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# Therapeutic Art Practice: How experimental art practice can radically inform the development of our therapeutic technologies

**Leah Heiss**

*Abstract: Through this paper I will investigate the expansion of innovation when art practice approaches inform the development of therapeutic technologies. Within the context of this paper experimental art practice refers both to ways of making work and thinking about work. "Ways of making" encompasses such artistic methods as the generation of iterative models; material-led experimentation; hands-on brainstorming; problem solving through making prototypes; and trans-disciplinary approaches to making work. "Ways of thinking" focuses on the use of theoretical framing to drive the making of artwork. This framework includes issues such as considerations of empathy, sensory plasticity and codification of the jewellery artefact. The paper reports on two case studies which employ experimental art practice approaches to the development of therapeutics: the Seed Sensor and Diabetes Jewellery. Both are trans-disciplinary projects in which experimental art practice ways of making and thinking have led to radical innovation.*

*Keywords: Experimental art practice, trans-disciplinary collaboration, nanotechnologies, innovation, empathy, therapeutic technologies, sensory plasticity, jewellery*

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# Therapeutic Art Practice: How experimental art practice can radically inform the development of our therapeutic technologies

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## Introduction

> Art is doing: it is not only knowing, not only thinking, not only using. It is doing: constructing consciousness by constructing things (Luciano Fabro, 1987, cited in Lesley Duxbury, 2008, p.17).

Through this paper I will investigate how using experimental art practice approaches can radically amplify innovation in the development of therapeutic technologies. Within the context of this paper experimental art practice refers both to ways of making and thinking about work. "Ways of making" encompasses such artistic methods as the generation of iterative models; material-led experimentation; hands-on brainstorming; problem solving through making prototypes; and trans-disciplinary[1] approaches to making work. "Ways of thinking" focuses on the use of theoretical framing to drive the making of artwork. With regard to the case studies discussed in this paper the framing structures are empathy, codification of the jewellery artefact, sensory plasticity and perceptual augmentation.

Within this paper I will discuss two projects in which I have consciously employed experimental art practice approaches to the development of therapeutics: the Seed Sensor and Diabetes Jewellery. Diabetes Jewellery is a jewellery device for applying nano-engineered transdermal patches to the skin for diabetics, replacing syringes. This project, developed through an artist residency with Nanotechnology Victoria, used art practice ways of thinking and making to generate non-invasive drug delivery technologies. The project was focused on augmenting artefacts with health functionalities; empathy between people and their life affirming technologies; and jewellery as a site for therapeutic investigation. Art practice ways of making included trans-disciplinary development, problem solving through making prototypes and the generation of iterative models.

The second case study is the Seed Sensor: a swallowable device that detects gas fluctuations in the body (methane, carbon dioxide etc) that may be a symptom of undiagnosed disease. This project illustrates how experimental ways of making and thinking can help to develop the therapeutic technology design (form, functionality, and interface) before a commitment to the "hard technology" is made. Experimental art practice lays the groundwork and parameters for developing the technology. Art practice 'ways of thinking' inform the work as it is concerned with temporary sensory plasticity and empathy between people and their jewellery artefacts.

Through these two projects I will illustrate how art practice ways of making and thinking about work can enrich the development of therapeutic technologies. In both cases the emotional experience of the user has been paramount in developing the technology. This concern is rarely manifest in the mainstream creation of therapeutics, in which design is only

[1] Within the context of this research the term trans-disciplinary refers to the process of working flexibly in multidis ciplinary teams to solve complex problems. I draw from the definition offered by Weismann et al in the Handbook of Transdisciplinary Research: "Transdisciplinarity implies that the precise nature of a problem to be addressed and solved is not predetermined and needs to be defined cooperatively by actors from science and the life-world. To enable the refining of problem definition as well as the joint commitment in solving or mitigating problems, transdisciplinary research connects problem identification and structuring, searching for solutions, and bringing results to fruition in a recursive research and negotiation process. Transdisciplinarity thus dismantles the tradi tional sequence leading from scientific insight to action" (Wiesmann et al., 2008, p. 436)

considered at the end of the development process. The case studies illustrate how the use of iterative models can lead to expansive ideas, options and design solutions.

