Outline

Introduction

The Need for Objective Tracking

Wearables Applied to Athlete Performance

Barriers and Considerations for Integration of Wearable Tech

Creating an Infrastructure for Gaining Insights

Data and Visual Analytics
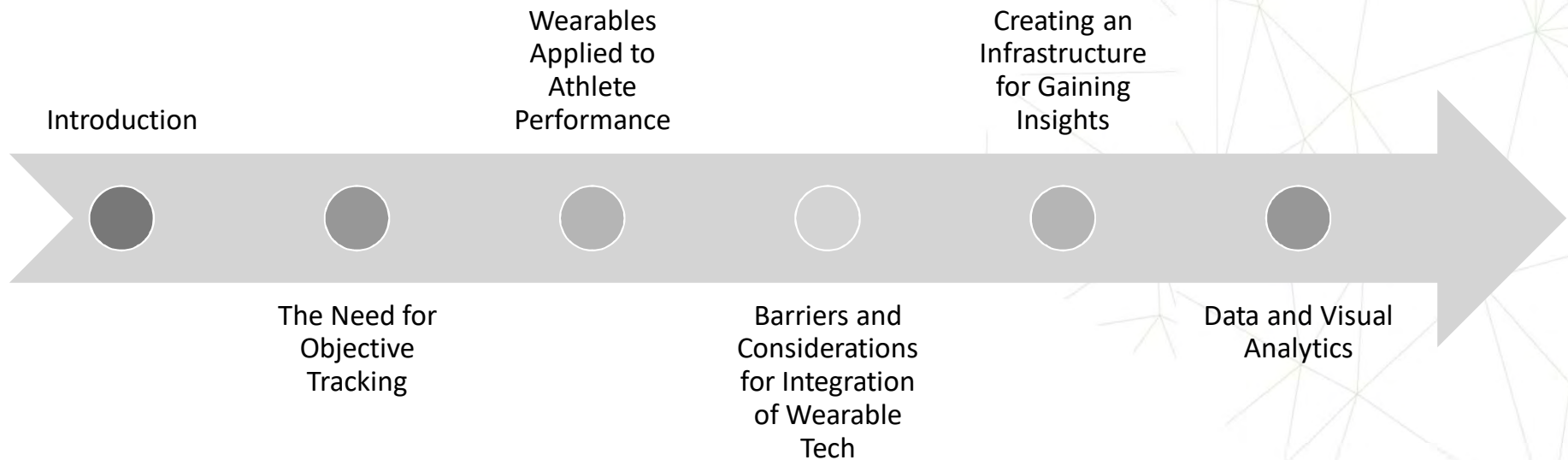
The mission of the Korey Stringer Institute is to provide research, education, advocacy and consultation to maximize performance, optimize safety and prevent sudden death for the athlete, warfighter and laborer.

Wearable Companies Studied and Organizations Assisted with Wearables

- WHOOP
- Quest
- NIX
- HALO
- BSX
- GE
- Air Force

- Army
- Polar
- Timex
- DHAMA
- MISSION
- Portugal Soccer
- NY Giants

Maximize Performance

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Mitigate Risk

Need for Objective Tracking

- Optimize readiness prior to competition... managing load... minimizing fat... individualizing... protocols
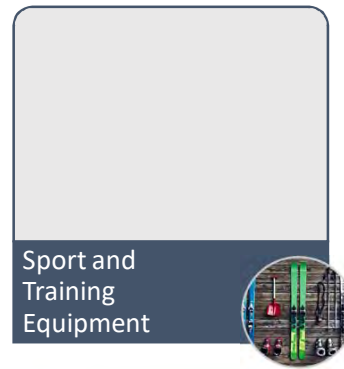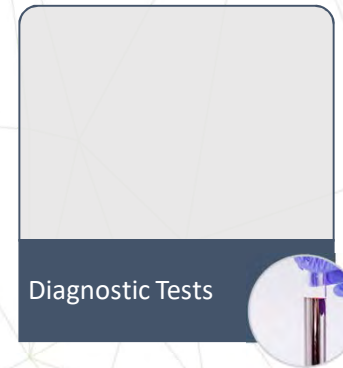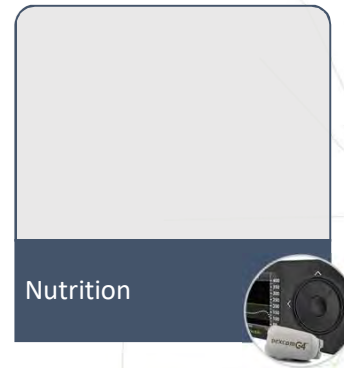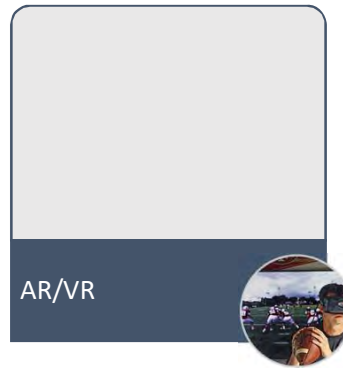
- Scientific and objective ...h to periodizing ...g programs and ... peaking at the ...ght time

Readiness

Peaking

Return to Play

Injury/Illness Risk

- Ensure loads are appropriately pos... injury/illness to s... and exceed pre-in... capacity

...Monitor load-injury ...ationships to better ...tand and minimize ...o and individual risk factors

Sport → Position → Athlete

Sport Technology Classification

Wearables

Computer Vision

AR/VR

Nutrition

Diagnostic Tests

Sport and Training Equipment

Software Applications

SPORTS INNOVATION LAB

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THE HOLY GRAIL

What if we had an objective, real-time, non-invasive, cost-effective field measure of....?
Hydration – Workload – Body Temperature – Sleep...

