R.

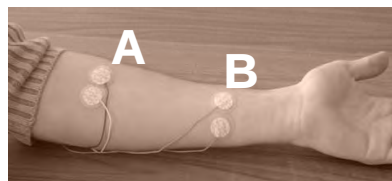
Anesthesiologists must monitor many sources of information around them during a surgical operation. And there are many other distractions in the operating room.



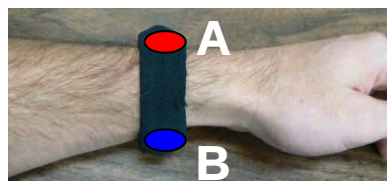
Vibro-tactile display on the Forearm (VF)



Electro-tactile display on the Forearm (EF)



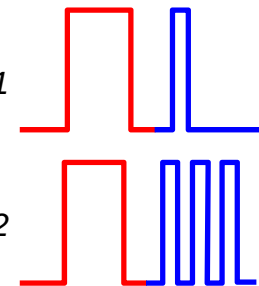
Vibro-tactile display on the Wrist (VW)



I
n
c
r
e
a
s
e

Level 1

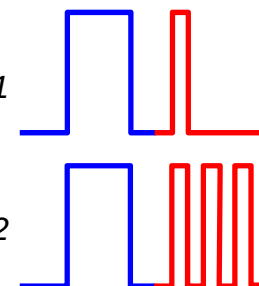
Level 2



D
e
c
r
e
a
s
e

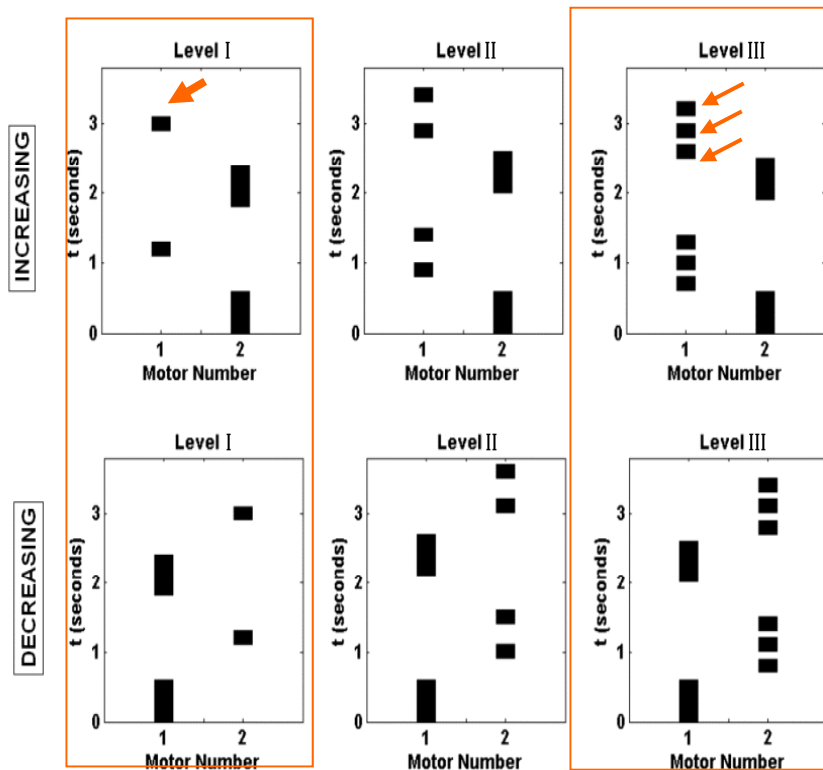
Level 1

Level 2



Forearm Prototype

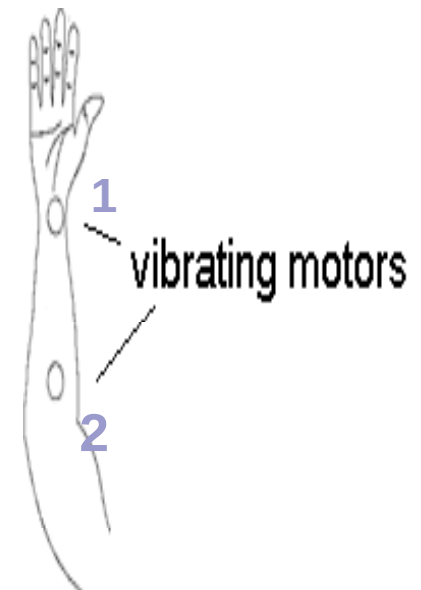
- 6 possible patterns (Ng 2006).



