Under the Icecap and GeneMusiK; Explorations in BioSonics.

Dr. Nigel Llwyd William Helyer and Dr. Mary-Anne Lea
Adjunct Professor Maquarie University, Sydney, Australia
sonic@sonicobjects.com
http://www.sonicobjects.com

Collaborating Scientist for "Under the IceCap".
MaryAnne.Lea@utas.edu.au
http://www.imas.utas.edu.au/people/profiles/current-staff/mary-anne-lea
University of Western Australia & University of Tasmania

Abstract:
This paper examines two art and science collaborations with outputs manifest as music. "Under the Icecap" is an Art and Science collaboration between Artist Dr. Nigel Helyer (Sonic Objects; Sonic Architecture) and Marine Scientist Dr. Mary-Anne Lea (Institute for Marine and Antarctic Studies at the University of Tasmania) linking scientific bio-logging data and GIS techniques with interactive acoustic cartography and the development of AudioPortraits that extend the conceptual and intuitive grasp of extremely abstract data.
<http://www.sonicobjects.com/index.php/projects/more/bio_logging>

"GenemusiK" is an ongoing creative research project that codes musical scores into DNA sequences and chemically and biologically 'remixes' them, to be recoded as musical scores for performance. The project is currently based in Bloemfontien, South Africa where the artist has been working with traditional San musicians and faculty at the University of the Free State.

Keywords:
Art and Science, Art and Environment, Data Sonification, Data Visualisation, Biologging, Antarctic, Genetics, Africa, Micro-biology.

Under the Icecap an introduction.
The seeds of our collaboration were planted during the Fourth International Conference on Bio-Logging (Hobart March 2010) when Dr. Helyer created an interactive sonic sound-map from satellite bio-logging data collected by IMAS, Australian Antarctic Division and French scientists from tagged marine species around the sub-Antarctic islands (Heard, Davis and Kerguelan Islands) see Figure 2. below.

This initial artwork formed the basis for an ongoing in-depth interdisciplinary research and development project that combines visual arts, new media arts and music with environmental science and advanced computer data-visualisation and sonification.