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Wearables Applied to Athlete Performance and Sport

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Movement and Physiological Tracking

Response and Adaptation

External/Internal Load Quantification

Recovery/Fatigue Status

Wearable Types

- Smart Watch (clock interface + Bluetooth)
  - Sony, Samsung, Asus, Motorola, LG, Apple
- Smart Band or "Activity Tracker"
  - Fitbit, Jawbone, Misfit
- Sport Watch
  - TomTom, Garmin, Polar and Suunto
- Player Tracking Wearable
  - Catapult, Polar, STATSport, GPSport, VXSport
- Biosensor Wearable
  - Hydration
    - BSX, Halo, NIX
  - Muscle Oxygen and Lactate
    - Humon, BSX, Moxy
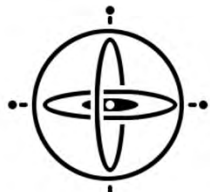- Sleep Tracker
  - WHOOP, Fatigue Science, Fitbit

Movement Sensors   vs.   Biometric Sensors

GPS   Accelerometer   Gyroscope   Digital Compass

Magneto meter   Altimeter   RFID Radio Frequency

GSR   Temp   PPG/NIRS   Respiration
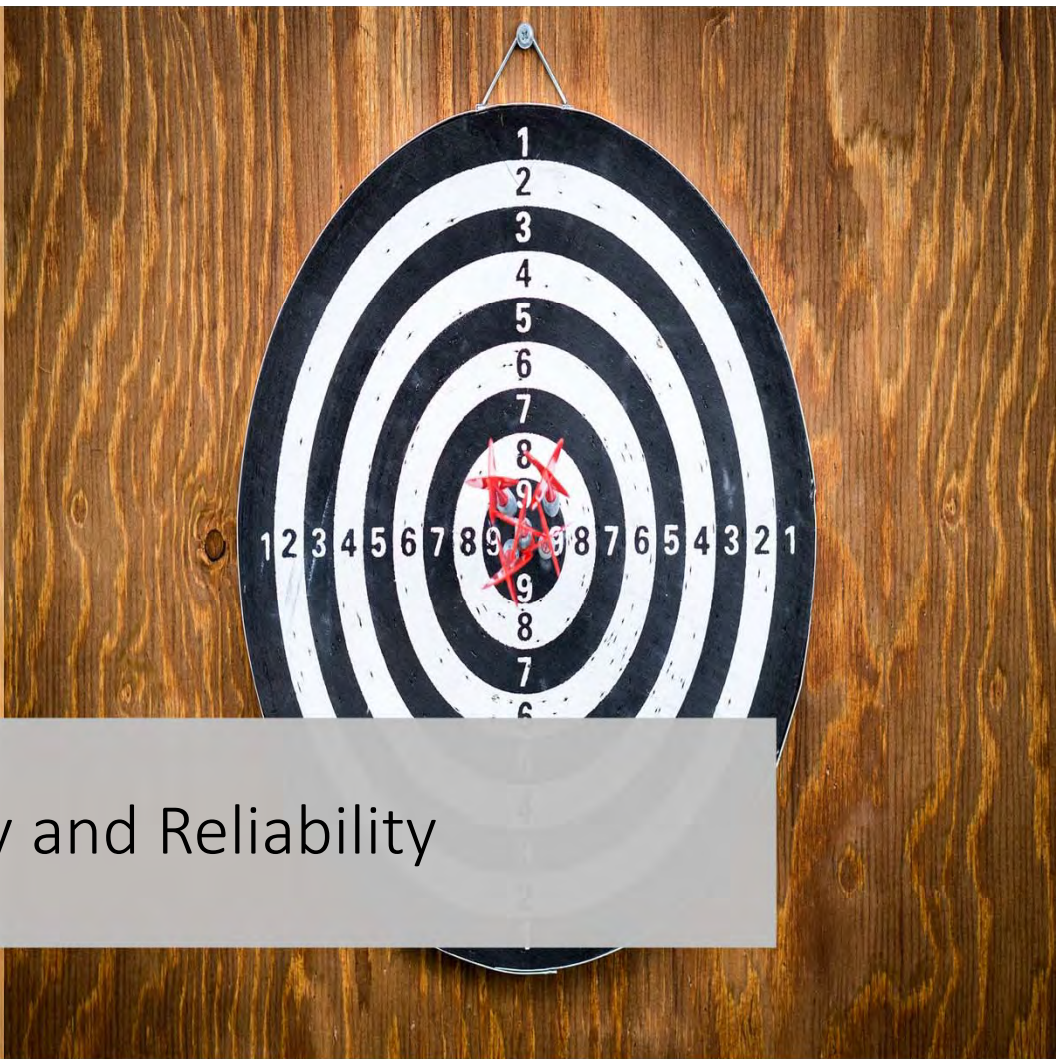
ECG   EEG   EMG

Barriers

Dynamic System

Complex Algorithms

Accuracy and Reliability

Data Leaks

Independent Research Cost

Needed to validate wearable technologies but…..
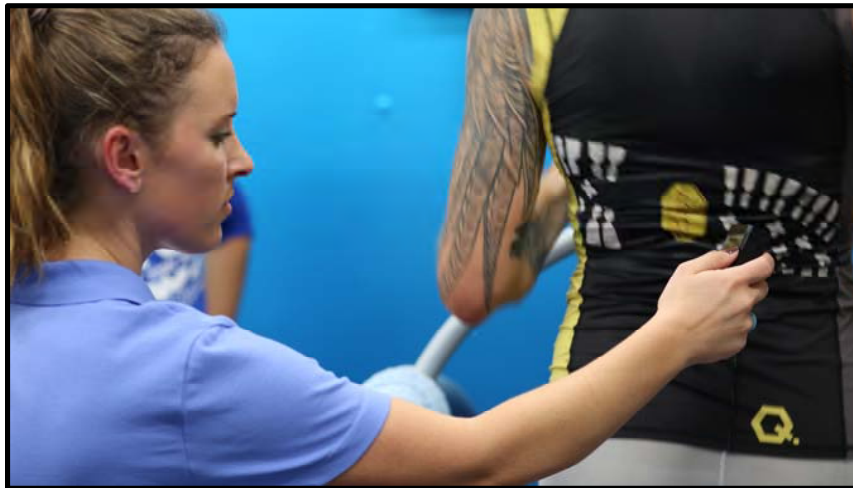
Can be costly

