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# ‘Sing Dem Dry Bones, Sing’: One Woman’s Personal Struggle with Piezoelectric Collagen and the Journey Towards Singing Bone

*Boo Chapple*

**ABSTRACT**

This paper explores questions of risk, legitimacy and failure through reference to a current research project directed towards making audio speakers out of pig bone. ‘Sing Dem Dry Bones, Sing’ articulates the different, and sometimes contradictory, requirements for legitimacy that operate in the sciences and the arts and investigates the risks involved in making interdisciplinary work that potentially satisfies neither. It questions how work that straddles disciplinary boundaries should be understood and asserts the importance of sharing the research process, including its frustrations and disappointments, with the wider community. Finally, the paper expresses a belief in the importance of pursuing difficult visions and novel combinations despite the problems that may arise from conflicting disciplinary agendas.

Traditionally, I understand one of the key similarities between art and science practice to be the fact that they both generate knowledge and artefacts through a situated exploration of material relations. New understandings are reached and new relationships are drawn through the research and exploration process. In both areas, there is also a tension between the need to engage in this type of situated, open ended investigation and the need to produce; results, products, cures, exhibitions etc. Many would argue that ‘true science’ with its exploratory research model has been increasingly sidelined at the expense of technology-driven, product-directed funding models, and the increasing drive towards ‘creative industries’ funding points to a similarly functionalist approach to the arts. To set out on an investigation that does not produce its intended results, that fails to yield its expected cultural or economic capital can jeopardise future funding and/or career options. To engage in research for its own sake is now both more risky—and more vital—than ever.

One of the important differences between art and science, in their ‘ideal’ forms, is that, in art practice the embodied involvement of the particular artist creating the work is foregrounded and used to legitimate the artefacts, whereas in science, an embodied relation to the work is obscured, and any hint at the contingency of the situation and/or the personal investment of the scientists involved is a threat to the legitimacy of the work. In the arts the quality of a work is assessed on its ability to communicate or engender experience, whereas good scientific research must generate abstract knowledge, purged of experiential specificities. Working at the intersection of art and science, I must negotiate my own path between these two conflicting frameworks for determining the legitimacy and evaluating the quality of work. In doing so, I risk doing ‘bad science’ under the guise of being an artist, and, in turn, creating ‘bad art’ by merely re-presenting science (done badly) in an artistic context. As I grapple with the issues surrounding the nature of biological life and material transformation I also engage in a philosophical project of sorts. Is it possible to do philosophy through artistic and scientific methodologies and practice? Or do I risk doing ‘bad philosophy’ as well?

In this paper, I will explore how these issues—of risk, failure and legitimacy in art/science practice—operate in an ongoing research project of mine entitled ‘I’ve Got Rhythm.’ I embarked on this research with an interest in electromagnetic capacities of the human body and the intention to make work that foregrounded the intricate interactions and feedback loops that exist between living and non-living systems. I wanted to disrupt conventional conceptions of biological life by ‘making strange’ its lesser-known capacities. From this initial impetus, there has developed a specific project to create audio speakers out of pig and cow

bone (Fig 1). From a philosophical interest in the nature of biological life, I have progressed to engaging with the scientific processes of material transformation, with the intention of creating an art object that engenders an experience both of the capacities of a particular biological material and of the scientific culture that I negotiated in order to create it.

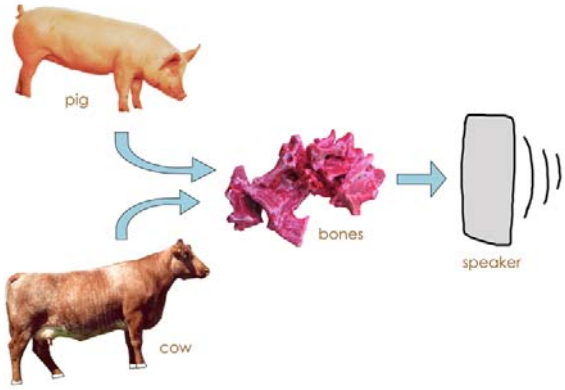



**Fig. 1: Audio speakers from bone.**

The most obvious risk involved in this project—one which relates to the tension between research and product—is that I will be unable to create the speakers. The most important question in response to this is: Does it matter, and if so, how? What am I risking if I don't succeed? Secondly, in regards to the disciplinary integrity of my work, if I do succeed, then what will I have created? How do the speakers function in relation to the scientific, artistic and philosophical contexts in which 'I've Got Rhythm' is situated? Before addressing the questions directly, I will first explain each aspect of the project in more detail.