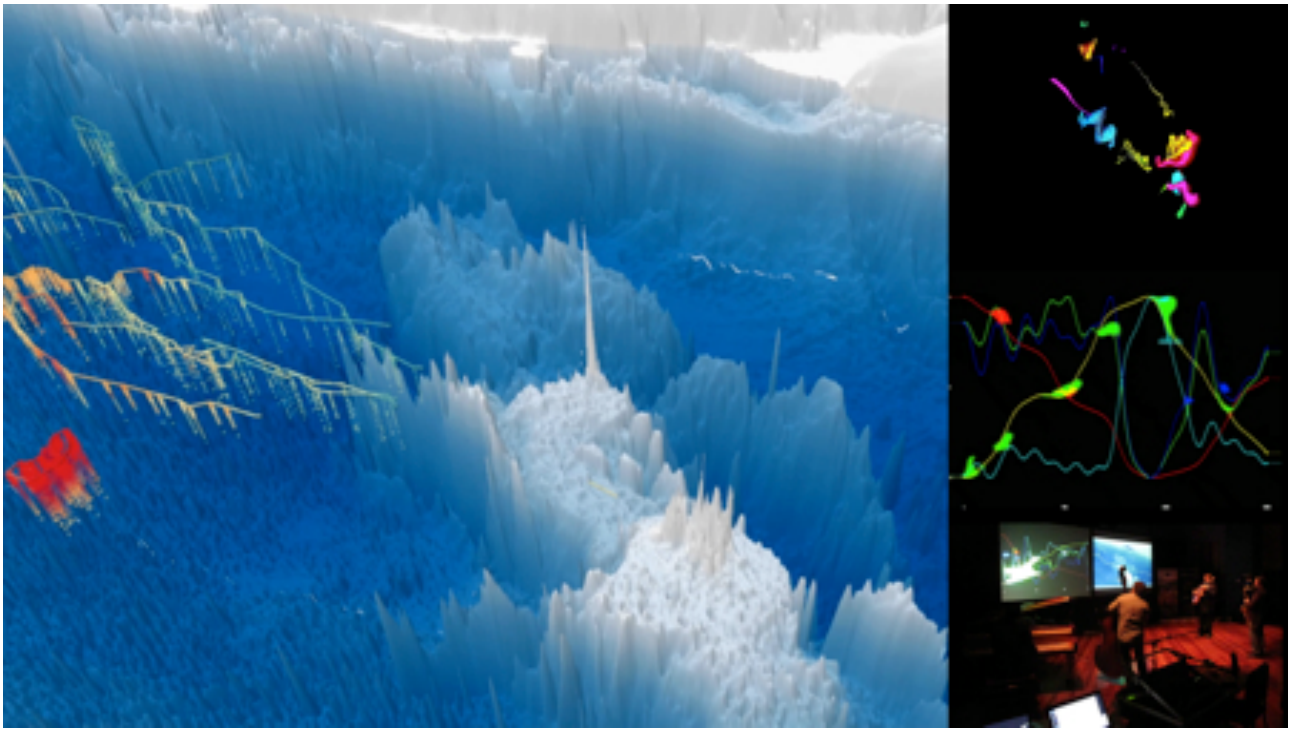

Figure 1. 3D animated data map and data-generated graphical scores (image Helyer 2012).

The collaborators realised that the extensive and extremely complex datasets collected by southern elephant seals (Mirounga leonina) diving under Antarctic Ice, or transiting across the Southern Ocean, represent a considerable interpretive challenge and provided the potential for a hybrid art and science exploration of new methods and forms for manifesting the data and for developing novel forms of public awareness and debate.

Our aim is to develop novel techniques for visualising and sonifying the complex bio-logging data collected by Southern Elephant Seals on their deep dives under the Antarctic Ice shelves and their long Southern Ocean transits. We are exploring new ways to make these data-sets palpable, manifesting them as a series of experimental music concerts and visual and sonified installations.

Our methodological intention is that the artistic and scientific paradigms which intersect in 'Under the Icecap' form the basis of a robust and productive trans-disciplinary collaboration. The word collaboration is widely and often incorrectly used in art+science projects, typically one discipline being subservient to the other. However the emphasis within "Under the Icecap" is to design an open, consensual and collective creative research process, that balances the knowledge bases, motivations and target audiences of the art and science disciplines involved.