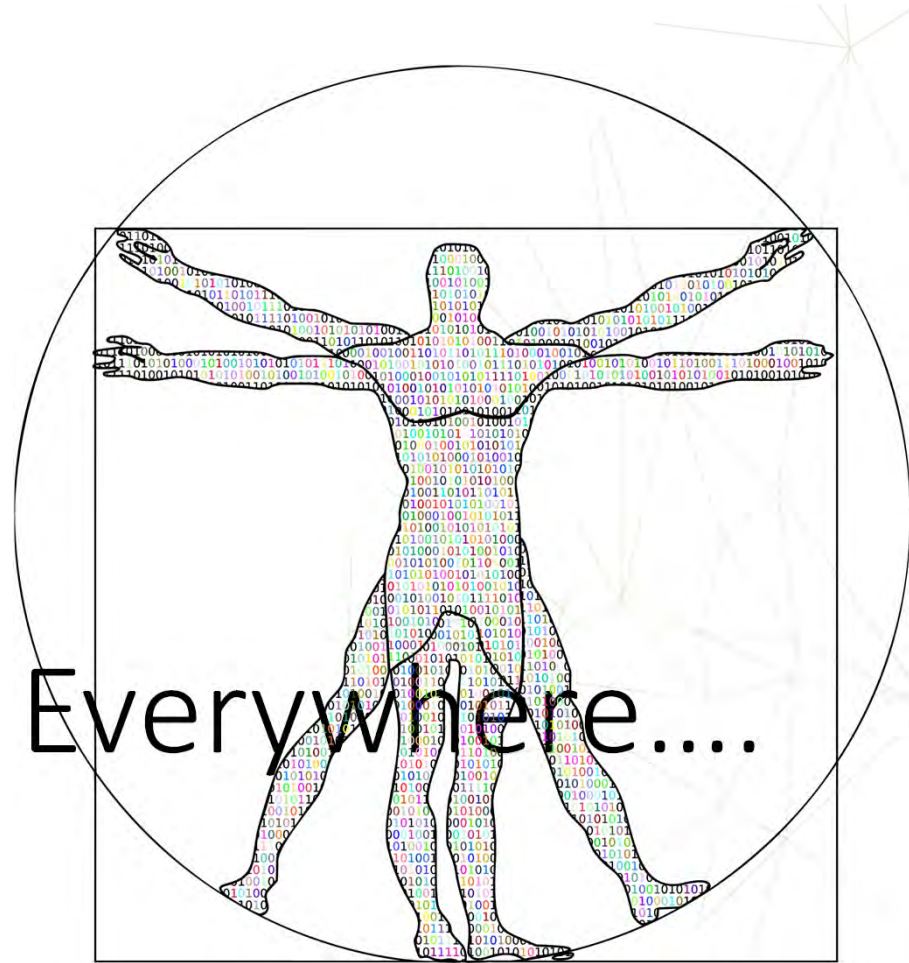How do you critically analyze the wearables in the market place?
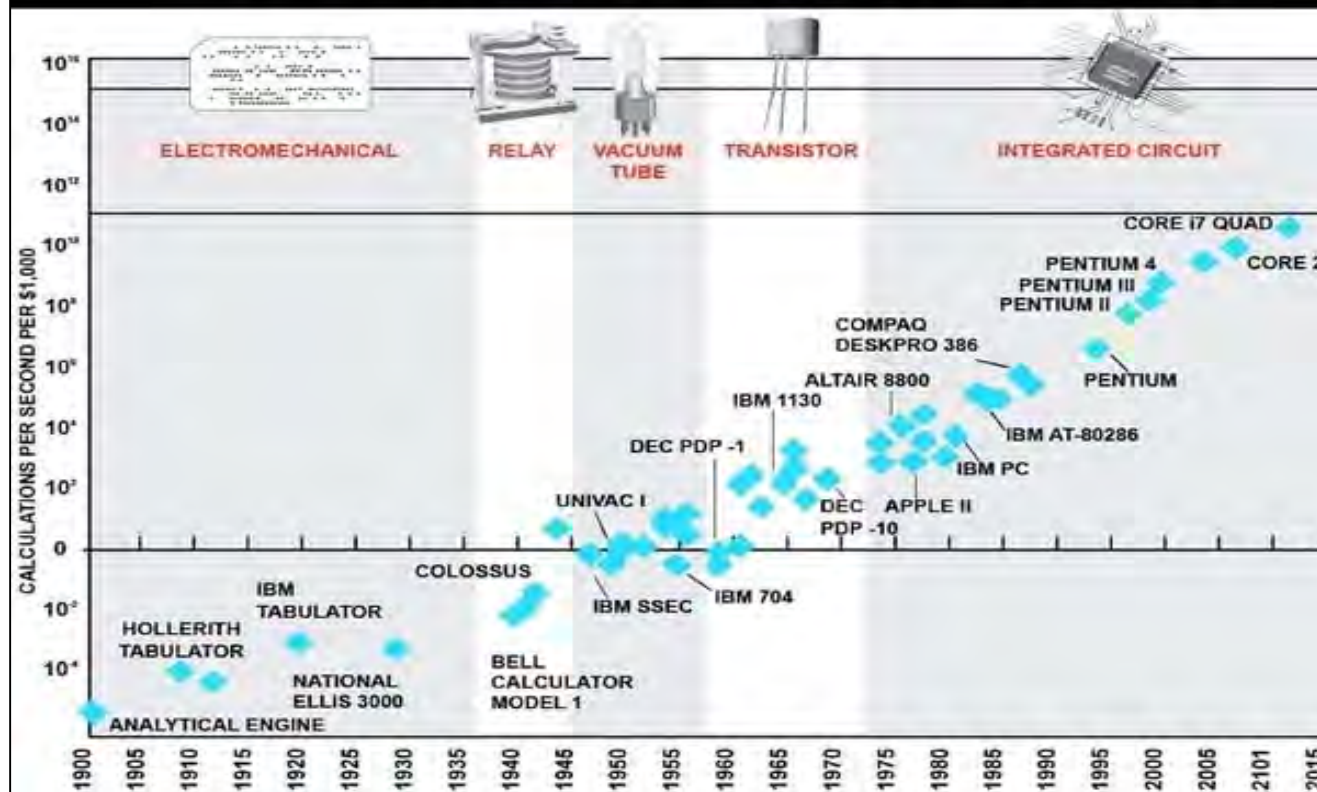
Over 1600 Sports Tech Companies