Decreasing
heart rate



Increasing
heart rate

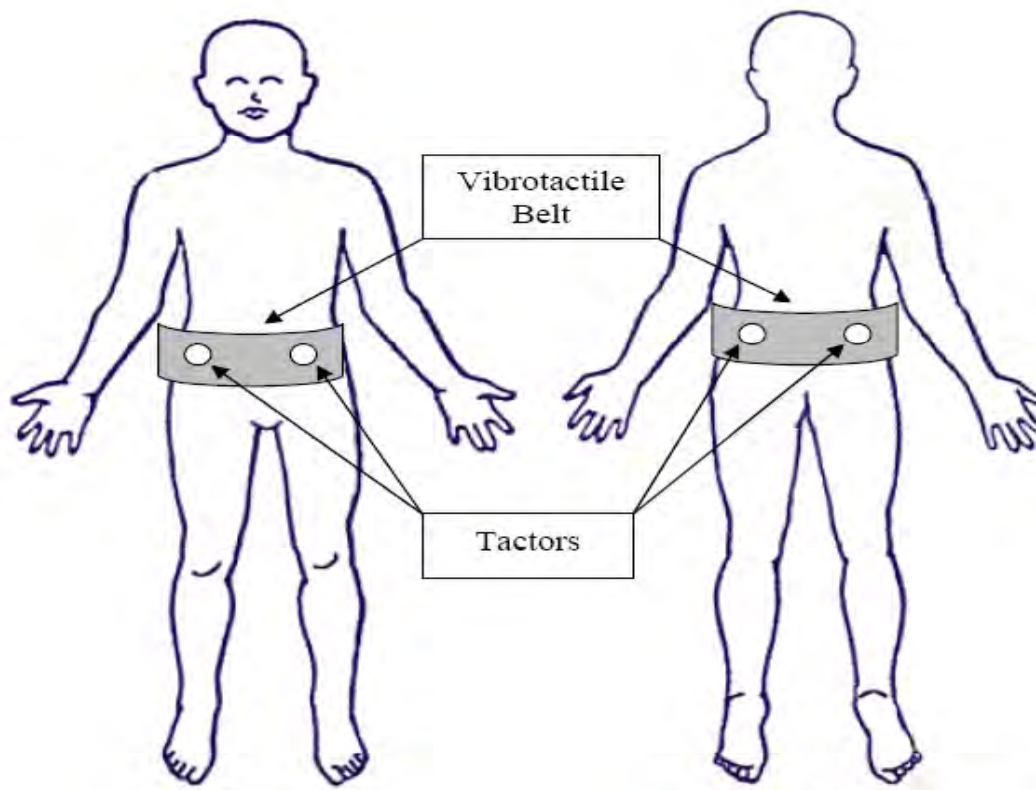


Armband vs Vest Display





Tactile Belt (Ventilation)