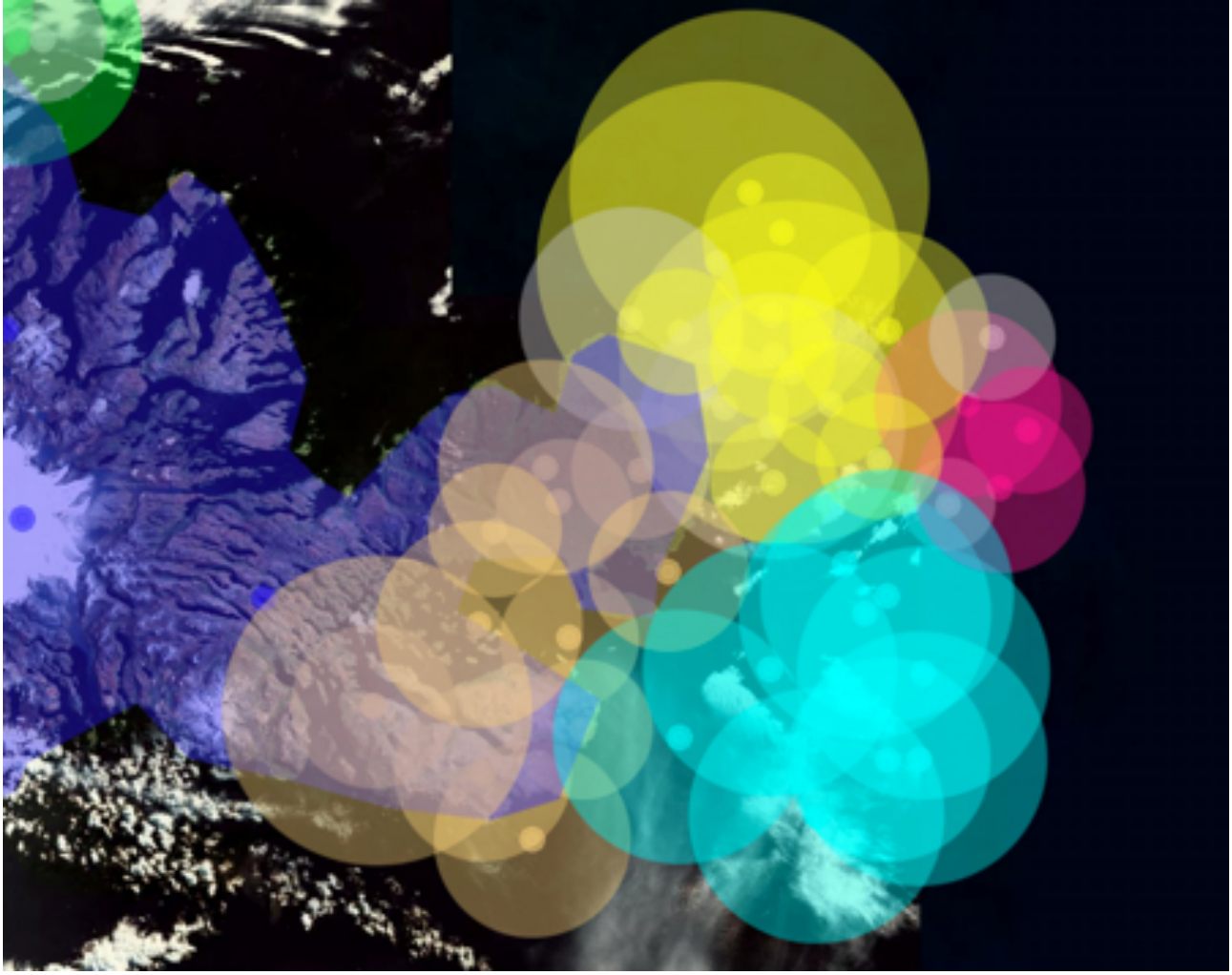

Figure 2: Sonic Cartography, location sensitive interactive map with x14 audio channels. (image Helyer 2010).

Environmental background - geography and species.

Firstly, some contextual information about the species and environment that generate our source data. The Southern Elephant Seal is the largest pinniped and exhibits strong sexual dimorphism, the males being significantly larger than the females. Males have been recorded to weigh up to 4000kg with a length of 6.85 m. The smaller females forage mainly in the pelagic zone whilst the males will forage in both pelagic and benthic zones, diving to depths of up to 2000 m with the ability to remain submerged for two hours. There are three main sub-populations, the South Atlantic, the Indian Ocean and the sub-Antarctic islands of the Pacific Ocean. The bio-logging devices illustrated below (Figure 3) are attached once the animal has moulted and with luck can remain in-situ for up to a year. The device transmits a range of data to a satellite each time the seal surfaces providing information about location, temperature, salinity, pH and other water qualities etc. Because of their capacity to dive deep in the water column and their habit of foraging under the Antarctic ice shelves, southern elephant seals have provided information otherwise unobtainable regarding and deep water formation associated with the production of ocean currents (thermohaline circulation) and sea ice formation, both vital indicators of global climate change.

Figure 3: Antarctic Chic; Biologging trackers carried by southern elephant seals (Image Ben Arthur and Clive McMahon 2010).