Considerations
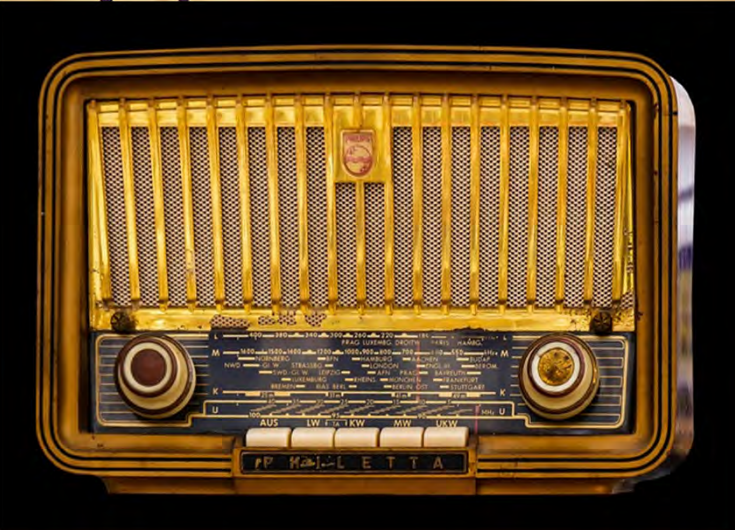
Information is Everywhere….

