1st Invitational Workshop Workshop on
Body Area Network Technology and Applications
Future Directions, Technologies, Standards and Applications
June 19-20, 2011
Worcester Polytechnic Institute

WPI Body Area Network Conference

"Practicality of BAN for Physiological Monitoring and Various Applications"

June 20 2011, Worcester, Presenter: Brian Russell

BioHarness™ - BlueTooth BAN

- **Biometric Monitors**
  - ECG, Heart rate,
  - Breathing Rate,
  - Skin temperature,
  - Activity
  - Posture

- **Built in BioSense® analysis algorithms**
- **Logging for 20 days**

- **Local wireless (Bluetooth)**
- **Wired (optical) - defense**

Blood Oxygen

Blood Pressur

Shirt

BioModule

Prototype

BioHarness

Mobile feedback

Radio interface device
to voice radio

Bluetooth®

BAN to Internet

Connects to other Apps – e.g. DISPATCH
Zephyr's API will allow channel partners to

Zephyr Vault
The web portal securely stores all Published data from remote sensors. From here **mobile phones** and **personal computers** can access the information transmitted by the devices in real time

Personal Data
User transmitting personal bio-statistics through a Zephyr BioHarness

BioHarness

Blood Glucose
Blood Oxygen
Weigh Scale
Blood Pressure

Radio Device
Person uses radio/phone to connect to the cloud

Web Portal
Performance is viewed and analyzed in the cloud.

- BAN connects system to the cloud
- Data is valuable when viewed some where else

BAN Tactical Communications

Command and Control

C2 = Command and Control
TCCC = Tactical Combat Casualty Care

Group Medical Summary

Sat / Tactical Radio
or
Cellular

Satellite

Cellular

Tactical Radio

UWB / Bluetooth

Soldier

Squad
Commander

Medic

MEDEVAC

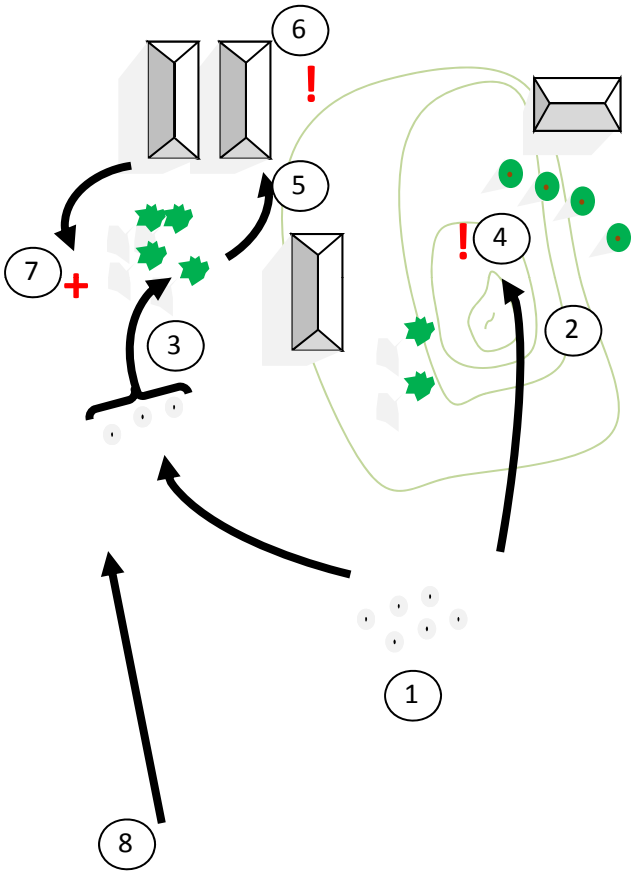
Local Commander

FOB
Field Hospital

HQ

100 ft *2 to 10 miles* *over the horizon*

BAN should support concept of operation



1. Squad quick ropes from helicopter
2. Sniper goes to high ground
3. Attack group assembles behind ground cover
4. Sniper is ambushed and injured. He uses his personnel PSM display to treat himself. Squad commander sees the injury on his device and changes tactics assuming no over site from fire control. Medic uses his PSM display determines Sniper is dealing with bleeding and is not in shock so stays with attack team.
5. Attack team splits and enters building.
6. Attack team has casualty, medic sees this on his display and attends casualty.
7. Medic takes casualty to CCP, casualty collection point.
8. COC, command and control at FOB, Forward Op Base, sees causalities on their display and immediately deploys QRF, Quick Reaction Force.
9. MEDEVAC sees vitals on their PSM display, gives advice and treats immediately.