R – Airway pressure
L – Minute Ventilation
Ant – Increase
Post – Decrease

Testing of tactile belt in HPS

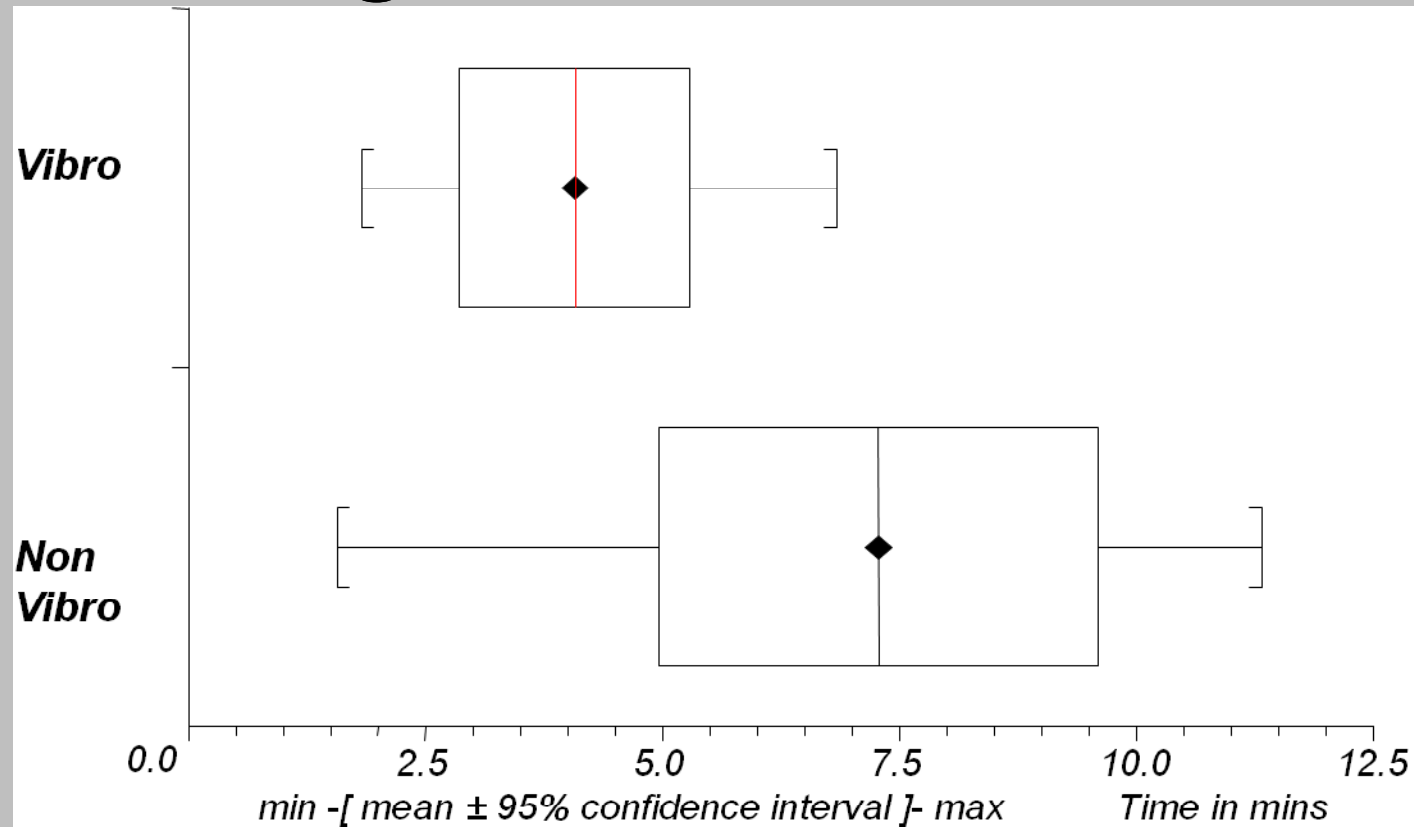
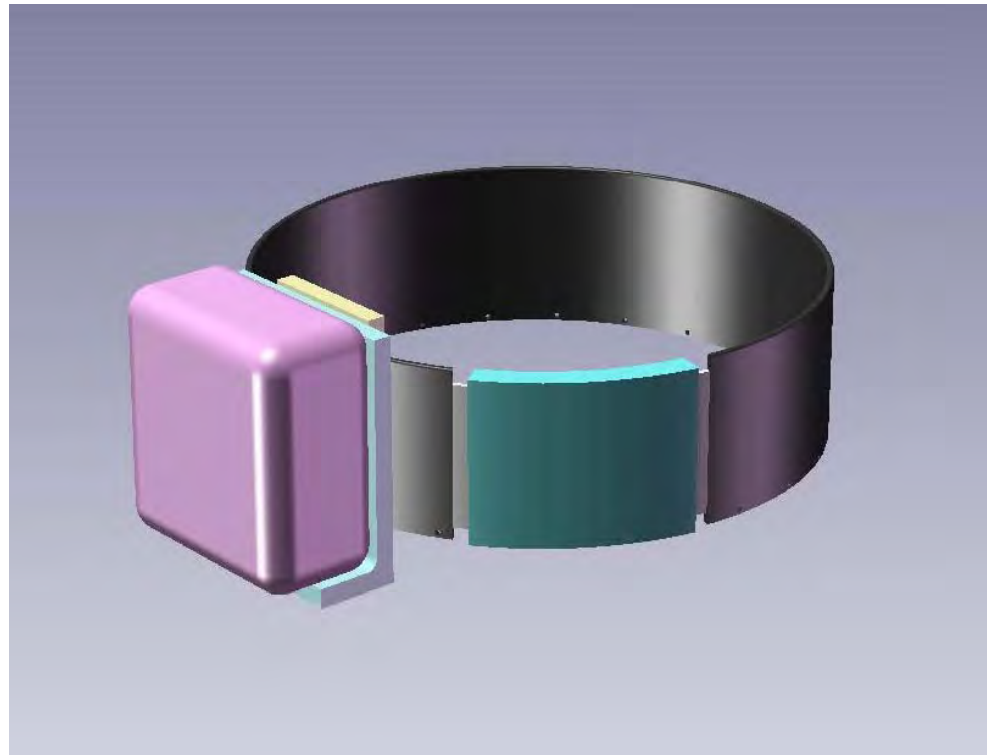