Through this paper I hope to highlight the ideal scenario in which the creative practitioner[2] informs the development of therapeutic technologies from the outset. This has myriad impacts on creative and scientific outcomes: it encourages scientists to think more broadly about the human impact of their products prior to progressing too far down the development channel and in turn informs the creative practice of the artist.

### Developing Therapeutic Technologies

Therapeutic technologies are developed in laboratory circumstances in response to an identified health issue or need. Considerations of human interaction with therapeutics are rarely considered at the outset of projects. Rather, a designer is engaged at the end of the innovation process to design a housing or applicator to take the product to market. The lead time for the development of therapeutic technologies is a time-consuming process which starts with the conception of an idea, feasibility studies, refinement of the technology, device development, clinical trials and infiltration into the market: a process which can take anywhere from 5-15 years (Heiss & Morgan, 2010).

| | | |
|---|---|---|
| Discovery Phase | 3 years | |
| Preclinical Trials | 2 years | |
| Human Trials | 7 years | 15 YEARS |
| Regulatory Review | 1 year | |
| Market Launch | 1 year | |

Table: A typical timeline for the development of therapeutic technologies.

In this traditional approach creative thinking ends up firmly at the end of the innovation process when the commitment to the technology has already been made. The scope for form and function development is very limited at this point as the technology as its interface (sensors, interactivity etc) have been committed to. As a result, valuable technologies often fail through poor interfaces which do not resonate with users or beneficiaries.

However, through incorporating experimental thinking into the development of therapeutic technologies at an earlier stage, great leaps of innovation can be made. The first approach is to locate an artist in the scientific organisation to respond to the technologies being developed and bring a new set of tools to the innovation process. This is the scenario in which I developed Diabetes Jewellery. The second approach is to invert the usual development process and start with experimentation. In this scenario experimental art practice ways of making and thinking mould the form and function of the technology before the 'hard science' is complete and technology forms and interfaces have been committed to.

### Diabetes Jewellery – Collaborating With The In-House Artist

Through the Diabetes Jewellery project I created jewellery-based wearables to utilise Nanotechnology Victoria's transdermal patches which replace syringes for drug delivery. The patches enable pain-free and continuous delivery of therapeutic drugs - for example, insulin - in a convenient format. The polymer patches are 10mm in diameter by 2mm thick and have a surface structured with microneedles. The drug (which can also be nanostructured) is incorporated by either coating it directly onto the external surface of the patch or through direct inclusion into the polymer matrix (Heiss & Morgan, 2010). NanoVic's transdermal patches have a number of advantages over traditional methods of drug delivery. These include: direct delivery into the outermost layer of the epidermis, allowing for pain-free

[2] As a trans-disciplinary practitioner working at the intersection of art, design and technology I do not draw strong distinctions between art, design and craft practices. Rather my way of working relies on transgressing these traditional boundaries and drawing on the broad from a wide range of material and research resources at my disposal.

and blood-free drug delivery; rapid uptake into the body thus increasing efficacy; simple self-administration; and easy disposal.

The function of the Diabetes Jewellery Applicator Neckpiece is to discreetly apply the transdermal patches to the skin. The Diabetes Rings keep the patches against the skin once they have been applied. Thus, rather than having to inject insulin with a syringe the wearer has simply to apply a pre-loaded patch to the inside of the finger with their neckpiece and position the ring to keep the patch in place.

Image: Diabetes Jewellery - Neckpiece Applicator (left) and Diabetes Ring with transdermal patch (right). Photographs: Narelle Sheean

I developed Diabetes Jewellery while artist in residence with Nanotechnology Victoria from 2007-8. *The Subtle Technologies* residency set out to address the question: Is it possible to augment our personal artefacts with extra functionalities—the power to heal, correct and treat our physical ailments? Throughout the residency I employed numerous experimental art practice approaches including generating iterative models, problem solving through making prototypes and trans-disciplinary collaboration (the team comprised nanotechnologists, engineers, and intellectual property experts). Through being embedded in the scientific organisation the residency process allowed me to respond dynamically to changes in technologies, processes and intellectual property. The approach also facilitated a more seamless feedback loop between the parties involved in the innovation process as the scientists were on hand to respond to ideas, models, drawings and concepts and to help resolve technical issues.