PSM use examples in First Responder

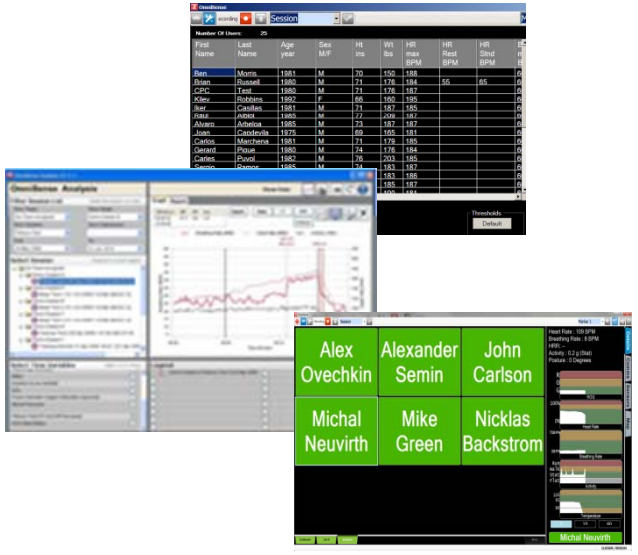
- **ON SCENE**
  - UPDSIDE DOWN = BAD always
  - STATIONARY = BAD for a Fire Fighter
  - HEART RATE RECOVERY= indicates fatigue, uses combination of HR and Acceleration.
- **REHAB**
  - Automate vital sign monitoring. HRrest, BRrest, BP, SpO2
  - Reduce EMS workload, trending offers more insight than occasional data.
- **FITNESS**
  - Increased fitness = less risk of heart attack and increased situational awareness. Europe has a VO2max > 45 ml/min/kg
- **TRAINING**
  - Remote vital signs to monitor performance for job related training.
  - Normal levels indicates safety and continuation is acceptable.

Usage Philosophy

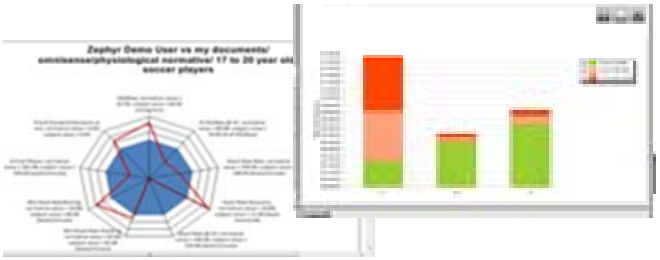
Enter personnel into database

Baseline physiology

Monitor live



Reports
(change conops based on historical data)



Value Analysis of new technology

Incremental Function Value

Reference Function Value

- Incremental value = sum of increased function or decreased hassle associated with innovation type.
- Reference value = what customers use as the next best alternative

- A product in general should excel in at least 6 areas of innovation to have good chance of success.

New Technology – value analysis

PERSONAL

1 **FASHION COMFORT**
Only unnoticeable tech
Will be adopted.
No one wants to look silly.

2 **ENTANGLEMENT RISK**
Tech should not encumber or snag.

3 **DONNING DOFFING**
Ease of use is imperative

PERFORMANCE

4 **RADIO RANGE**
Under all realistic obstacles and interferes

5 **BATTERY LIFE**
Operational ease of use.
Multi mission capability.
Minimum spares.
Easily purchased in the field.
Battery life time vs cycles.

6 **SIZE WEIGHT**
Always a minimum.
Extra weight removes
Other equipment or
Increases fatigue.

WORK FLOW

7 **DEPLOYMENT**
At base, going to on scene, during the mission, maintenance

8 **TRAINING LOAD**
Easy to use and remember how to use.
Applies to wearer and the support /command team.
Uses standard measures

9 **EQUIPMENT INTEGRATION**
Radio, computers, displays, computers, uniform

ORGANISATION

10 **SITUATIONAL AWARENESS**
Allows prediction future mission success. Increased safety. Personal and to commanders

11 **COST SAVINGS**
Can be from increased mission efficiency, decreased injuries or less overall equipment

12 **STANDARDS**
Susceptibility to jamming,
Detectability by others,
Environmental loads

NFPA, FCC, Intrinsic safety, CE,
FDA, HIPAA …

Value Analysis Examples

COLD: Custom short range ISM radio

good for situational awareness, interference issues, not enough range for operational use, not a standard interface to other systems.