Figure 1: Time taken to administer epinephrine

Ford, S et al Anesthesia and Analgesia (2008).

Concept Development

- Develop a concept that could achieve the Design Requirements



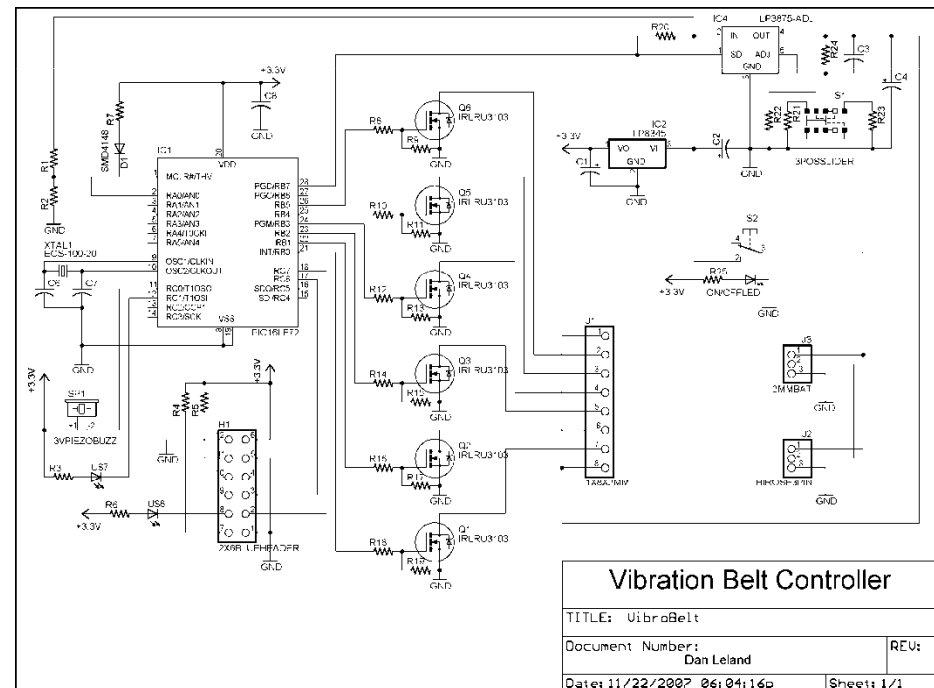
Mock-up



Detailed Design

■ Phase Deliverables:

- Hardware Design
- Software Design
- Enclosure Design
- Belt Design



Device Fabrication



Design Verification



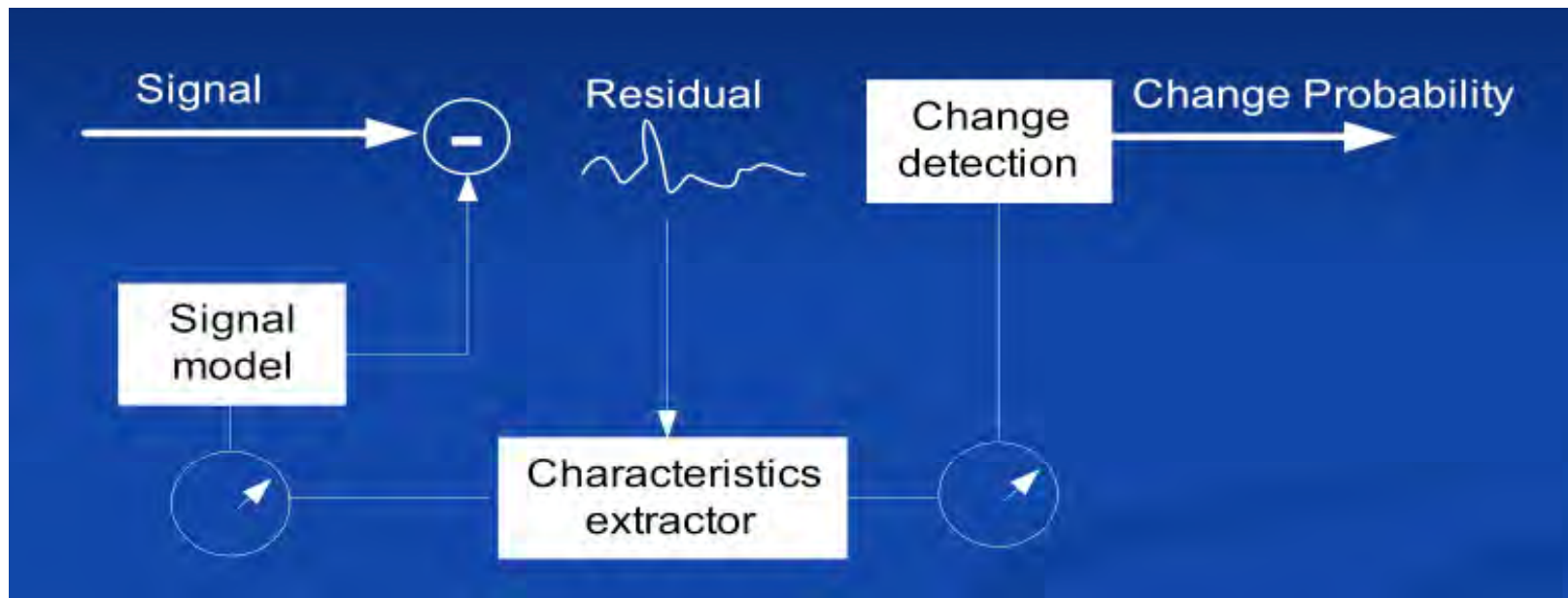
Tactile Belt Prototype



