

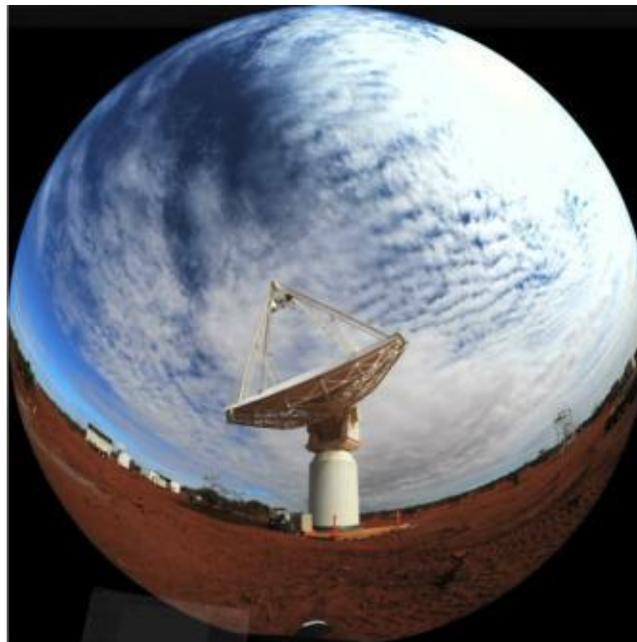
# SKY KNOWLEDGE: THE SQUARE KILOMETRE ARRAY (SKA) AS A FOCUS FOR ART-SCIENCE COLLABORATIONS

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Radio astronomy is being developed globally through the Square Kilometre Array (SKA) project. The decision for its location, either in Southern Africa or Australia, is expected in 2012 with construction from 2014 to 2024. How will the SKA be understood by broad audiences beyond the scientific community? This paper examines the potential of the SKA as a catalyst for art-science conversations and collaborative projects.



*Ilgarijiri: 'Things belonging to the Sky'. Photo © John Goldsmith, ICRAR*



*ASKAP Fisheye Photography. Photo © Paul Bourne iVEC@UWA with Jonathan Knispel*

## Introduction

The Square Kilometre Array (SKA) will be an array of dishes and antennas, which together form an enormous radio telescope. Collecting data from radio waves that can penetrate through cosmic dust, allows astronomers to study the centre of our galaxy. The SKA will extend current capabilities and enable astronomers to look into the past at the history of the Universe. Current developments towards this goal include the building of the Australian SKA Pathfinder (ASKAP) in Western Australia and the MeerKAT in Southern Africa. These telescopes will trial new technologies for the international SKA design.

The project is gaining momentum; it is therefore timely to see how the potential benefits are being communicated and appreciated beyond the scientific community, or how those involved in the development of the SKA are building cultural links with others interested in, or affected by, its development. In this paper I will explore how the SKA is portrayed, especially in art-science conversations and collaborations.

Radio astronomy has been the subject of artworks and a focus for theoretical discussion, as in *Astronomy: Leonardo Art and Astrophysics Working Group*. Examples of works include 'Radio Astronomy' (2004), a project by Radioqualia, devised by Honor Hagar; 'Deep Space' (2006) by Hellen Sky with Paul Bourke; 'Void Love' (2008-2009), a web-based soap opera by Nicky Forster and Willoh Weiland, with Dr Chris Fluke, Centre for Astrophysics and Supercomputing, Swinburne University, Australia; and 'Beam Me Up,' by the German group, Xcult, an online exhibition with guided tours curated by guest curators as part of the 2009 Year of Astronomy. The International Year of Astronomy in 2009 was a catalyst for work in this area. Examples of activities from Australia included star hunt programmes, commemorative coins, and travelling exhibitions from The World at Night (TWAN) photographers group.

Related areas of astronomy and space travel have been explored through artist in residence schemes, including NASA's residencies which started in 1962 (NASA 2009). Planetariums are important places for visual displays of the night sky. The aesthetics of these displays owe a great deal to the pioneering work of artist Donna Cox. Planetariums have also provided a venue for creative works such as 'Celestial Mechanics' (2005), a planetarium-based artwork installation devised by Gabriel Dunne and Scott Hessels. The 'Space, About a Dream' exhibition (Kunsthalle, Wein, April to August 2011) celebrated Yuri Gagarin's space flight. There is therefore a significant body of art works, in traditional media and electronic formats, demonstrating popular cultural interest in space exploration, through telescopes and by space flight.

Against this background of creative responses to the subject of astronomy, I will consider two examples of the exploration of aesthetics and creativity relating to the SKA that are associated with the physical site for the Australian SKA Pathfinder (ASKAP) in Western Australia. One provides the context for discussing the physical site and engagement with the traditional owners of the land, where a fully functioning SKA could be built in Western Australia. The other concerns how the SKA is being visualised *and* depicted using digital technologies. Images from both of these examples are becoming popular representations of this globally significant scientific and technological development. This commentary will provide the starting-point for suggestions about the characteristics of further art-science collaborations.