The Diabetes Applicator Neckpiece was developed in collaboration with a product engineering company who helped to deliver the internal mechanisms for the jewellery. The rings and the applicator neckpiece were developed through an iterative 3D modelling approach, rapid prototyped and cast in silver. This is a non-traditional way of developing jewellery but has many advantages. Firstly, it allows for more seamless collaboration between the artist and the product engineers, as there is a shared language of 3D modelling. Secondly, it allows for easy reproduction of the pieces. Thirdly, in the case of the residency, it allowed for NanoVic to have greater input into the development process as I could demonstrate the designs digitally throughout development process, allowing the team to provide feedback before printing and casting.

## Diabetes Jewellery—Empathy And Codification Informing The Jewellery Artefact

In his article “Till Death Do Us Part: Jewellery and its Human Host”, Kevin Murray suggests that the jewellery artefact and its wearer are woven into a bi-directional contract in which the wearer does not have greater significance than the jewellery. Rather, the artefact has a rich inner life and will often outlive the wearer. He writes:

> The question to ask of jewellery is not so much why people choose to wear it—a question which grants no status to the object outside of its usefulness—but *why jewellery wears people.* (Murray, 1992, p.5)

Murray goes on to look at jewellery which is both functional and representational. For instance a security badge is both ornament and also allows access to restricted spaces. Within this reading Diabetes Jewellery is both a piece of adornment and is also the device keeping the wearer alive. Susan Cohn suggests that a primary role of jewellery is to "…imply that a wearer has an active inner life, *kept as a secret*. Wearing the object becomes a way of preserving this secret, but also a provocation for the viewer to break its codes, to make the jewellery 'talk'." (Cohn, 2007, p.74)

Diabetes Jewellery is made to look like contemporary jewellery and is also a drug delivery mechanism. It gives the power of disclosure back to the wearer, to reveal the hidden functionality of the jewellery or to leave it in the realm of aesthetic ornament. As Cohn goes on to suggest "It is the wearer who is the most important person in a jewellery-object's life: for though the maker brings the object into being, the wearer charges it with life" (Cohn, 2007, p.78). The wearer of Diabetes Jewellery brings the jewellery-artefact to life, yet the jewellery-artefact also keeps the wearer alive. This may be interpreted as a type of empathy in which a strong relationship exists between the wearer and their jewellery: each responsible for the task of keeping the other alive.

**The Seed Sensor: Designing the technology before the technology**

The Seed Sensor is a trans-disciplinary art/science/engineering project developing unique ways to harness and use medical data gathered from the body. Its form and user interface are being designed through an art practice approach which utilises iterative models; material-led experimentation; workshop-style hands-on brainstorming; and problem solving through making prototypes. The outcome is a scenario in which the form and user interaction of the therapeutic is being developed prior to committing to a particular technology.

The Seed Sensor is a swallowable device that detects gas fluctuations in the body (methane, carbon dioxide etc) that may be a symptom of undiagnosed disease. The "seed" is a swallowable tablet that unfolds like a flower once in the small intestine deploying a sensitive membrane which captures particles of gas as it moves through the digestive tract. It has an enteric coating which is designed to withstand the acids in the stomach and to dissolve in the alkaline environment of the small intestine. Once the coating has dissolved, the membrane can be activated to "open up", slowing the sensor down to collect particles of gas through tiny pores on the membrane surface. The aim of the project is to achieve a less invasive biomedical application where current applications are still relatively rudimentary.