Live performance series "Vox on the Rox."

The premise of the first stage of the collaboration was the creation of interactive sonic-cartographies that combined bio-logging data with ambient recordings of Antarctic species. This system invited participants to explore a media rich map space of accurately geo-located soundscapes.

Using this as a starting point, we began to investigate the potential for other and more dynamic means to interpret the data. We began working with a group of gifted improvisation musicians from the Tasmanian Conservatorium of Music on the premise that musical training provides a unique skill-set; dynamic response, collaborative action and strong interpretive abilities.

Thus a new set of possibilities and challenges opened up, concerning how to visualise and transact data in such a way that it could be translated into music, not digitally but by live performers. Whilst musical interpretations of graphical scores are synonymous with Modernism; and whilst sonification goes hand in hand with the history of computer music, our experiment was with the effectiveness of translating massive data sets into animated visualisations, and hence to a real-time musical response (evaluated as utility for science and affect for culture) presenting us with a carte blanche which were are eager to explore.

The central question being how we can understand information about our environment in a radically different manner and how we can communicate this difference to both generalist and specialist audiences; in the hope that the environmental issues at stake are bought to the foreground.

The Concerts; an example approach.

For the first of the 'Vox on the Rox' concerts we grouped our datasets into three movements. In the first movement we created animated graphical scores that displayed the track of a single animal show as four sets of paired variables (surface wind speed (ms), depth (m) with salinity, depth with temperature and ocean bottom with density). The second movement represented two animals with two sets of paired variables and the third movement four animals with one set of paired variables. The animated graphical scores were synchronised with an animated three-dimensional underwater map-scape representing the seal dives and transit tracks (see Figure. 5 below). The four performers were free to follow both visual data flows simultaneously.

Figure 4: "Vox on the Rox" concert showing 3D animated map and graphical score (image Helyer 2011).

In the first movement each instrument was assigned a set of variables collected by a single seal, for instance piano to surface wind speed, saxophone to depth and salinity, double bass to depth and temperature and guitar to ocean bottom and bottom density. In the second movement each of the two animals has two instruments assigned to its data and thus in the third movement each seal was followed by a single instrument, our attention being drawn to the points in the data flow where seals intersected geo-spatially and the potential for the musical interpretation to likewise correspond.