## The Square Kilometre Array (SKA)

The Square Kilometre Array (SKA) project is going to give scientists unique opportunities to study the formation of the early Universe. The SKA will be the world's largest radio telescope and is the focus of a

project started in 1993 when the International Union of Radio Science (URSI) established a Large Telescope Working Group. After a period of growth and consolidation the project now comprises an international partnership between 67 organisations in 20 countries. In April 2011 the Jodrell Bank Observatory, Manchester, UK, was selected as the host Project Office and a Founding Board established for organising the next phase of development of what is now terms a 'mega-science' project with €1.5 billion funding.

The decision for the final site will be made in 2012. The sites under consideration are in Southern Africa, with extensions to the Indian Ocean Islands, or Australia, with extensions to New Zealand. From the central area an array of antennae will spiral out to cover 3000 kilometres or more. The criteria being used to evaluate these sites include the availability of radio quiet zones, characteristics of the atmosphere, climate, infrastructure, maintenance and operational costs. There will be a pre-construction phase from 2013-2015 and then two phases of construction (2016-2019 and 2018-2023) followed by full science observations from phase one in 2020 and phase two in 2024. When the SKA is operating, sensitivity of telescopes will be 50 times and the survey speed 10,000 times that of current equipment. [1] The data will be used by the scientific community to explore fundamental unanswered questions about the formation of stars and black holes, the evolution of galaxies, and existence of magnetic fields. Researchers will also investigate gravity to ask further questions about the theory of general relativity and seek to detect extra-terrestrial signals, and search for amino acids to detect forms of life or places where life might be supported. These questions are of interest to others beyond the scientific communities and have been investigated by artists, individually or as part of a collaboration with scientists.

#### Ilgarijiri: 'things belonging to the sky'

A project directly related to the SKA in Western Australia was Ilgarijiri, meaning 'things belonging to the sky' in the Wajarri language. This was a joint project between Professor Steven Tingay and colleagues, from Curtin University and the International Centre for Radio Astronomy Research (ICRAR) and staff and artists of Yamaji Art, Geraldton, Western Australia. The project explored the connections between Aboriginal astronomy and the astronomy associated with the SKA. These artists live in the region of the proposed location of the SKA. Radio astronomers from Curtin University spent time with the Yamaji artists and shared stories, scientific and traditional, about the way they observed nature and the sky. Work by the Yamaji artists, resulting from these conversations and a visit to Mullewa and Boolardy Station, was exhibited in Geraldton Western Australia in June 2009 and then at the University in Perth, Western Australia in October 2009. The work also went to the Australian Institute for Aboriginal and Torres Strait Islander Studies (AIATSIS), in Canberra, and was on view from November 2009 to January 2010. The work was also shown internationally as part of a 'Communicating Astronomy with the Public' conference, held in Cape Town in 2010.

Paintings from the exhibition bring to life stories from indigenous astronomy. [2] For example, a painting by Margaret Whitehurst, 'Emu in the Sky' shows the Emu representing the dark space in the Milky Way that is recognised for its 'emu' shape. The emu's head is near the Southern Cross and its body and legs are dark areas that reach towards the Milky Way in the direction of the constellation of Scorpius, in the southern night sky. The greater visibility of the emu, from May to September, was a sign to hunt for emu eggs, a welcome food for the community. Radio astronomers comment on the relationship between this recognition of the dark spaces in the sky, as opposed to the stars, and their exploration of space through radio waves. As well as recognising the different ways of interpreting the sky, similarities were noted about recognition of visible and invisible parts of the spectrum.

The exhibited paintings gave audiences a view of the richness afforded through observing the night sky and ways of relating the changes in the sky to everyday living patterns and the seasons. The sharing of knowledge was a conversation, with the Yamaji artists embracing ideas from the trip to see the possible location for the new equipment for radio astronomy, as some of the paintings in the exhibition are also a record of that journey to the possible site of the SKA. For the astronomers and the exhibition audience there are opportunities to embrace views of the cosmos with a long and enduring timespan of development. There were also opportunities to work with the local community and collect video documentation of stories about the paintings. Through the project the scientists were able to connect with the traditional owners in the local community where the proposed SKA would be built. The science was therefore contextualised within a social context that embraced the location of the ASKAP. Direct economic benefit also came to the indigenous community through the sale of works from the exhibition and ongoing publicity through a website, TV and press coverage. [3]

The ASKAP project is bringing economic change to the remote area. The Ilgarjiri project is making important educational and cultural links, especially between art and science. It is also providing a context within which to understand our appreciation and reactions to remoteness in an increasingly populated and networked world. For radio astronomers to collect data about the universe radio-quiet locations are needed. Landscapes and environments in a remote location on Earth is being associated with the gathering of information from even more remote locations and across immense distances. In a globally shrinking networked world we are still challenged and excited by the immensity of physical space. As a counterpoint to this demonstration of remoteness and distance, the Ilgarjiri project interestingly demonstrates connections across time. Links are being made between the indigenous knowledge, from a diverse culture with many different groups, to the scientific activities and engagement in a global research project developing new technologies to see back though time and ask questions about the evolution of the Universe.