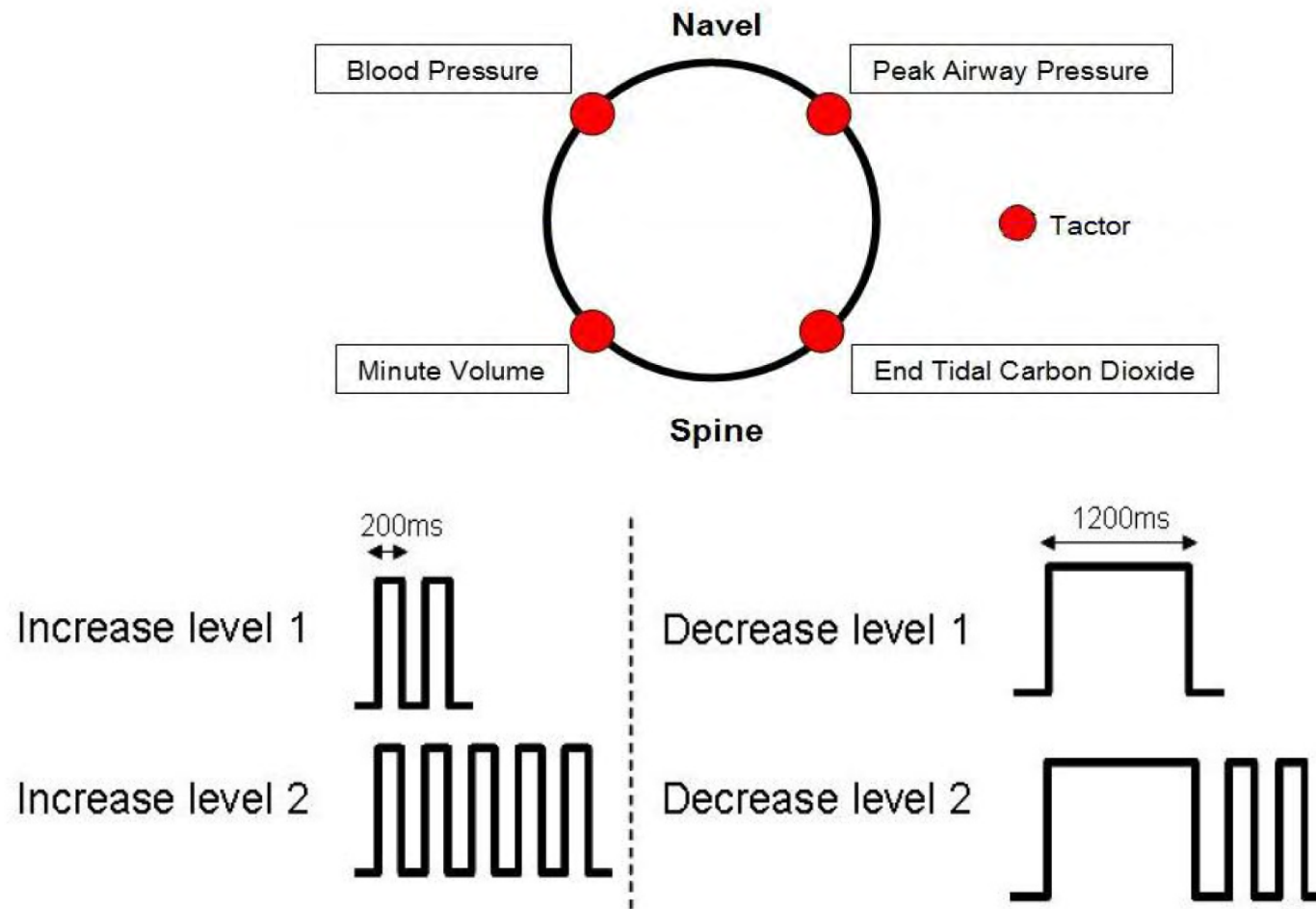
Adaptive Change Point Detection

- Modeling: Signal variations
- Prediction error: Trend changes
- Change point detection: Cusum test
- Online adaptation