WARM: Bluetooth connected shirts to APCO Radios

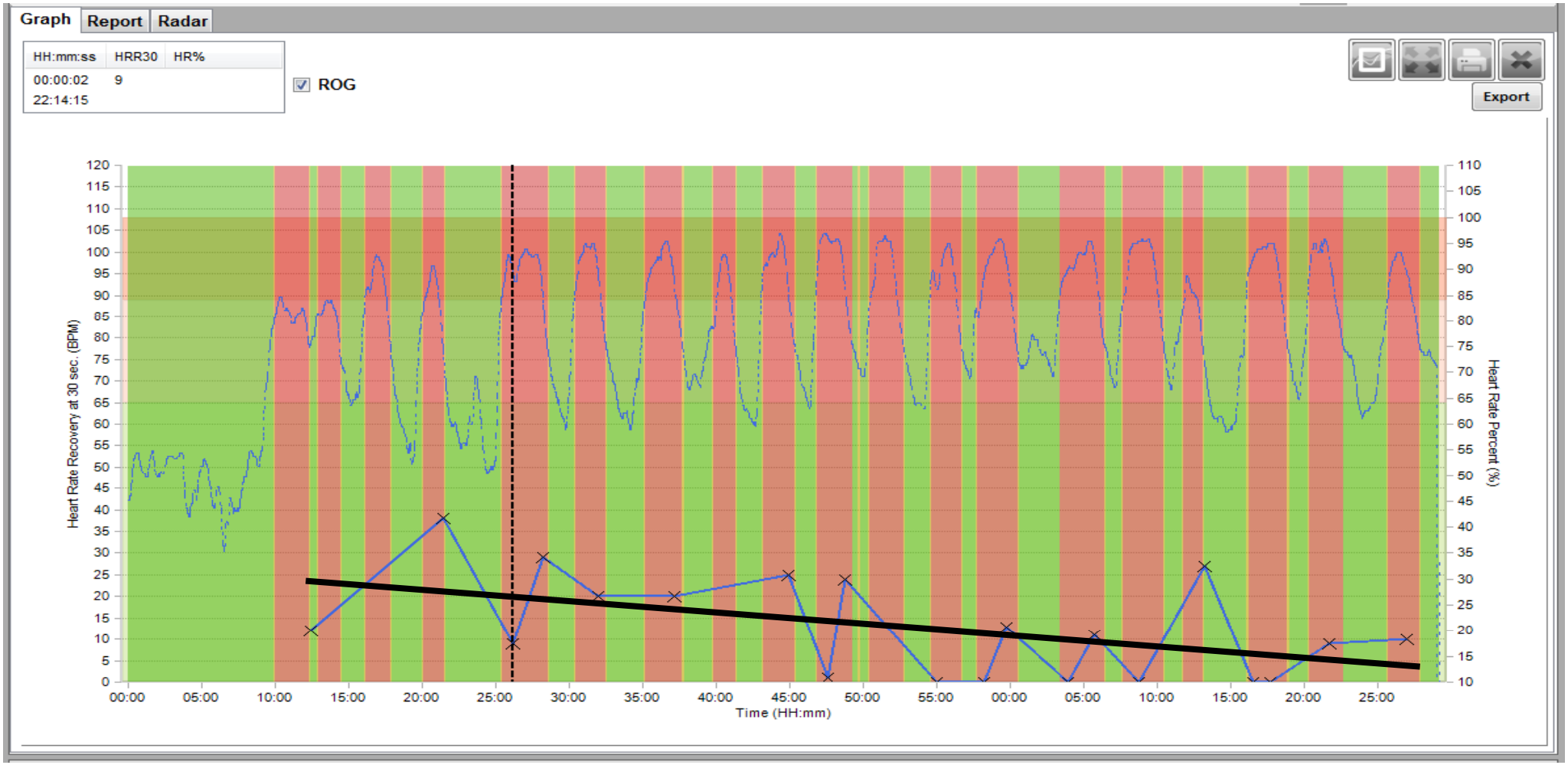
good for situational awareness, integrated into uniform, Bluetooth good for displays, requires Motorola radios

HOT: Cellular connected shirts

Secure cellular in uniform. Zero deployment hassle and always connected to internet. Still needs BAN for displays