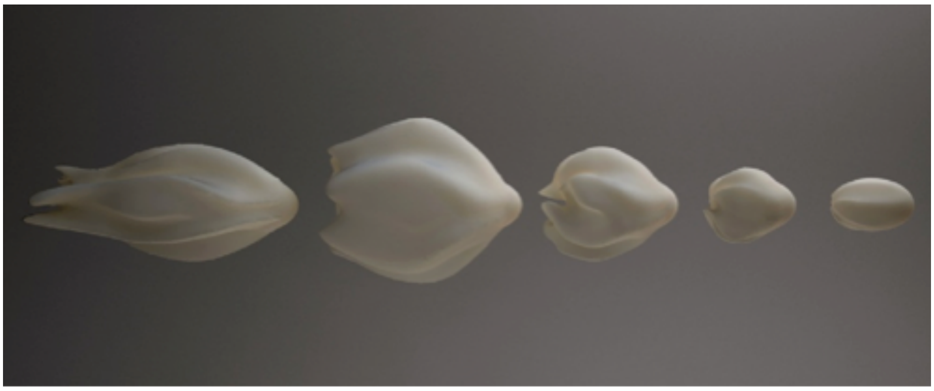

Image: Seed sensor sequence showing the seed in capsule form (far right) and the membrane as it unfolds within the digestive tract to capture gas particles.

A primary design challenge of the project is how to develop a device that will slow down or stop intermittently within the intestine to sense and transmit information. This is a particularly complex issue as the intestinal process of "peristalsis"—the contraction and relaxation of muscles in the gastrointestinal tract – is designed to propel contents forward.

**Workshopping the Seed Sensor—iterative modelling**

In the concept generation stage of the Seed Sensor I hosted a hands-on prototyping workshop with RMIT Interior Design students. The workshop focused on generating seed sensor morphologies which had the capacity to open and close in the digestive tract.

Images: Seed Sensor workshop with RMIT Interior Design Skinning students, 2011. Seed Sensor prototype: Ahmed Al-Busaidi (right).

This initial material-led brain-storming session lasted for around three hours, and through the process we generated around eighty Seed Sensor prototypes which were categorised into five morphologies: hookworm, flower, membrane, sponge and "grain wave". The final Seed Sensor was inspired by the central circular membrane with the "pores" of the Grain Wave (far right).

Image: Seed Sensor morphologies developed through the Seed Sensor workshop. From left: Hookworm, Flower, Membrane, Sponge, Grain Wave. Models developed by RMIT Interior Design Skinning students, 2011.

Following on from this initial brain-storming process we developed a series of Seed Sensor sequences in both modelling clay and latex. These allowed us to clarify the scale and thickness of the membrane prior to 3D modelling and rapid prototyping. Three model series are currently being produced: the first are solid polymer prints which allow for identification of form and scale issues; the second are a series of flexible polymer prints in which to integrate shape memory polymers and test the 'opening' capacity of the membrane; the final series are ceramic models printed for exhibition. The models and prototypes are being used to develop technology solutions to activate the therapeutic.

Image: The Seed Sensor unfolding sequence in latex. This sequence depicts the Seed Sensor from capsule stage through the unfurling process. Sequence: Simon Lowther.

**Seed Sensor—Taking Advantage Of Sensory Plasticity**

Through the Seed Sensor project I was interested in devising a therapeutic that could facilitate a form of sensory augmentation while simultaneously fulfilling its primary task of collecting biological data. The basis for this sensory augmentation was to exploit sensory plasticity—the ability of the brain to integrate new forms of sensory input. The Seed Sensor is designed from bio-compatible materials so that the body will attempt to grow cells on the seed as it passes through. It is also designed to allow for temporary sensory augmentation—it provides an enhanced biofeedback sense for the user while it is moving through the digestive system.

Studies by Paul Bach-y-Rita in the late 1960s and early 1970s demonstrated the capacity of the brain to substitute the sense of sight with tactile vision. His experiments involved congenitally blind participants learning to use a sensory substitution system. Bach-y-Rita suggests that while the blind may have lost vision they have not lost the capacity to see—as it is the brain, rather than the eyes that do the seeing. He writes:

> The brain is a plastic organ, with various mechanisms of information transmission and mechanisms of compensation for damage and sensory loss. Reorganisation of brain function is possible not only in early development, but throughout life… (Noë & Thompson, 2002, p.498)

Experiments by Kevin Warwick also highlight the existence of human sensory plasticity which can facilitate the integration of new sensory inputs. In Warwick's pioneering experiments he had a chip implanted in the median nerve of his arm which allowed him a range of extra-human capabilities. One of these was the capacity to sense space through the perception of ultrasonic signals (Warwick, 2004). This hitherto foreign sense was quickly incorporated by the brain, suggesting a capacity for sensory plasticity. In these and other experiments the brain recognises the new inputs as being from the body and reorganises itself to accommodate the new information.