Dosani 2009, Yang 2010



Vibrotactile Belt





Realtime evaluation

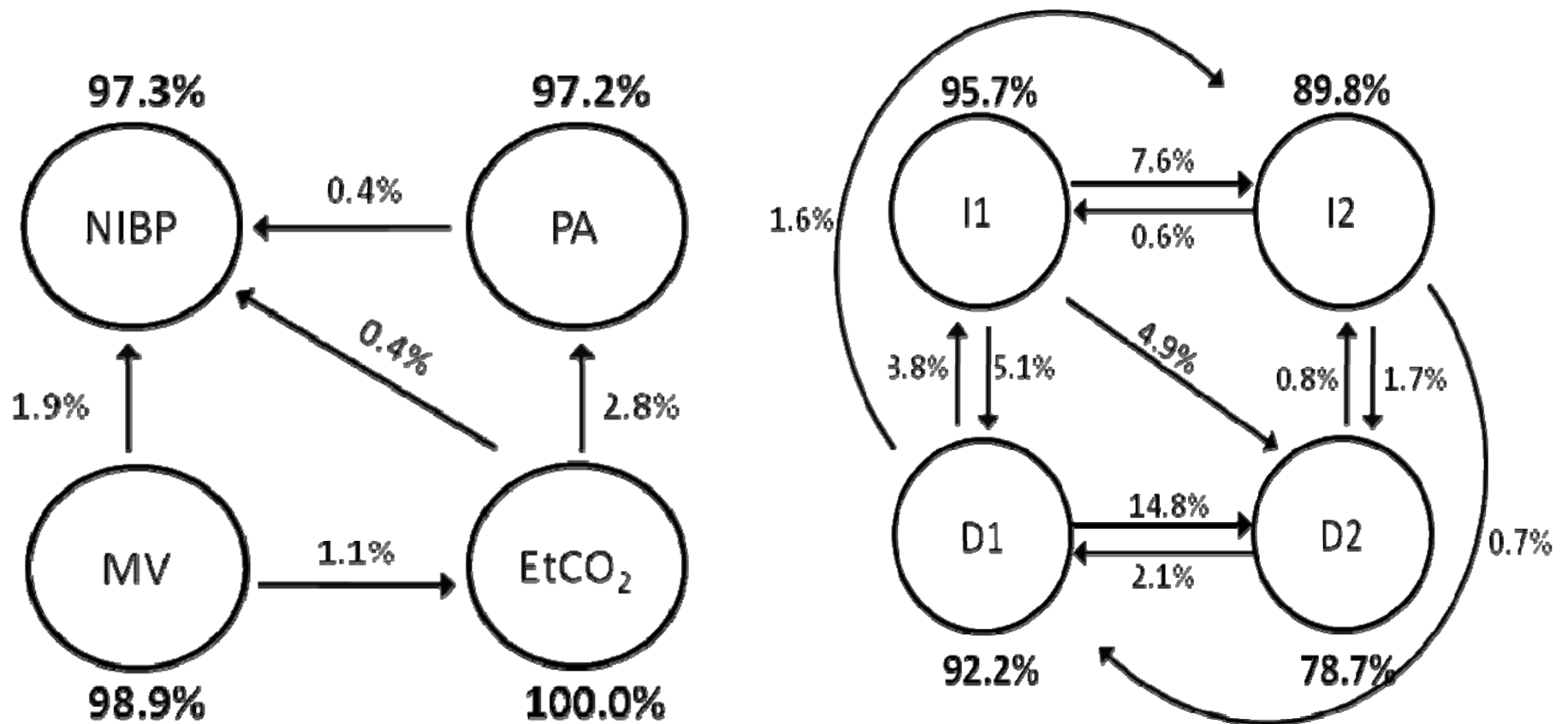
17 anesthesiologists, 57 cases

Table 2. Rated and Unrated Alerts for Each Monitored Variable

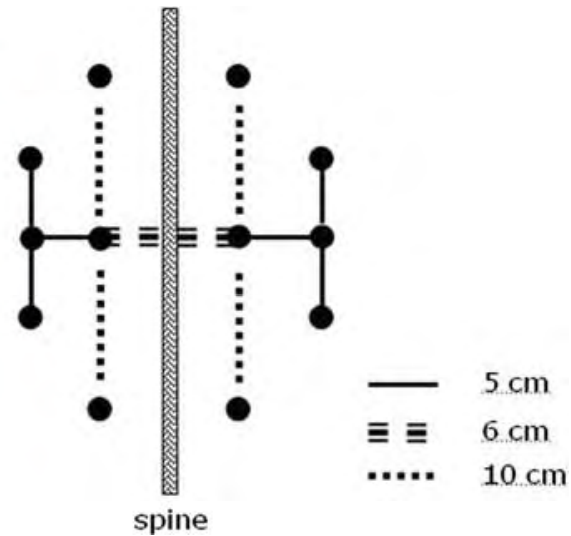
Parameter	Total number of alerts	Number of rated alerts	Number of unrated alerts
NIBPmean	313	257	56
Ppeak	54	36	18
EtCO ₂	62	49	13
MVexp	104	88	16

NIBPmean = mean noninvasive arterial blood pressure; Ppeak = peak airway pressure; EtCO₂ = end-tidal carbon dioxide partial pressure; MVexp = expired minute ventilation (MVexp).