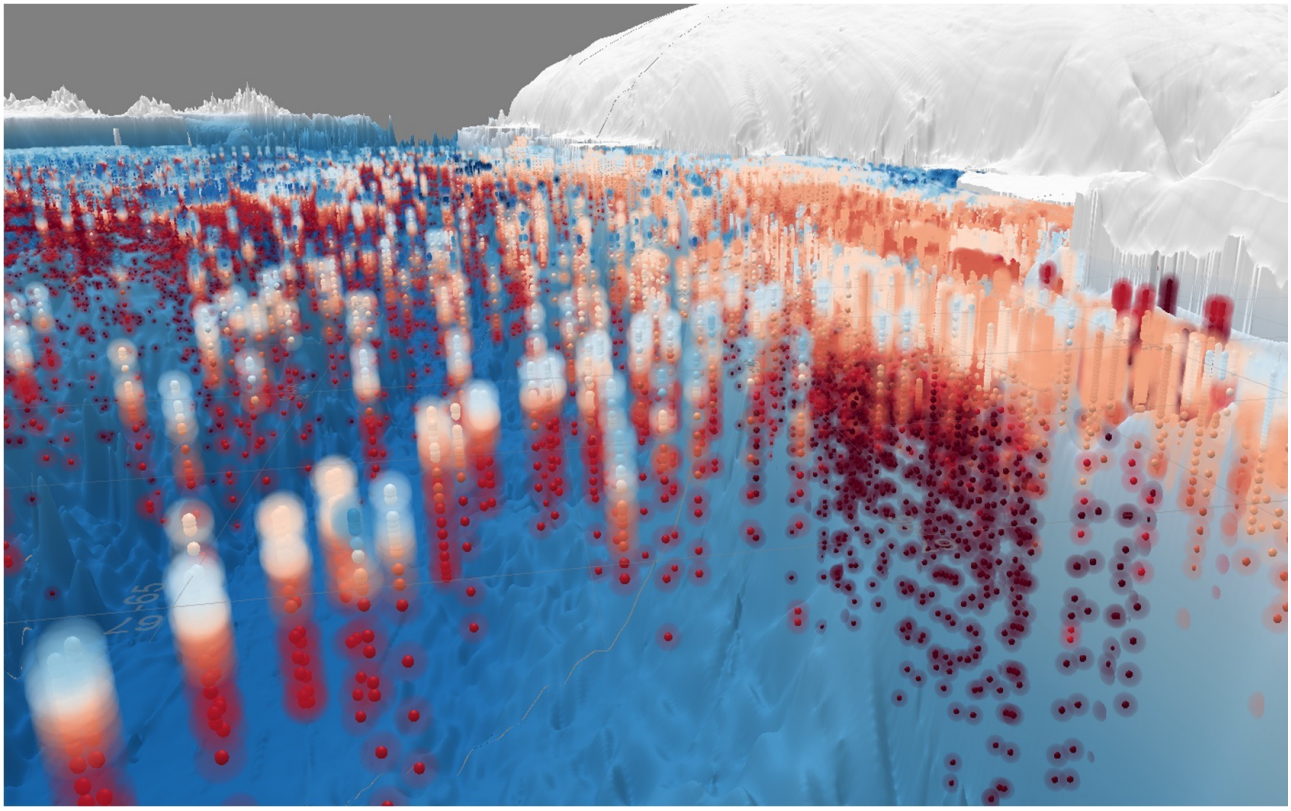

Figure 4. showing an animated 3D underwater mapping of Seal data trails.

From a metaphorical perspective the relationship that evolved between the four improvisation musicians during their first encounter with this data-environment (we agreed not to review or rehearse the material) forges strong parallels with the situation of animals foraging in the harsh underwater world of the ice shelf. In both cases information has to be processed instantly and a response generated on the fly. However this is not simply a response to the perceived external environment but also builds a network of communications within the group, developing a form of entrainment, establishing a collective response to the unknown, inventing a methodology that maps around the environment.

Naturally from a strictly scientific perspective a valid criticism can be raised concerning the level of ambiguity and ambivalence of any intuitive response to such graphical scores and 3D mappings, especially when they are an initial response, generated instantaneously, to be simultaneously negotiated within the ensemble. However even the data itself is an abstract, generic and scant description of the vast and complex reality of the living environment, not to mention the mediation of statistical tools and representational techniques that are employed to give meaning during data analysis.

The "Vox on the Rox" concert series continued throughout the year (2012) iterating our hunch that the skills and perceptions of musicians placed them in a good position to interact with complex streams of real-time information and that through a process of iteration we hoped to locate a sweetspot connecting the traditional scientific approach, with a creative sensibility, effectively opening up an enormous range of human enquiry into the natural world to a wider public.

Futures-Interactive Exhibition and Chamber Opera.
In the next phase of the research "Under the Icecap' aims to illuminate the fundamental connection between human economies and planetary dynamics, embodied in a cultural rather than a statistical form.

The byline for the Institute of Marine and Antarctic Studies is Turning Nature into Knowledge. The "Under the Icecap" project supplies a second line Turning Knowledge into Culture encapsulating a powerful Art and Science synthesis and simultaneously raising the expectation but also the risk of the endeavour. As stated, the primary aim is to produce a creative work which is compelling and affective but is at the same time a work of scientific utility ~ a tall order perhaps but one worth striving for. The key focus is the relationship of the environmental knowledge generated from Antarctic bio-logging data with the Anthropogenic changes in the biosphere.

