TECH TALK: Empatica E4

The Empatica E4 is a medical grade wearable device that is worn on the wrist and is capable of measuring body temperature, skin conductance, activity (acceleration), heart rate and inter-beat interval. The table below is a technology selection decision support tool and not a substitute for business procurement processes. Information is correct at time of publication

What's in the box	Technical specifications		Set up investment and required skills

What's in the box

Image source: Empatica E4

Hardware

Manufacturer:	Empatica
Model and release date:	E4
Price (est):	AU$2,500 (ex GST and shipping)
Weight:	25g
Size:	Case: 44 x 40 x 16 mm Wrist: 110 – 190 mm > 24 hr streaming > 32 hr recording
Battery:	
Memory:	< 60 hours
Measure and sample rate:	Temperature (0.25 Hz) Skin Conductance (0.25 Hz) Acceleration (32 Hz) Heart Rate (HR) (1 Hz) Photoplethysmography (64 Hz)

Technical specifications

Connectivity

Connection:	Bluetooth Low Energy (BTLE) USB 2.0 (custom adaptor)
Power:	Battery (< 2 hr charge time)
Access:	Data accessed using an Empatica Connect account

Recommended PC Specification

OS:	Windows 7, 8, 10
Device:	PC or tablet must conform to Microsoft .NET4 system requirements
USB:	Type A port

Tracking and Applications

Skin temperature:	At wrist. Temperature changes due to ambient temperature, exertion, and stress
Skin conductance:	Changes with perspiration. Perspiration events (not heat related) occur with changes in arousal and stress
Acceleration:	Movement in xyz axes indicates wrist motion
Photoplethysmography:	This is used to determine HR and inter-beat interval (Heart Rate Variability; HRV). HR increases with exertion. HRV can be used to determine physical and psychological stress

Set up investment and required skills

Key Compatible Software

- *E4 manager*, for syncing data acquired via offline recording
- *E4 real-time* for capturing streaming data (iOS and Android app)
- Access to *Empatica Connect,* visualising and downloading raw data

Key Knowledge (depending on application)

- Using the device is easy, interpreting the results and getting useful measures requires a biomedical/physiological background
- Software such as Kubios is useful for Heart Rate Variability but this is the E4's least reliable metric. Skin conductance data requires programming experience

Practical Task Setup
(as experienced by engineers)

- Very easy to use "out of the box". There are quick start guides for the device, the app and the online download portal
- Offline recording is easy, press a single button and wait 40 seconds for start
- Online recording gives a live readout of data stream which syncs automatically
- Some measures are limited if engaging in more than light activity
- Getting the data is easy, processing the data requires tools that don't exist commercially. This is a major barrier

PEOPLE PERSPECTIVE: Empatica E4

Task/Environment Suitability	Usability Features	Task/Environment Considerations	Usability Considerations	Key Opportunities & Applications	Guidance for Implementation
Portable Worn on wrist like a watch. Has excellent battery life **Tasks** The HR monitoring features are sensitive to knocks and bumps Over long periods the device will capture usable data even with disturbances Incompatible with tasks where watches are prohibited **Outdoor use** Direct sunlight and exposure to water may impair performance/data quality	**Performance** Very quick and easy to set up (e.g. device self-calibrates each time) and begin data collection. There is only one button so the device is either on or off Visualising the data is quick and intuitive through the *Empatica Connect* online portal and the app. Raw data is downloaded quickly and easily A broad suite of different measures relating to exertion, physiological and psychological stress are obtained in a small and convenient package **Real time feedback to users** App delivers live readings but the data needs analysis and interpretation. Desktop and mobile application programming interface (API) can access real-time data **Customisation** Adjustable band provides comfortable fit for range of wrist sizes **Safety** Non-invasive, uses infrared and green light for heart metrics and silver electrodes for skin conductance. Can be used by those with pacemakers	**Accuracy/performance will be reduced by:** Bumps & knocks. You will acquire limited data if using the device while completing manual labour-intensive work, especially with the hands The E4 is slightly bulkier than a normal watch and may interfere with some tasks (e.g. limit dexterity when completing tasks in confined spaces) and presents a snag hazard Temperature sensor is placed against the wrist and is tolerant of changes in ambient temperature, but not direct sunlight If working with Infrared and green light, this may interfere with the sensors	**Performance** The quality of the data depends on the device having been properly secured to the wrist. Skin conductance is measured by electrodes on the wrist. Applying pressure to the electrodes artificially (e.g. if device is pressed against a wall or surface) increases the signal **Data Usability** Getting useable metrics from the data isn't straightforward and requires interpretation by someone biomedically trained **Safety** Skin conductance electrodes contain silver and shouldn't be used by those with silver allergies Prolonged use may cause discomfort	**Health and Safety** Long- and short-term physiological monitoring may help identify stress and changes that could be precursors of injury (i.e. someone showing fatigue symptoms could be allocated to lower risk tasks, or require more breaks) **Ergonomic Analysis** Can help better understand aspects of workforce performance and improve processes to identify risks and contributing factors **Future applications** This sort of device is a good entry point and can help build technological familiarity and confidence so that users are well-placed as the technology advances and applications mature	Initial set up of device, PC, account and app is quick and easy. Ensure the USB drivers are also downloaded Accessing the data is a smooth process; it is presented by date and device, which is convenient if using more than one In house capability to process the data (e.g. using programming software Python or MATLAB) is needed to effectively use metrics collected The device collects physiological (health) data thus It will be important to have data privacy policies in place prior to use with a clear understanding of when data will be collected, and for what purposes it will be used. Policies and procedures will also need to address duty of care responsibilities in terms of data potentially identifying health conditions. Secure data storage is essential

These suggestions are formulated from a human factors research trial involving the integrated use of augmented reality and collaborative robots during assembly of an electrical cabinet. Selection and implementation of a technology should consider the abilities of the person doing the task, the task requirements, and the environment in which the work is to be undertaken.