But is not yet data

Moore's Law
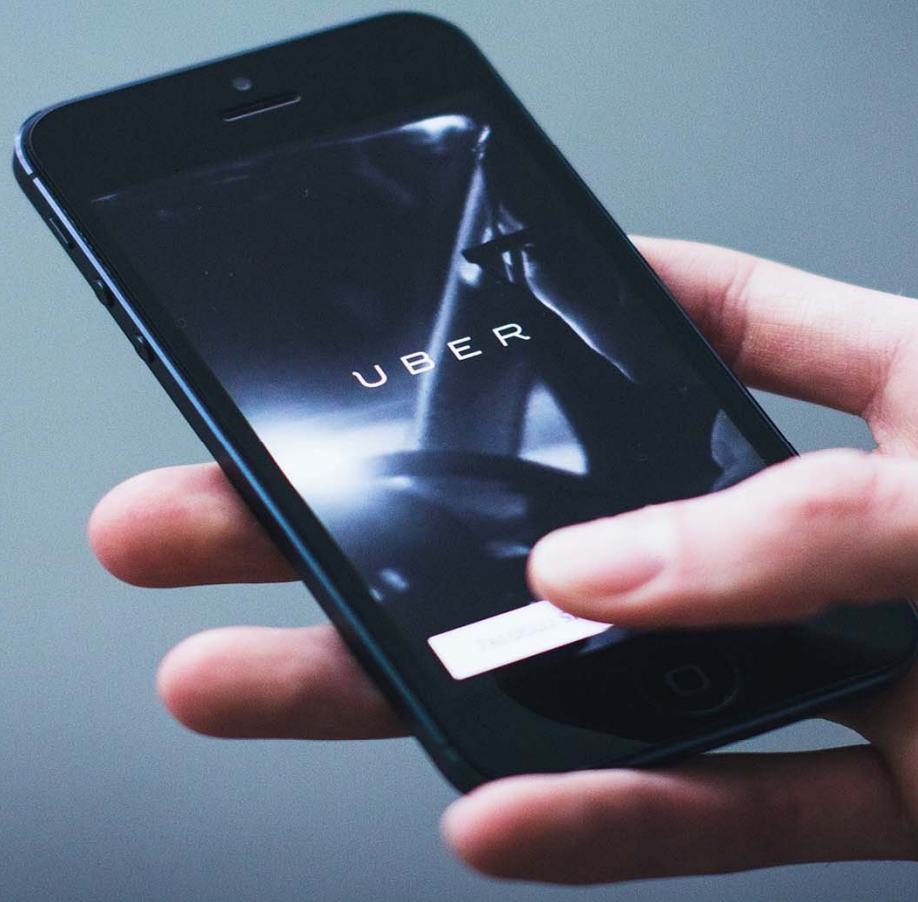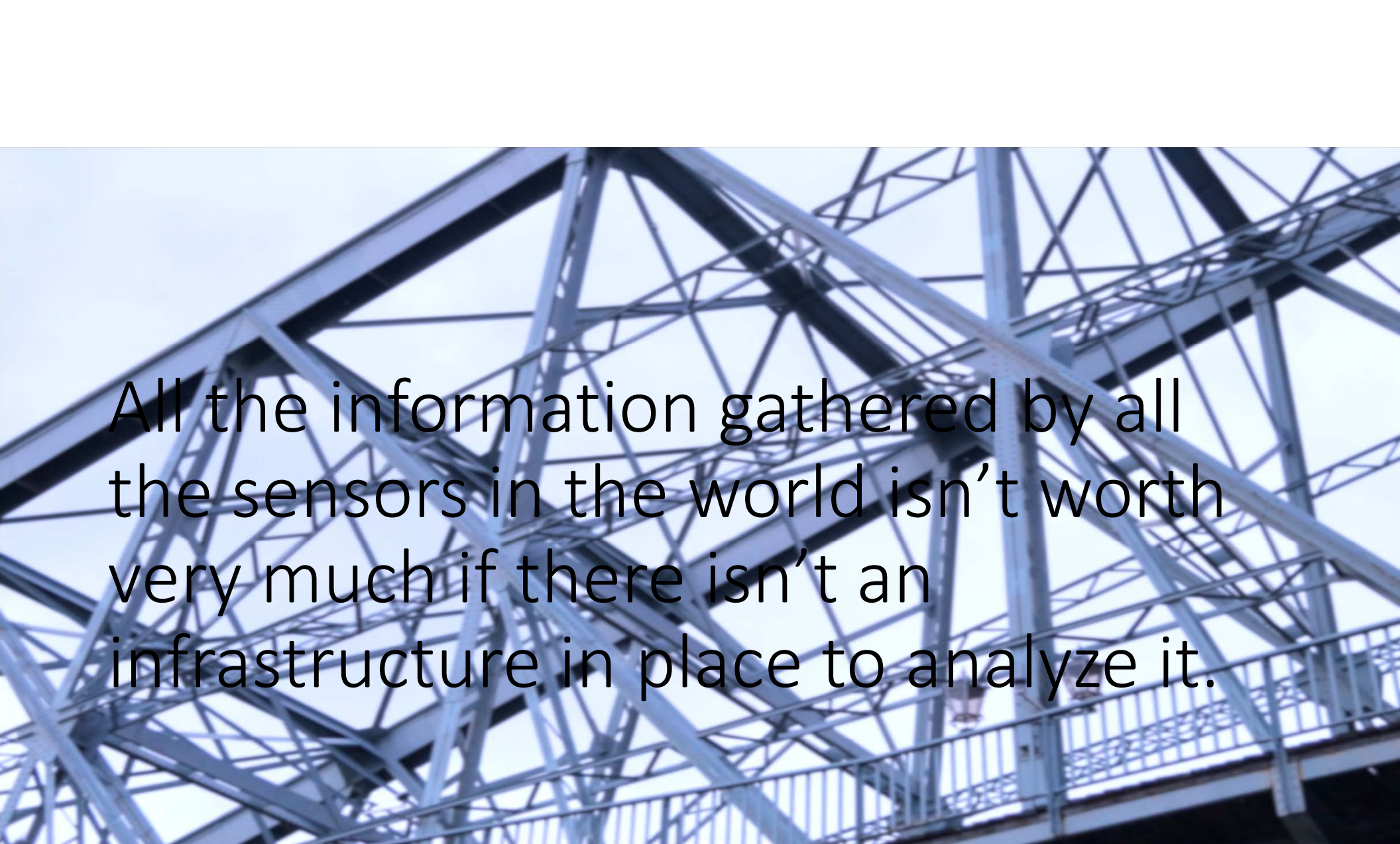
Wearable Form Factor

Connectivity

All the information gathered by all the sensors in the world isn't worth very much if there isn't an infrastructure in place to analyze it.

Athlete Management Systems (AMS) or Athlete Performance Platforms (APP)

Data Analytics

The Analytics Process
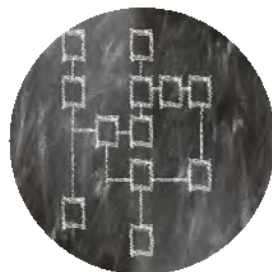
| Question | Capture | Manage | Analyze | Decide |

Domain Knowledge

The only true limitation is our
ability to ask relevant questions

Coaches Want to Know

Are they fit?

Are they ready to perform?

Are they improving?

Choose Metrics

Workload	Sleep	Hydration	Anthropometrics	Recovery Status	Wellness Surveys	Fitness Status
• Distance • PlayerLoad • Avg. Speed • Session Load	• Sleep Quantity • Sleep Sleep Quality • Wake Time, Light Sleep, SWS, REM	• USG • BML • Urine Color	• Height • Body Mass • Body Composition	• ANS (RHR, HRV, HRR) • Blood Biomarker • Neuromuscular performance	• POMS • SAS2 • Stress, Fatigue, Soreness	• VO2max • Lactate Threshold/OBLA • Strength • Speed