Scientifically, the potential to make audio speakers out of bone exists because collagen, one of the main components of the bone matrix, is piezoelectric. Piezoelectricity is a property of certain crystals and polymers, such that when they are subjected to a mechanical vibration of a certain frequency they emit an electromagnetic wave at that same frequency and conversely, when they are subjected to a particular frequency of electromagnetic wave they vibrate mechanically at a corresponding frequency. The reason that piezoelectric materials have this unique transductive quality is due to the nature of their molecular structure, in which

> "the positive and negative electrical charges are separated, but symmetrically distributed, so that the [material] overall is electrically neutral. … When a stress is applied, this symmetry is disturbed and the charge asymmetry generates a voltage." [1]

When the material is deformed through a repetitive pulling and pushing motion the constantly changing direction of the field generates an electromagnetic wave. In turn, an oscillating voltage applied to the material causes a regularly repeating mechanical deformation. This movement causes a displacement in the air around the material. If this displacement is large enough, and if the original electromagnetic frequency corresponds to a frequency within audible range, then we will hear sound.

The piezoelectric nature of the bone matrix was first determined by Fukada and Yasuda in 1957 [2]. It has been suggested that the phenomenon plays a role in the way in which bone remodels in response to stress and that the piezoelectric nature of collagen in general, making up 70 percent of connective tissue in the body, may be a factor in intra-cellular signalling. Fukada and Yasuda's original work, both on bone and collagen, generated a host of further research into the phenomenon, which seemed to peak in the late 70s. In determining the method below, I referred to many of the papers from this period and I am also greatly indebted to another artist, Marta Lyall, for sending me some of her notes and a paper by Yadav and Singh [3] on the process of fabricating piezoelectric ultrasonic transducers from bone. The following section presents a short description of the process; for images refer to Figure 2.

**Step 1) Acquire the bones**

- Purchase a bag of bones from the butcher. Try to get large bones with as little flesh remaining on them as possible.

**Step 2) De-fat the bones**

- Scrape as much meat off the bones as possible with a scalpel blade.
- Place the bones in 'rotting tank' for up to 3 weeks. The rotting tank is large insulated plastic tub full of water heated to 37° Celsius by an aquarium heater. This allows necrotic bacteria to thrive and digest fat and flesh from the bones.

**Step 3) Dry the bones**

- Soak bones in 100 percent ethanol for 1 week to kill bacteria and remove moisture.
- Leave the de-fatted bones in an oven at 45° to 50° Celsius for up to two weeks.

**Step 4) Cut the bones**

- Cut the bones into small flat sections using a rotary saw.
- Cut the sections at an angle of 45 degrees to the direction of the fibres in the bone matrix using a slow speed water-cooled saw so as to avoid heat damage to the collagen.

**Step 5) Make the transducers**

- Coat the two flat faces of each section with conductive silver paint and attach electrode wire using conductive silver loaded epoxy.

**Step 6) Test the transducers**

- Drive the transducers with up to 100 volts AC and test response using a condenser microphone and a vibration sensor.

Since March of this year (2006) I have been working on this process with a Biomedical Engineering Honours student, William Wong. As I write this now at the end of June, we are just about to begin an intensive period of testing.

Artistically, this project relates to the tradition of experimental sound art within which there are many examples of the use of non-traditional materials for sound generation. One example is Richard Lerman's 1982 piece 'News Filters' in which he

> "made microphones out of coins, paper money, rice paper, aluminium foil, cellophane, plastic shopping bags from Radio Shack, strips of film, copper, bronze and wire gauze." [4].

The project is also influenced by the work of Cornelia Parker, best known for her piece 'Cold Dark Matter' that involved blowing up a garden shed filled with junk and then suspending the collected fragments in a gallery. Parker talks about her work directly in terms of material transformation. She states that "The whole notion of transubstantiation, the changing of one substance into another, has clearly influenced the way I think as an artist." The way I conceive of 'I've Got Rhythm' is framed in the language of performance art. The speakers are understood as artefacts of a performative engagement with the materials of life and the processes of science. They are intended to draw an audience into a moment of witnessing, not to be a static object, but to engender an investment in the actions performed during the period of their creation.