Whilst the philosophical aims and direction of "Under the Icecap" remain consistent with its earlier manifestation as a concert series we now intend to develop the aesthetic scope, methodology and modality into a multi-modal format that encompasses sound-sculpture; installation; animated GIS mapping projections; and a significant live performance component. Future performative elements are envisaged as an experimental chamber Opera with both instrumental and vocal elements, set against data sonifications and ambient Antarctic recordings - in effect embracing, Geophony; Biophony; and Anthrophony.

Science is constrained by Objectivity and Impartiality and perhaps Art is constrained by Subjectivity and Partiality. Ironically, both disciplines experience similar difficulties in establishing an effective communication with either the public at large or the structures of governance and policy. The "Under the Icecap" core team is committed to exploring the environmental, social and political issues that are currently transforming our biosphere and are experimenting with radical means of expressing complex scientific research as cultural works that can render this knowledge into a broader cultural discourse.

GeneMusiK.
Starting in 2003 artist Joe Davis and I exchanged a series of ideas for encrypting information in DNA. Davis pursuing textual codes and I musical. At that time I was collaborating with the School of Agricultural Science (University of Western Australia) to develop a proof of concept system designed to translate music into DNA which when inserted into the plasmid DNA of Bacteria was able to be re-mixed, to be subsequently extracted and de-coded into novel musical forms.

Fast-forward eleven years to 2014 and Davis is working to realise his Malus Ecclesia project at the Harvard Medical School. Davis plans to transpose the fount of all human knowledge, Wikipedia (sic) within the junk DNA of an ancient strain of Apple. Malus in

Latin represents both Apple and Evil (whereas Ecclesia refers to Church - and pays an Homage to George Church the Harvard Professor with whom Davis is working).
This reprise of the Garden of Eden scenario, Davis will ultimately fill a grove of grafted apple trees which will presumably contain all branches of Knowledge. However the apples may be covered by an indictment against consumption, this time issued not by Jehovah but by the US food and drug administration!

In a similar vein I have continued to nurture my interest in the parallelism between Genes, Memes and Musical Notation considering them as mnemonic structures capable of evolution and functioning to embody and transmit memory.

Figure 5. Dr's Helyer and Albertyn at the UFS Microbiology Lab, Bloemfontien SA with GeneMusik bacterial cultures.

It is this powerful mnemonic metaphor that drives GeneMusiK to create a re-mix of cultural, social and biological pathways, by hybridising one set of cultural values with another via the transformations of musical and genetic codes employing Bacterial cultures.

To describe the method in simple terms - standard musical notation is converted to DNA codons using a set of conversion tables; the DNA is synthesised in the lab and can be manipulated, in-silica; in-vitro or in-vivo (in this case using E.Coli bacteria).

The 'rearranged' DNA can then be extracted and de-coded by the same conversion tables and rendered once again into musical notation.

In 2014 the VryFees Festival in Bloemfontien, South Africa invited me as an artist-in-residence to re-develop the GeneMusiK project. Based between a Micro-biology lab and a music conservatorium I worked with indigenous South-African San musicians who live in a bleak re-settlement camp some two hour drive to the West, near Kimberly in the Northern Cape. The aim - to hybridise local ethnic music with the epitome of the western musical tradition, a string Quartet from the University of the Free State, Odeion Music School.