Sleep.WHOOP.2016

Instat.Individual.2016

Demographics.2016

GPS.2016

BodyComp.2016

BodyMass.2016

Schedule

USG.2016

BodyComp.2016

ID	Date	Tricep_mm	Subscapular_mm	Suprailiac_mm	Bicep_mm	SumSites_mm	LeanBM	FatBM	BF_Percent
UConn20	8/2/16	9	8	6	5	28	157.3	21.3	11.91%
UConn28	8/2/16	5	9	6	3.5	23.5	148.8	16.2	9.85%
UConn55	8/2/16	10	10.5	12	7	39.5	157	30	16.02%
UConn44	8/2/16	14	14.5	11.5	6	46	154.6	33.6	17.86%
UConn52	8/3/16	4.5	8	11.5	9	33.00			13.86%
UConn34	8/2/16	6	8	5	3	22	168.7	16.8	9.07%
UConn27	8/2/16	12.5	8	7	3	30.5	144.5	21.5	12.92%
UConn35	8/2/16	5	12	6	3.5	26.5	137	17.4	11.26%
UConn38	8/2/16	3.5	8	4.5	2.5	18.5	156.9	11.9	7.06%
UConn40	8/2/16	7	11.5	6	3.5	28	126	17	11.91%
UConn46	8/2/16	8.5	10	6	3.5	28	172.9	23.4	11.91%
UConn43	8/2/16	6.5	10	10	4	30.5	155	23	12.92%
UConn45	8/2/16	4	11	6	3	24	165.1	18.5	10.09%
UConn54	8/2/16	8	8	6.5	3.5	26	146.9	18.2	11.03%

Data Infrastructure

Data Cleaning
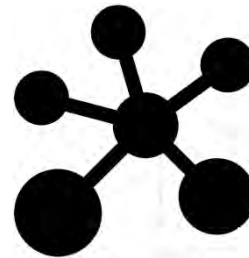
Data Relations

Database

Data Repository

Data Processing

Data Exploration

Visualization

Clustering
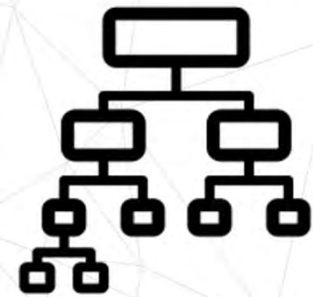
Classification

" The shortest distance between truth and a human being is a story. "

– Anthony de Mello

What is data visualization?

- A way to find **patterns**

- A method used to **tell a story**

- A way to perceive and **make sense of vast quantities of data**

- A technique to facilitate **decision-making**

- A way to not only answer questions **but to reveal them as well**

History and impact of visualization

Florence Nightingale's Chart of Mortality
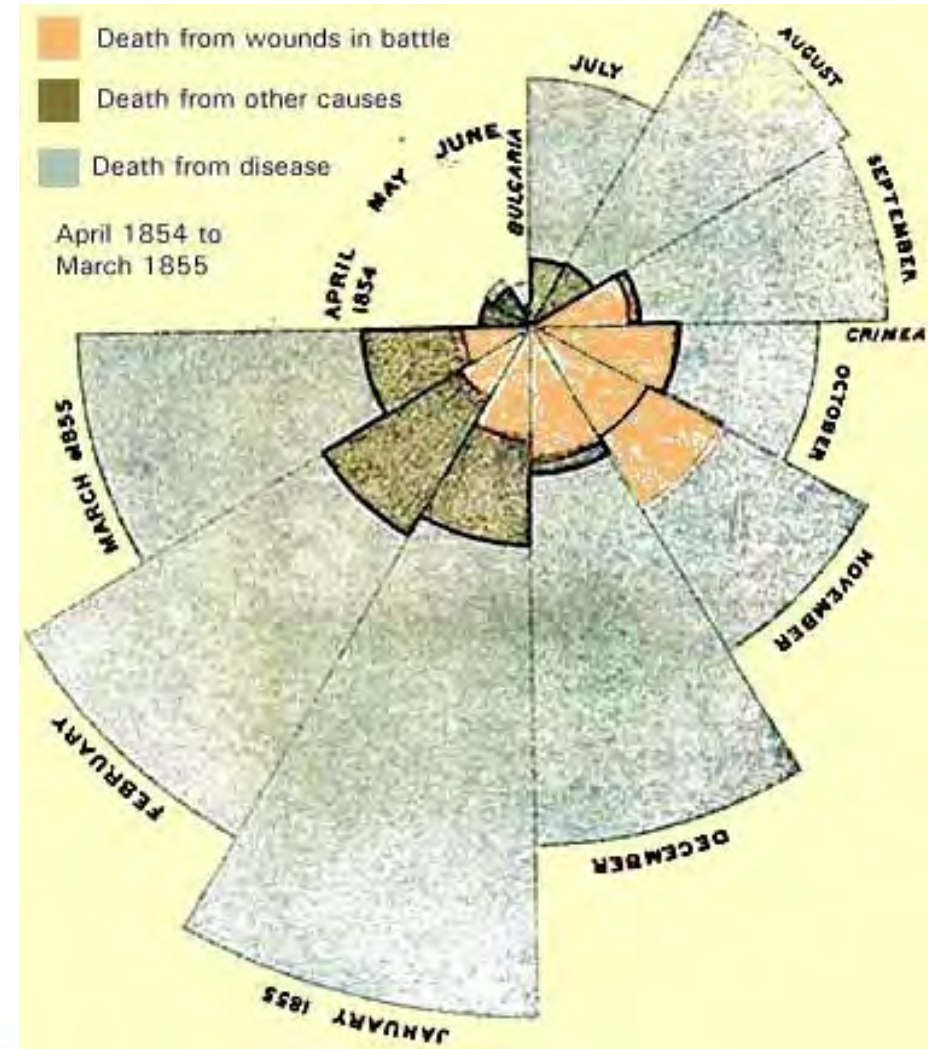
Collaboration

The purpose of sports technology and data analytics is to guide strategies and *interventions* to optimize performance

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XC Sleep Distribution by Athlete