In this reading the Seed Sensor allows for temporary sensory augmentation and, depending on the biocompatibility of its materials, may be recognised by the body as being "part of the body" rather than a foreign object. In this instance the Seed will augment the sensory capacity of the user for as long as it remains within the digestive tract. During this time the user will have access to hitherto inaccessible information about their internal health and wellbeing.

## Conclusions

Through this paper I have investigated the expansion of innovation when art practice approaches inform the development of therapeutic technologies. Within the context of this paper *experimental art practice* refers both to ways of *making* work and *thinking about* work. “Ways of making” encompasses such artistic methods as the generation of iterative models; material-led experimentation; workshop-style hands-on brainstorming; problem solving through making prototypes; and trans-disciplinary approaches to making work. ‘Ways of thinking’ focuses on the use of theoretical framing to drive the making of artwork. In reference to the case studies these theoretical structures include models of empathy, codification of the jewellery artefact, sensory plasticity and augmentation.

Through Diabetes Jewellery the positioning of the device as an intimate jewellery artefact meant that from the outset the device was concerned with issues of empathy and connection between the user and their technology. Diabetes Jewellery is interested in codification as it may be read as jewellery or medical device, at the discretion of the wearer. The impacts of this framing and the intrinsically personal nature of the jewellery provide the device with a range of affordances that would not normally be part of a drug delivery mechanism. From a “making” viewpoint Diabetes Jewellery relied on such experimental approaches as generating iterative models, problem solving through making prototypes and trans-disciplinary collaboration.

Seed Sensor illustrates how experimental ways of making and thinking can help to develop the therapeutic technology design (form, functionality, and interface) before a commitment to the “hard technology” is made. In this example, experimental art practice lays the groundwork and parameters for the development of the technology. The project is being driven through the generation of iterative models, material-led experimentation, workshop-style hands-on brainstorming, and problem solving through making prototypes. Theoretically, Seed Sensor questions whether the biocompatible device may allow for an experience of temporary sensory augmentation, allowing the user a fleeting insight into the body’s interior.

There are myriad benefits of incorporating experimental ways of making and thinking into the therapeutic development process. Within the case studies discussed, the input of the artist has led to clearer communication of complex ideas to a broader range of people. The approach in both case studies is to embody complex science into physical prototypes. These prototypes are then exhibited, reviewed and presented in the public realm, allowing inclusive access and helping to facilitate important debate about the impact of therapeutics in our lives.

Artists tend to think beyond technology to consider whole-of-life human experience— the users, situations, environments etc.—in which the technology will be used. This broader focus is critical in trans-disciplinary teams as in this context artists represent the non-scientific public and eventual users of technologies. Artists ask ‘human’ questions that allow technologies to become more sensitive to users’ needs. Seed Sensor and Diabetes Jewellery are examples of how we might move toward an ideal model of simultaneous synergistic innovation in the design of therapeutic technologies. This is where the development of the human interface and the “hard science” occur in parallel in a trans-disciplinary team environment.

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Leah Heiss is a Melbourne-based artist and designer whose practice is located at the nexus of art, design and science—utilising advanced technologies to develop potent human scale projects. Her process is deeply collaborative—working with experts from nanotechnology through to fashion design. The outcomes include therapeutic jewellery and electronic garments through to hand-held devices and large scale installations. Her Diabetes Jewellery, developed in collaboration with Nanotechnology Victoria, received wide international media exposure and was featured on Australian television, radio, and in print. Leah has extensive knowledge of next-generation materials and processes and an arts practice approach to the making of work, particularly an emphasis on communicating work through exhibition and discussion in the public realm. Her research, practice and teaching are transdisciplinary and her work has been exhibited and presented both locally and globally. Leah holds a Masters of Design from SIAL and lectures through Interior Design at RMIT University, Melbourne.