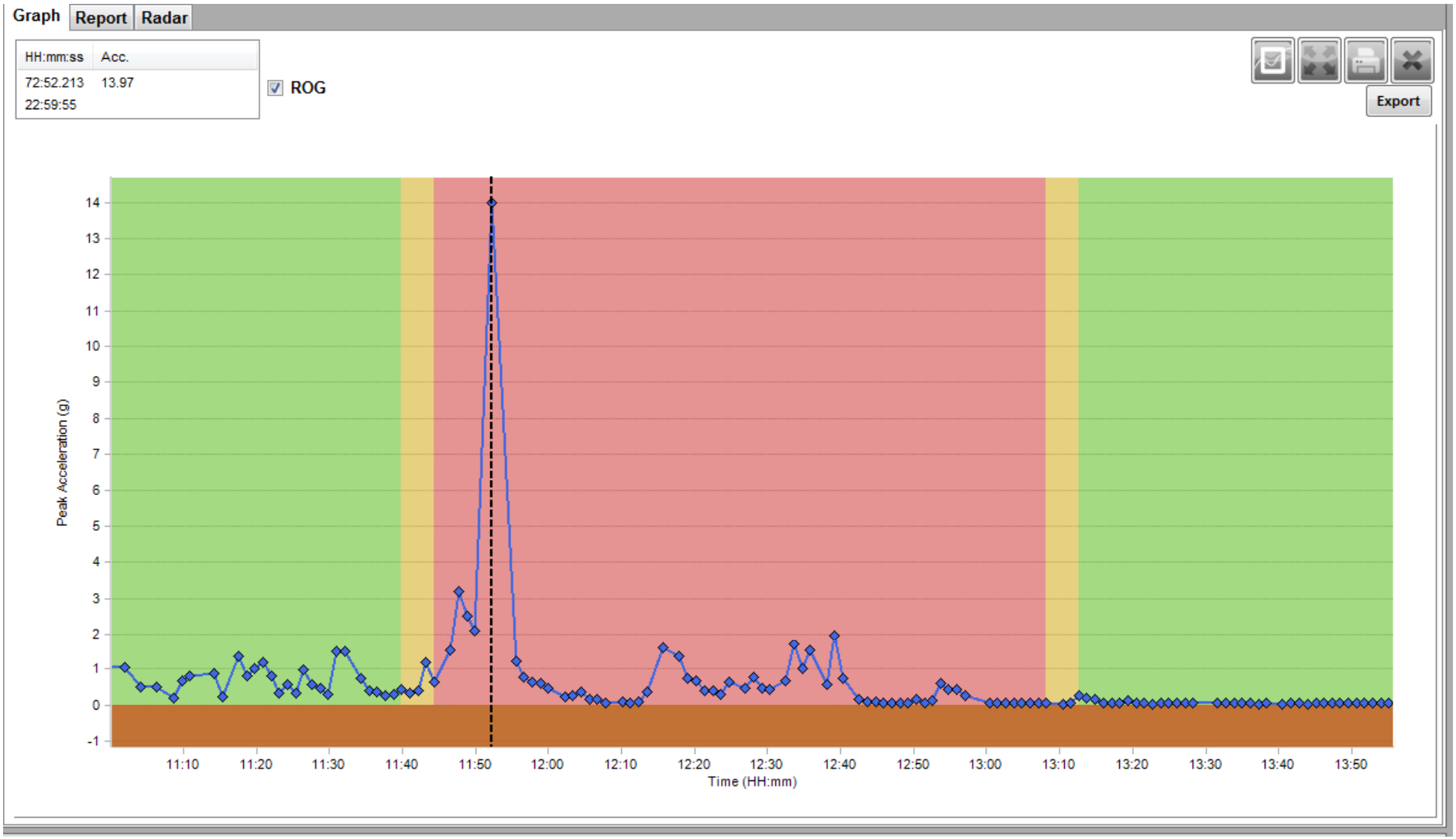
Thank you

Tracking and Managing Player Fatigue



This plot shows Heart Rate Percentage and Heart Rate Recovery trends over time through an entire hockey game. The downward trend in Heart Rate Recovery correlates to the fatigue of the player resulting in a decrease in sharpness and performance as well as a decrease in aggressiveness of play. HRR can be tracked in live mode based on our algorithms which automatically detect and display the data in the player's bioguage. Knowing what level is too low for a player is key to knowing how ready they are to perform at their optimal level of performance.

Tracking/Detecting Impact on Players



Continuous measurement of impact, track how much abuse players are enduring game to game. This image shows a 14g impact when one player was slammed into the boards.