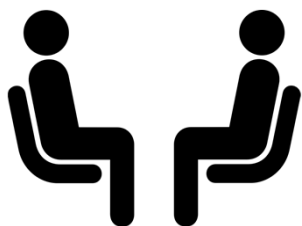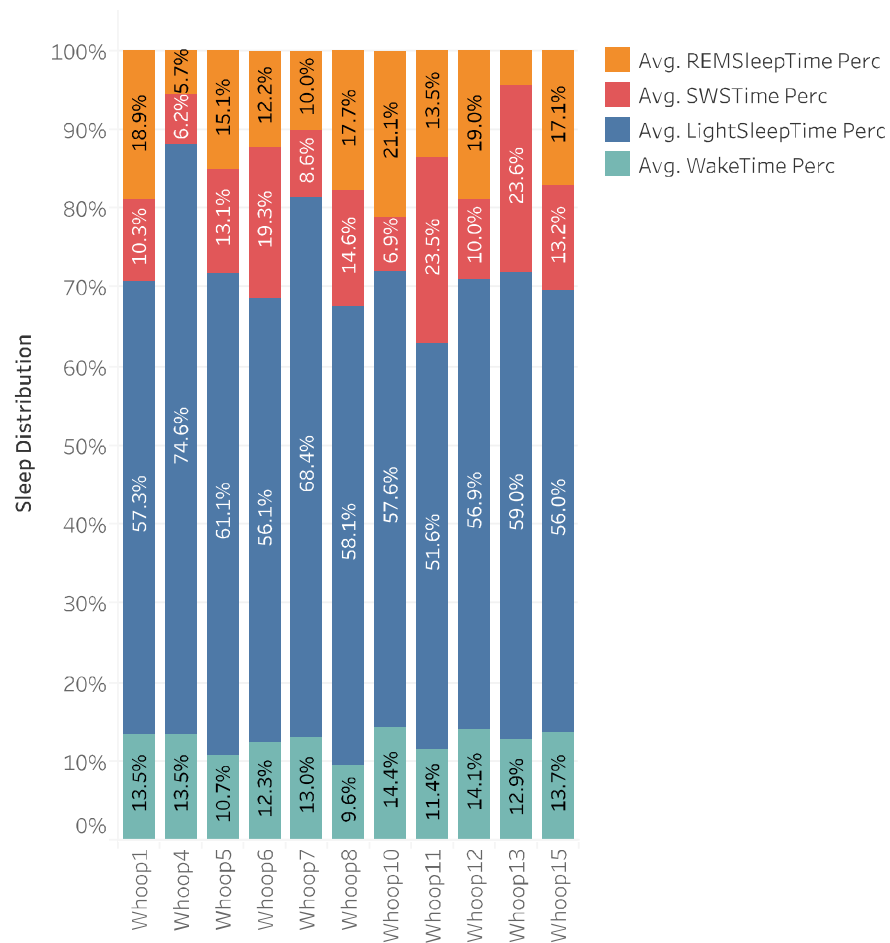Soccer Sleep Distribution by Athlete
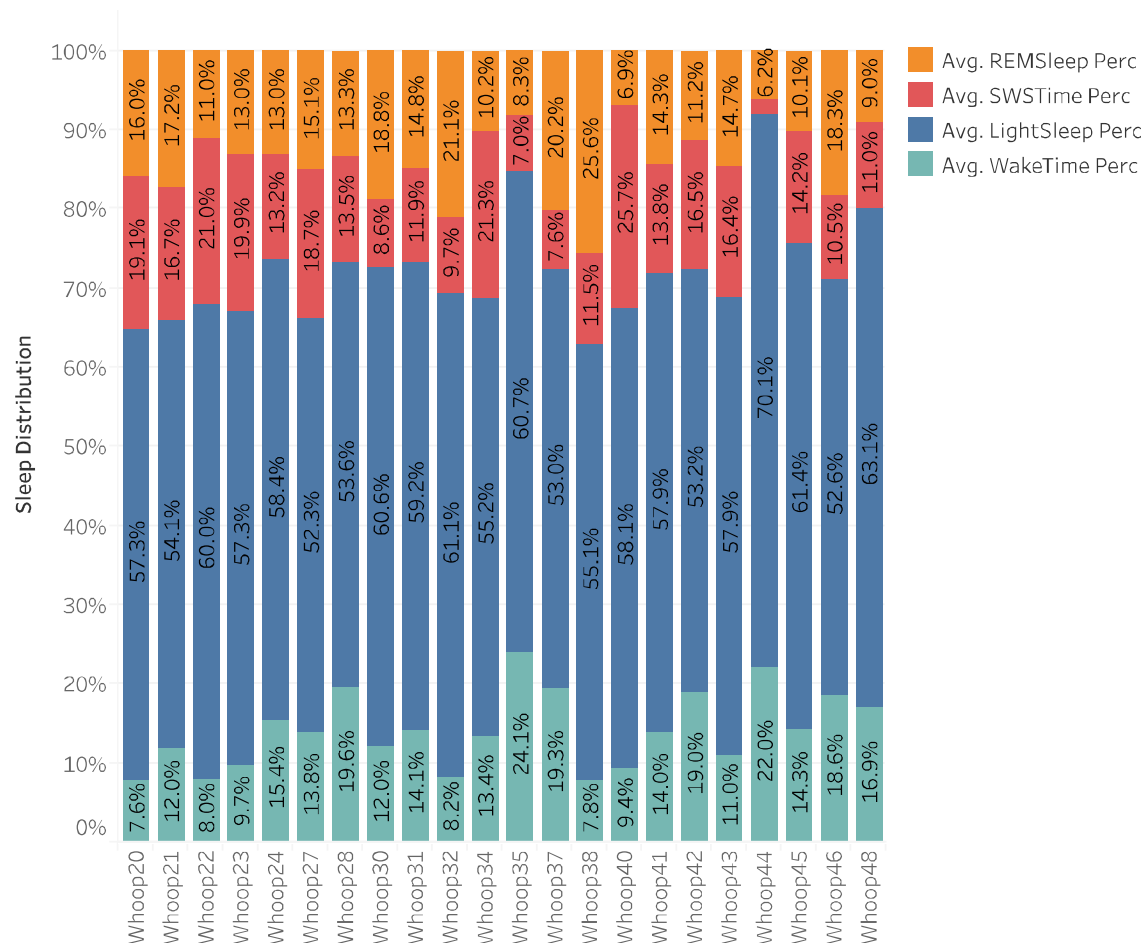
Soccer Sleep Distribution by HRV Group