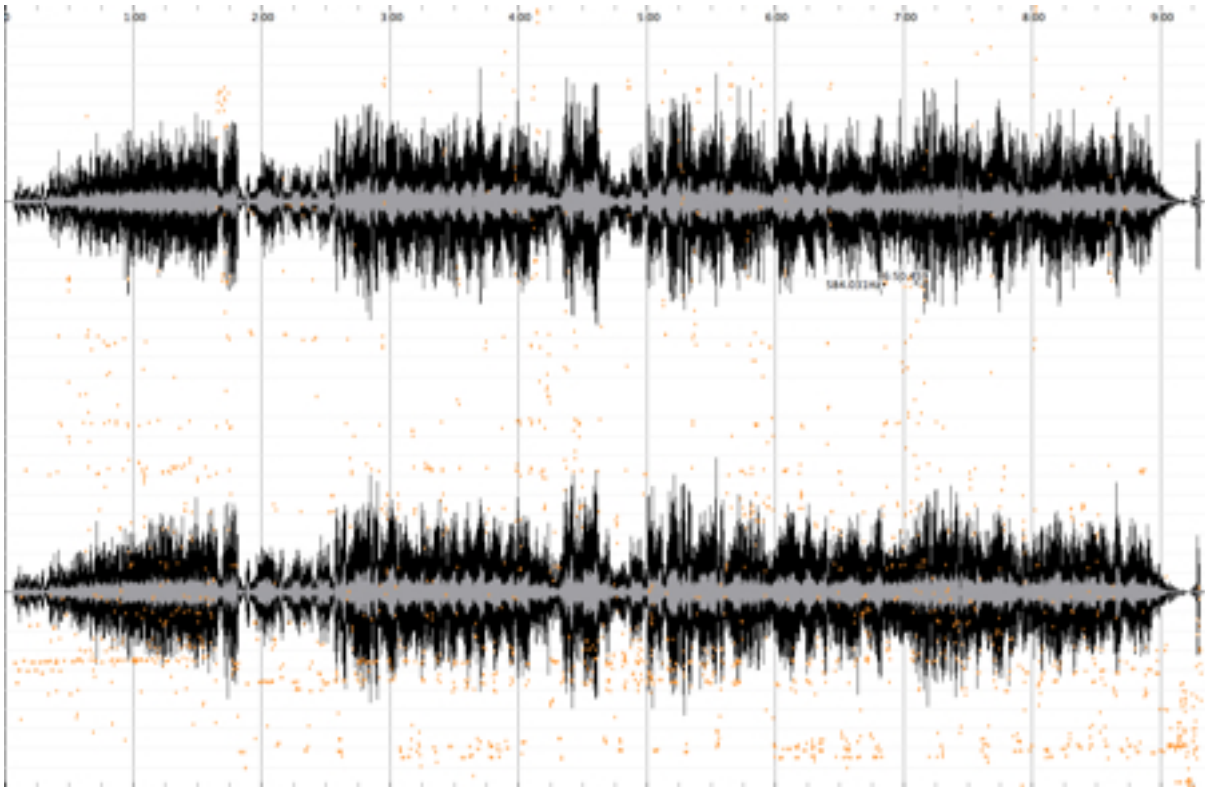

Figure 6. Sonogram of field recording of a San song.

During my sojourn in Bloemfontein, the project established a successful prototype of all the functional components that comprise the complex chain of transformations - taking audio field recordings (of San musicians) into musical notation, thence into DNA and then into Bacterial culture, to subsequently be extracted and ultimately rendered as scores for musical performance.

On my research travels I was fortunate enough to uncover a unique early transcription of San music discovered in an explorers publication from 1810. W.J. Burchell was a British polymath, scientist, botanist, musician and intrepid traveller and it was in his "Travels into Southern Africa" that I came upon an illustration of a seated San bushman playing a mouth bow (Gorah) accompanied by a musical transcription