### Scientific Visualisation and the SKA

The SKA is being publicised internationally through a promotional animation that is freely available for viewing along with other images and resources available for downloading for educational purposes. [4] The promotional animation was produced by the 3D Productions Group attached to the Centre for Astrophysics and Supercomputing at Swinburne University of Technology, Melbourne, Australia. The movie takes viewers on a fly-over tour of the site showing the three different kinds of telescope array, followed by a depiction of the scale of the enterprise when it is finished. The animation has to represent a site that has not yet been chosen.

The group has also produced a promotional animation movie for the ASKAP, which takes the viewer through a scene where the telescopes are shown in a visualisation of the Murchison terrain against the backdrop of a rapidly changing sky, from sunrise, through daytime and night time. The smooth movements of the telescopes are shown against the silhouettes of vegetation, depicting a vegetated but otherwise sparse and empty environment. As a viewer we 'fly' over this landscape, as if in a plane, able to see but not touch.

The ASKAP project has provided an interesting subject for experimentation in visualisation. In 2010 Paul Bourke and Jonathan Knispel created visualisations of the Pathfinder on the Boolardy station. [5] As the designs for the SKA telescopes are still being developed, the visualisations, such as these that are in circulation, are integral to the communication process within the project as a whole. In addition the images

are beginning to circulate as part of outreach and public communication side of the project. The images developed by Paul Bourke are also experiments for testing the latest technologies for high resolution gigapixel images, movies, fisheye images, files for Google Earth and Fulldome productions.

In these examples there is reference to 'realism' in so far as the digital technologies being used are associated with collecting accurate data and are photo-realist in style. But the examples comprise highly constructed virtual environments and depict models of the telescope still in evolution.

Roger Malina, a trained astronomer, artist and critic reflecting on dark matter, has commented on the importance of instruments that allow us to access the world beyond our immediate senses, saying that "It is hard to describe the thrill of building a new device and then being the first to be able to see a previously unknown part of the universe." Malina's comments are relevant for considering the relationship between science and technology, which he terms 'techno-science'. He emphasises the importance of instruments, noting: "Certain kinds of knowledge just cannot be obtained until an engineer has invented the right device." [6] Malina adds that for astronomy such instruments are the key to overcoming the limitation of the low range of senses offered by the human body.

The promotional visualisations of the SKA give primacy to the instruments to be used to collect the data. These virtual representations of the physical objects of the SKA are statements suggesting a 'grounding' of the project, which also presents us with iconic statements about the project's technological advancement.

These representations offer an opportunity to reflect on the changing relationship between astronomy considered as a pure science, answering fundamental questions, and the technologies needed to achieve its goals. The historian Paul Forman has reviewed changing attitudes to science and technology and the emergence of an identifiable postmodern reversal of the conception of technology as 'applied science' and as such inferior to science. In a postmodern view technology subsumes science. This is not technological determinism but recognition of 'ordering activities' that constitute culture. [7]

A greater appreciation of the instrumentality of the SKA and the current appreciation of these physical instruments within the development of astronomical knowledge places radio astronomy in the domain of postmodern science, where, in Forman's terms, technology is a set of means to an end or ends and there is less consideration of method. The visualisations account for the current stage of the project, but this may be an indication of the broader ways in which astronomy will be conceptualised as the project is developed. In Forman's terms: "In postmodernity, with technology acquiring primacy, the word 'technology' gradually becomes capable of including science in its denotative compass". [8] As the SKA progresses, artists will have the opportunity to explore the significance of these instruments and how they relate to the changing view of astronomy within postmodernity.

## Opportunities

A notable feature of these two related but distinctly different ways of creative and innovative engagement with the development of the ASKAP, as part of the development of the SKA project, is the strong sense of appreciation of a location to communicate ideas that are about exploring distant space. Both projects take us to the Outback in Western Australia and draw attention to the physical remoteness of the possible site for the SKA. This forms a focus for association with cultural attributes that might then become strongly associated with the project.

Choice of location is a predominant feature of the current development of the SKA. The projects described here highlight that preoccupation through the communication of information about interpretation of 'place' associated with one of the possible SKA sites. 'Real world' locations are therefore relevant to the broader narrative and can act as anchor points for future creative work.

There is immense potential for art-science collaborations to explore further aspects of the development of the associated science and technology. What the SKA offers is the potential for artists to consider the implications of the vast volume of data that will be produced that is even a challenge for those developing the SKA. [9] We also need to explore the shifting definitions of pure and applied science. This offers further opportunities beyond those already being demonstrated by the work of the many artists interested in 'applied' areas such as the bio-sciences and nanotechnology.

This interest in the 'applied' is consistent with the observations made above, of a shift to a 'postmodern' science. How will this affect our conceptions of astronomy when associated with the development of the SKA? Additionally, there will be many spin-off technologies. It will be interesting to see how art, associated with radio astronomy, can help us understand this shifting balance between science and technology.

#### **References and Notes:**

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