Conceptually, 'I've Got Rhythm' is concerned with expressing a complex set of relations between biological life, embodied experience and cultural context, in a bid to assert the contingency and indeterminacy of living information: The idea that the living body, in which concepts of life and the embodied self combine, can never be entirely abstracted, codified or controlled by the contemporary mechanisms of power that are so heavily invested in its management. I am influenced in this perspective, by Brian Massumi's idea of incorporeal materialism. Massumi [5] states:

> "When a body is in motion, it does not coincide with itself. It coincides with its own transition, its own variation. The range of variations it can be implicated in is not present in any given movement, much less any position it passes through. In motion, a body is in an immediate unfolding relation to its own nonpresent potential to vary. ... This is an abstractness pertaining to the transitional immediacy of a real relation – that of a body to its own indeterminacy (its openness to an elsewhere and otherwise than it is, in any here and now).".

By focussing on micro-molecular oscillations of bone that have the capacity to transduce between electromagnetic and mechanical energy, 'I've Got Rhythm' engages the complex, and often little understood, interactions take place between a living organism and its environment, constantly. Life is a multifaceted process of self-information with infinite 'potential to vary.' By explicitly foregrounding the performative nature of doing the science in 'I've Got Rhythm,' I include the interplay of social context and physical force at work in the material transformation of the bone, in the complex of relations through which life (biological and cultural) is continually informed. By working with animal bone, 'I've Got Rhythm' necessarily references the use of animals for scientific experimentation and production. However, by sourcing the bone from a butcher it functions to place the ordinary practice of eating meat into a more ethically charged context, by drawing attention to the complex capacities of the living animals that we eat. The project also grapples with the increasing instrumentalisation of living processes and the convergence of 'life' and 'device' at work in the biotechnology industry.

If I do not succeed in my aim to make the bone audio speakers then what do I lose? How is this different in relation to each of the aspects of the 'I've Got Rhythm' project that I have just outlined?

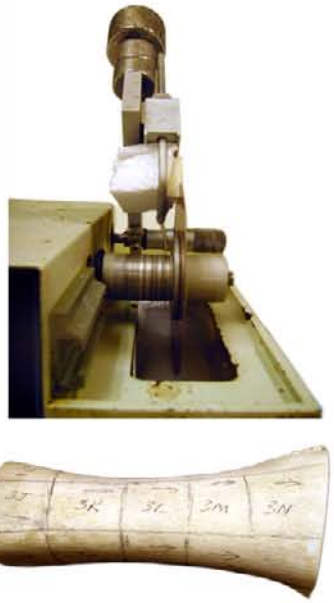
Firstly, I will not lose much in terms of my career if the scientific aim of the project fails, because I never intended to output the work in a scientific context and I am not subject to outcome-based funding conditions. What I lose for myself is perhaps a little of the optimism necessary to maintain the energy for difficult visions. I also lose the increased legitimacy that a technically functioning product may have leant my artistic or philosophical aims.

Artistically, I lose a product to exhibit. Or do I? Do the speakers have to work in order for me to exhibit them, or is this placing too much emphasis on the scientific aspect of the work? Should I fake it? How important is this scientific legitimacy of the work to the integrity of the project as a whole and to my relationship with scientific culture? To what extent is my work dependant on illustrating the scientific principles and making a functional product, and to what extent am I attempting to create a poetic or mythic object? Could I extract a speculative piece that focuses on the performance of the scientific processes instead?

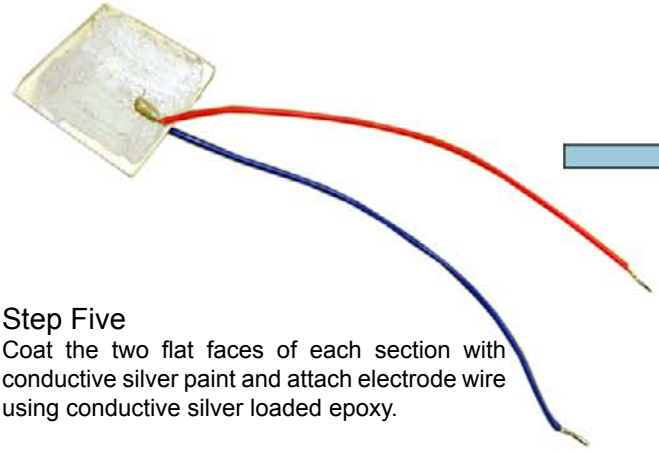
Step One
Purchase a bag of bones from the butcher. Try to get large bones with as little flesh remaining on them as possible.

Step Two
Scrape as much meat off the bones as possible with a scalpel blade. Place the bones in 'rotting tank' for up to 3 weeks.