Detection of location and pattern

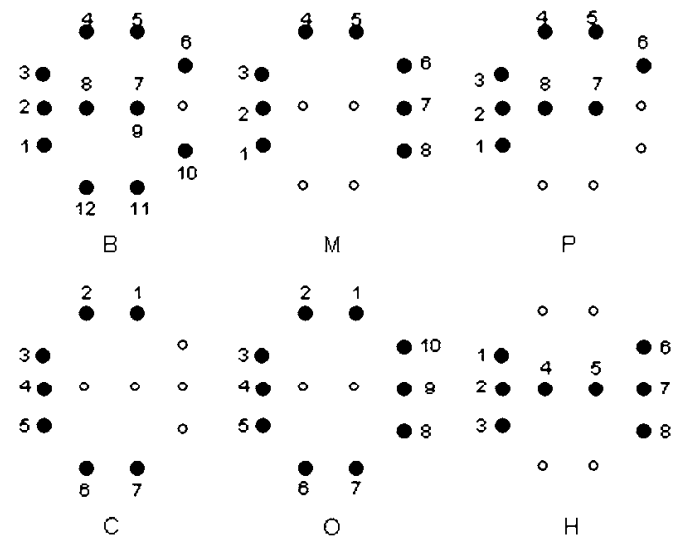


Dorsal Display

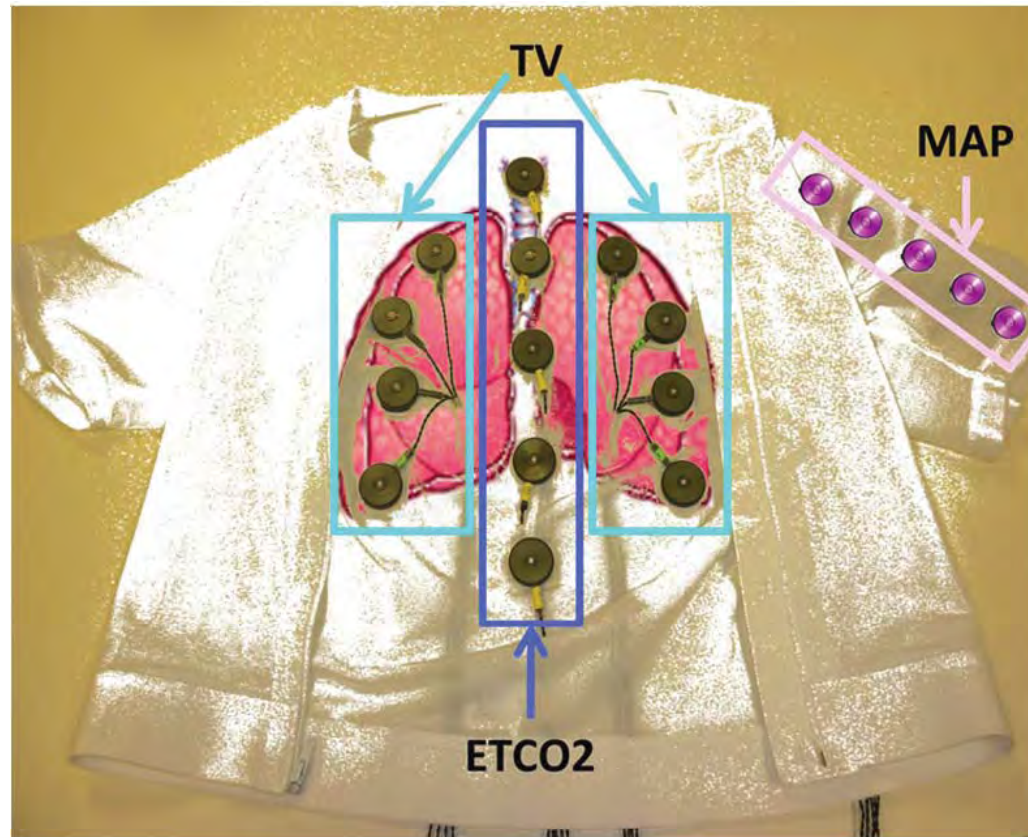


Easier to learn compared to tactile belt

Barralon 2009



Continuous Informing Display



Multimodal display improved performance under high task demand

Ferris 2011



BRITISH COLUMBIA
INSTITUTE OF TECHNOLOGY





Thanks for listening

Mark Ansermino

mansermino@cw.bc.ca