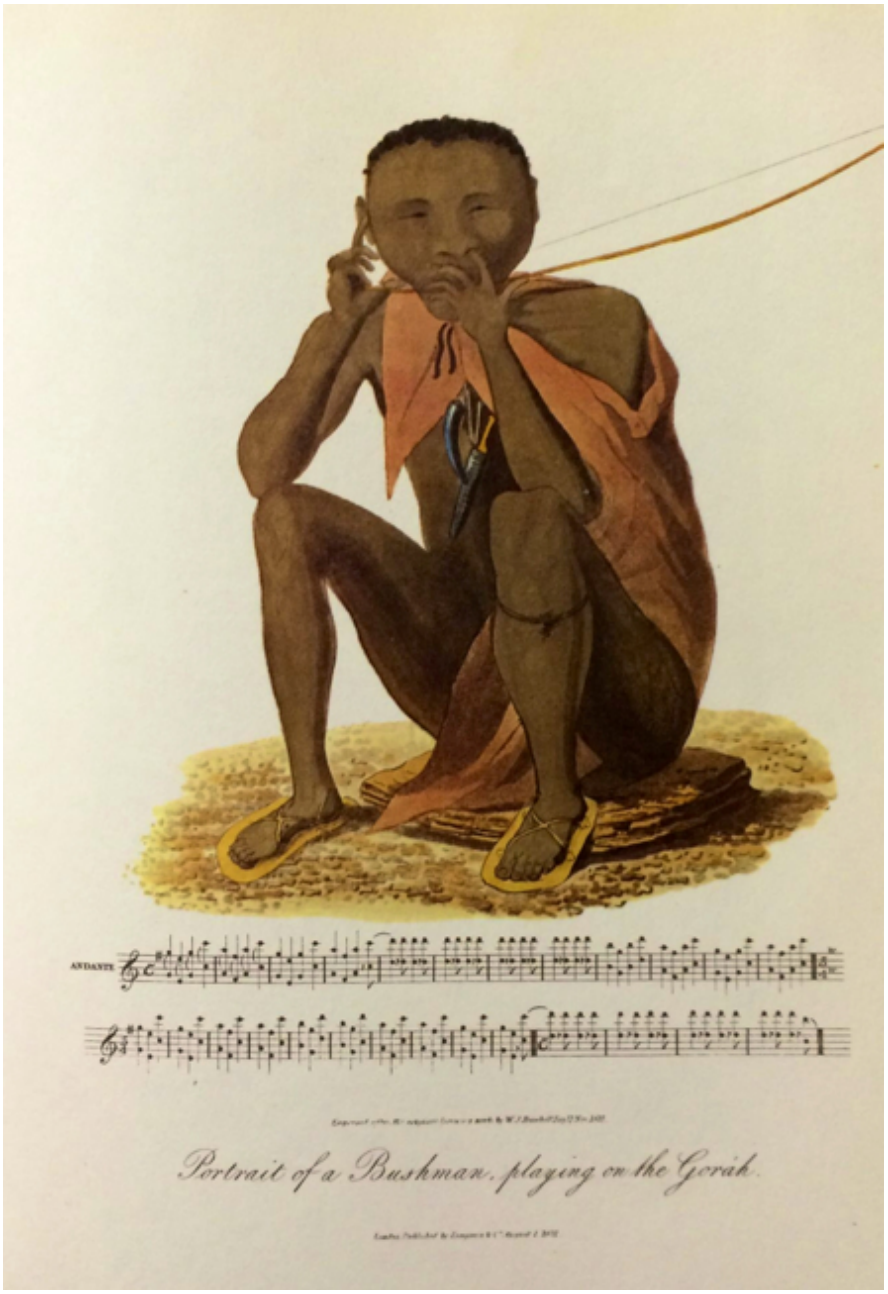

Figure 7. Drawing of a San Bushman playing the Gorah with musical annotation, from Travels in the Interior of Southern Africa, Burchill.

Using this simple score as an extra source of musical information an additional DNA sequence was generated and as before, the action of restriction enzymes were used to fragment the DNA code. The re-assembled fragments generating a novel sequence which was incorporated with the contemporary San content and merged into a final composition which was given to the Odeion String Quartet to play. The result from the initial rehearsals - a complex and challenging work and certainly not easy listening!

The next stage of the project will develop a full public performance, rendering a version of the South African national anthem and its multi-lingual lyrics.