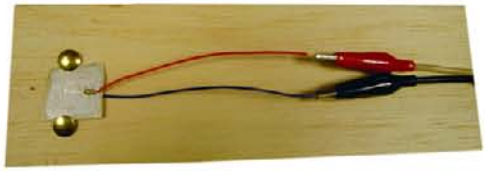
Step Three
Soak bones in 100 percent ethanol for 1 week. Leave the de-fatted bones in an oven at 45-50 degrees Celsius for up to two weeks to dry.



Step Four
Cut the bones into small flat sections using a rotary saw. Cut the sections at an angle of 45 degrees to the direction of the fibres in the bone matrix using a slow speed water cooled saw.



Step Five
Coat the two flat faces of each section with conductive silver paint and attach electrode wire using conductive silver loaded epoxy.



Step Six
Drive the transducers with up to 100 volts AC and test response using a condenser microphone and a vibration sensor.

**Fig. 2. Steps of the process to make audio speakers from bone undertaken so far**

Conceptually, I lose the ability to illustrate the strange capacities of biological materials and the indeterminate potential of living systems. But to what extent is it legitimate to use science, with its problematic claim to objectivity, to produce philosophical outcomes anyway? Or, how is it necessary, or possible, to use experiential aggregates to express philosophical concepts? Is it not more useful to write about the process, rather than exhibit an object in the first place?

By examining the potential repercussions of the failure to make the speakers to work, I begin to unravel the conflicts that have existed within the project from the beginning. It becomes possible to see that, should I fail to make the speakers function, the artistic goals of the project are not entirely lost, because they already bear a difficult relationship to the scientific aspects of the work. Should the speakers indeed function as intended, the potential for artistic failure is just as great. For example, the temptation to depend on the science to legitimate the art is increased and the difficulty of effectively using science to critique itself becomes more of an issue. Furthermore, by working with bone that has been sourced from a dead animal, taken out of the context of a living system, 'I've Got Rhythm' paradoxically reproduces the tendency of the biotechnology industry to instrumentalise life, hence undermining its intention to communicate life's indeterminate vitality. The tension, between the desire to foreground the performative processes at work in the science of material transformation and the risk of producing 'science communication' not art, is also accentuated.

These issues hinge upon how I want the investigations of 'I've Got Rhythm' to be understood. Do I want the artefacts to be assessed primarily on their merit as an object within the art canon and the extent to which they communicate to an art audience, or as research? If they are research then what is the importance of how they are presented as an object, and what type of research are they? Should I attempt to create different outputs for different disciplinary contexts or should the research be able to maintain its own integrity and validity? Not only do I set out on this research project, not knowing if the scientific aspects of 'I've Got Rhythm' are feasible, but also not knowing how successfully, or in what context the eventual artefact will operate. Will it be judged as illegitimate and poorly-formed from the perspective of all the disciplines upon which it draws, or will it be understood as something that stands in its own right?

Despite the difficulty of working with conflicting aims and modes of output, and the risk of doing everything badly, I maintain a belief in the legitimacy of striving for new ways of knowing and expressing knowledge that may be found at the overlap between art, science and philosophy. Art provides an understanding of how to communicate aesthetically, to create materially embodied experience. Science provides a knowledge of, and a fascination with, functional material relationships. Philosophy provides a conceptual framework within which situated material explorations can be contextualised. Embodied engagement with novel perspectives and practices in the sciences is an important mode of philosophical investigation. Furthermore, I believe that no research project is ever a failure, irrespective of whether or not it achieves its objectives. Certain expectations may not be fulfilled, but other things are always gained along the way. Not only this, but others are always able to learn from and build upon this knowledge. For this reason, it is critical to be open about the research process—not just the successes, but also the pitfalls and frustrations—in order that the wider community may benefit.

## Acknowledgements

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## Author Biography

***Boo Chapple*** *was awarded the 2005-06 Australia Council for the Arts SymbioticA Art and Science Residency and is currently a researcher in the School of Anatomy and Human Biology at the University of Western Australia. Previous work has been presented at the Beijing Biennale of Architecture, commissioned by ABC Radio, included on a compilation in the Australian Music on Disc series and in an exhibition of Australian sound art at the San Francisco MOMA. Her essay 'Journeys to the Other Side of the Navel' is to be published in a forthcoming book* Art of the Biotech Era.

## Author Email and Postal Address

Boo Chapple
E-mail: <boo@corpuseclectica.net>

194 Nicholson Road
Subiaco WA 6008
Australia