

TDL Case study number: 01/2011

Project Title: Smart knitted structures and garments

TDL Partner: Footfalls and Heartbeats Limited

Contact: Simon McMaster

Website: <http://www.footfallsandheartbeats.com>

Project Period: January 2011 – ongoing

**Partner Profile:** Simon McMaster and Karen Bender are partners in Footfalls and Heartbeats, a Wellington-based company that started in 2010 and is now on the cusp of producing consumer grade nano-technology garments to measure the wearer's heart rate, respiratory rate and other personal vital signs. A Kiwi, currently residing in Britain, Simon is a chemist by profession and is studying for a PhD at Leeds University. Simon's breakthrough textile research, which involves the development of fibre interaction at the nano scale intended for yarn production and product innovation, is applicable to sport, medicine and other applications where technology meets functionality.

**Project background:** Simon's ideas regarding this project were cultivated during his university studies and he subsequently developed the research to the point of implementation. Simon, and his business partner Karen, travelled from Melbourne to Auckland in 2010 to attend the 'Digital Strategies' symposium presented by the Textile and Design Lab (TDL) at AUT, and became aware of what the TDL could potentially do for them. Footfalls and Heartbeats is Wellington-based and they were keen to develop and produce their product in New Zealand. When they got to the stage of wanting to commercialise their research, they contacted the lab to help develop a series of prototypes in which changes in pressure or tension could be sensed using the structure of knitted fabrics. The yarn used for the sensory areas of the garment is electrically conductive and as the wearer breathes the knitted structure expands causing changes in the electrical resistance. These changes are detected and measured by a very small electronic device that is located in the back panel of the garment and transmits data to a mobile phone.

**Project Description:** Simon is developing functional prototypes with the TD and the final products are expected to consist of tight fitting knitted garments such as singlets, which will incorporate circuits made from conductive yarn with the ability to measure body functions such as heart rate and respiratory rate. The TDL's work has involved experimenting with various conductive materials in combination with a range of different yarn compositions and stitch structures processed on the lab's Shima Seiki knitting machine.

**Project Methodology:** Simon has been communicating directly with TDL technician, Gordon Fraser, from the project's inception in 2010. Simon has visited the lab on numerous occasions, but generally emails his project descriptions, design drawings, and knit structures through to Gordon. Simon provides the TDL with the special conductive yarns that are knitted into the garment panels. The time difference between the UK and New Zealand can affect communication and the distance can complicate the logistics of sending yarn, other materials and garments backwards and forwards. These difficulties have been largely overcome due to good communication and a streamlined process. As well as working with Gordon, Simon has also consulted with TDL researcher, Lyle

Reilly, about garment design, fit and technology integration.

In the pursuit of developing a washable, wearable, consistently performing electronic garment, a whole range of test samples have been produced. These include samples combining different yarn compositions knitted with conductive yarn, fabrics made with various pattern and stitch formations, and samples produced on different machines.

Whilst the intellectual property relating the nano-yarns and respiratory technology resides with Footfalls and Heartbeats, TDL staff have gained a good understanding of the principles involved and have been able to contribute to the measurement of yarn properties, fabric strength and the development and evaluation of different manufacturing techniques. Simon has provided criteria and concepts to Gordon who has developed new ways to incorporate them into the knitted fabric. The TDL makes sure the conductive yarn combines well with the other materials and determines whether they can be machine knitted into the fabric without breaking or causing inconsistencies. Other issues that have needed to be taken into account include the washing and treating of the fabrics and garments produced. The precision in the manufacturing processes and in the finished samples is of vital importance in order for the sensor technology to be able to interpret the slightest of movements within the fabric structure.

**Outcome:** The project is still a work in progress but is proceeding well with the development and production of sample garments, which are showing extremely promising test results.

**Feedback:** Positive feedback on the project includes quick turn around of sample pieces and garments. The fabric requirements have been able to be met and progress is being made on specific fabric properties as test results are reported.

**Insights:** Advanced fabric technology and design can realise new potential when combined with electronic technology. The area of smart textiles was recognised by the TDL as offering significant R&D potential, but early on staff lacked the experience to work effectively in this area. The project with Footfalls and Heartbeats has not only enabled the development of an innovative new product but has contributed to an understanding of ways electronics can be integrated into textile structures and how the behaviour of the resultant materials can be used to transmit information about the wearer's physical state. The project has also helped to increase the TDL's profile and capability to support New Zealand companies working with e-textile applications.

**Conclusion:** A final conclusion cannot be reached until the project has been completed. The project has presented both parties with an exciting opportunity to engage in the development of a new textile technology taken through to its practical state. One of the TDL's missions is to support capability development and value creation in the New Zealand textile and apparel sectors. The TDL's work with Footfalls and Heartbeats is assisting the development of a highly innovative new product and combining new nano-fibre research with textile design to produce prototypes with significant commercial potential.

**Documentation Used:**

Transcripts of interviews with Simon McMaster and Gordon Fraser



Functional Intelligent  
Textile Technology



The next dimension in  
athletic performance.

Use your heart rate  
and respiration rate to  
know when your body  
is recovered. Train your  
hardest when your body is  
at it's best.



#### Read

via Functional Intelligent textile Technology™

- The fabric gathers the information
- 3D data provides more relevant data
- Heart rate (including variability)
- Respiration rate

#### Transmit

- Transmission via Bluetooth protocols to your Smartphone or PC
- Alternative transmission solution via radio frequency protocols (conditions apply)
- Understand your body's recovery

#### Features

- Patent pending FITT™
- 3D Respiration Sensor
- Novel fabric connectors - no wires
- Comfort of natural fibres
- Washable

Footfalls &  
Heartbeats