Legend:
- Avg. REM Percent
- Avg. SWSPercent
- Avg. Light Sleep Percent
- Avg. WakeTimePercent

High HRV:
- REM: 14.81%
- SWS: 17.07% *
- Light Sleep: 57.48%
- Wake Time: 10.65%

Low HRV:
- REM: 13.38%
- SWS: 10.66%
- Light Sleep: 58.21%
- Wake Time: 17.75% *

*indicates significant difference between HRV grouping
---significant differences between Wake Time% and SWS Time%

HRV %Change by Sleep Group

- < 6 Hours: -1.6%
- 6-8 Hours: 0.8%
- > 8 Hours: 3.4%

PERFORMANCE NUTRITION

Food = Fuel

FUEL = minimally processed, high-fiber carbohydrates that provide sustainable energy

BUILD = lean proteins that provide the body the building blocks for repair and recovery

PROTECT = healthy fats that decrease inflammation and nourish the brain

PREVENT = colorful fruits and vegetables that proved the fiber, vitamins, minerals, and antioxidants needed for repair and immune function

HYDRATE = 1/2-1 ounce of water per pound of body weight per day

PERFORM

HYDRATE

Pre-training (1-2 hours before): drink 17-20 ounces
Immediately Before Training: drink 7-10 ounces
During Training (every 10-15 min): drink 7-10 ounces
Post-training: drink 20 ounces for every pound (2.2kg) lost

Body weight lbs (kg)	Ounces per day	Liters per day
120 (55)	60-120	2-4
150 (68)	75-150	2.5-5
175 (80)	90-175	3-6
200 (91)	100-200	3.5-7
225 (102)	115-200	4-8
250 (114)	125-200	4.5-9

PERFORM

SLEEP RITUAL

1) Block light from bedroom
2) Lower thermostat
3) Electronics powered down or silent
4) Calming activity 30min before bed
   -herbal tea, stretch, meditate, read
5) Focus on positives
   -review 3 positives from your day
6) Clear thoughts
7) Focus on breath
   -inhale 6sec, hold 4sec, exhale 10sec
   -repeat 10x

RECOVER

FUELING STRATEGY

1. Mindset
Did you have a proactive approach to fueling today?

2. Eat Clean
Did you choose minimally processed, nutrient dense food?

3. Eat Often
Did you eat breakfast within 30 min of waking and eat every 3 hours?

4. Hydrate
Did you drink half your body weight in water and lose less than 2% of body weight during your activity?

5. Recover
Did you properly fuel before, during, and after your activity?

PERFORM

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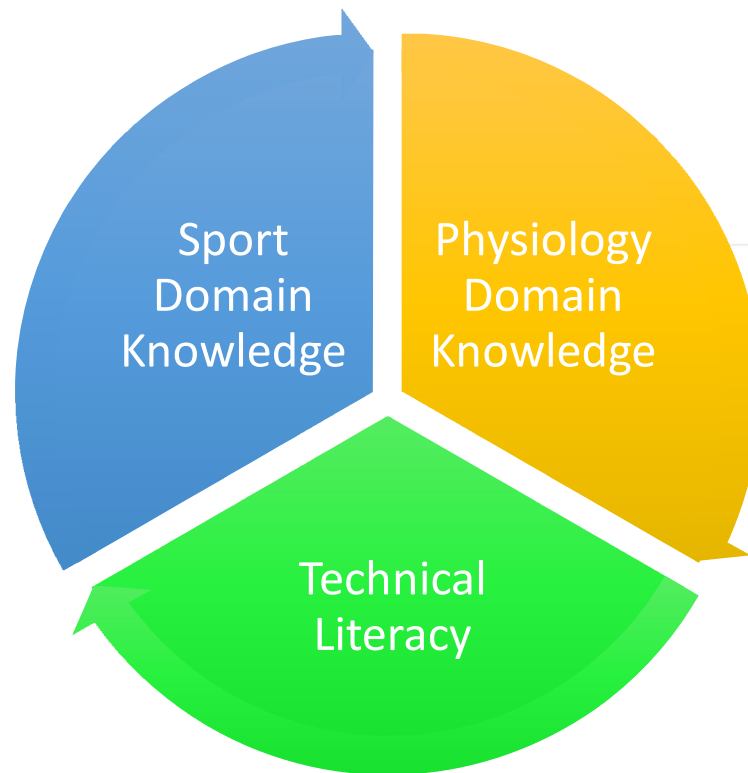# The Need for Data Science in Sport Science

Technical Literacy

Data Infrastructure

Connectivity

5 Questions to Ask Wearable Tech Vendors

Has the accuracy/reliability of the devices been assessed by a 3rd party?

What will the company look like in 5-10 years (avoid the washouts)?

Are you capturing data or providing insights?

How robust is your customer support?

How is the data collected being stored/protected and who has access to the data?

More Questions than Answers

- What are the right metrics to measure?

- What devices are producing quality data?

- Who's going to vet emerging technology?

- What devices will be approved?

- Who owns the data?

- Should data be monetized?

- Who's going to protect the data?

The only constant in the technology industry is change.

- Marc Benioff

Contact Details

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