StellrScopE

Eleanor Gates-Stuart

StellrScopE
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CSIRO Questacon The National Science and Technology Centre pufferfish

Contents

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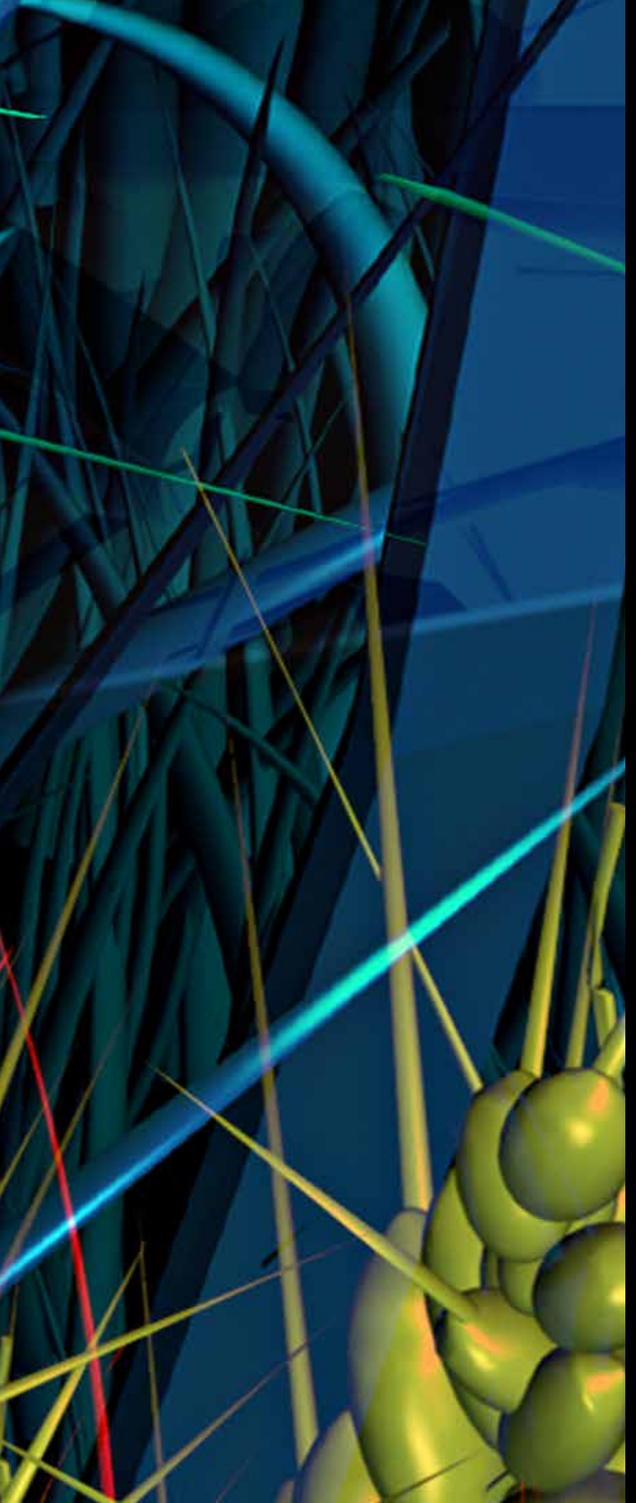
'Spikes'
Photograph by Dr Megan Hemmings, CSIRO



Contents

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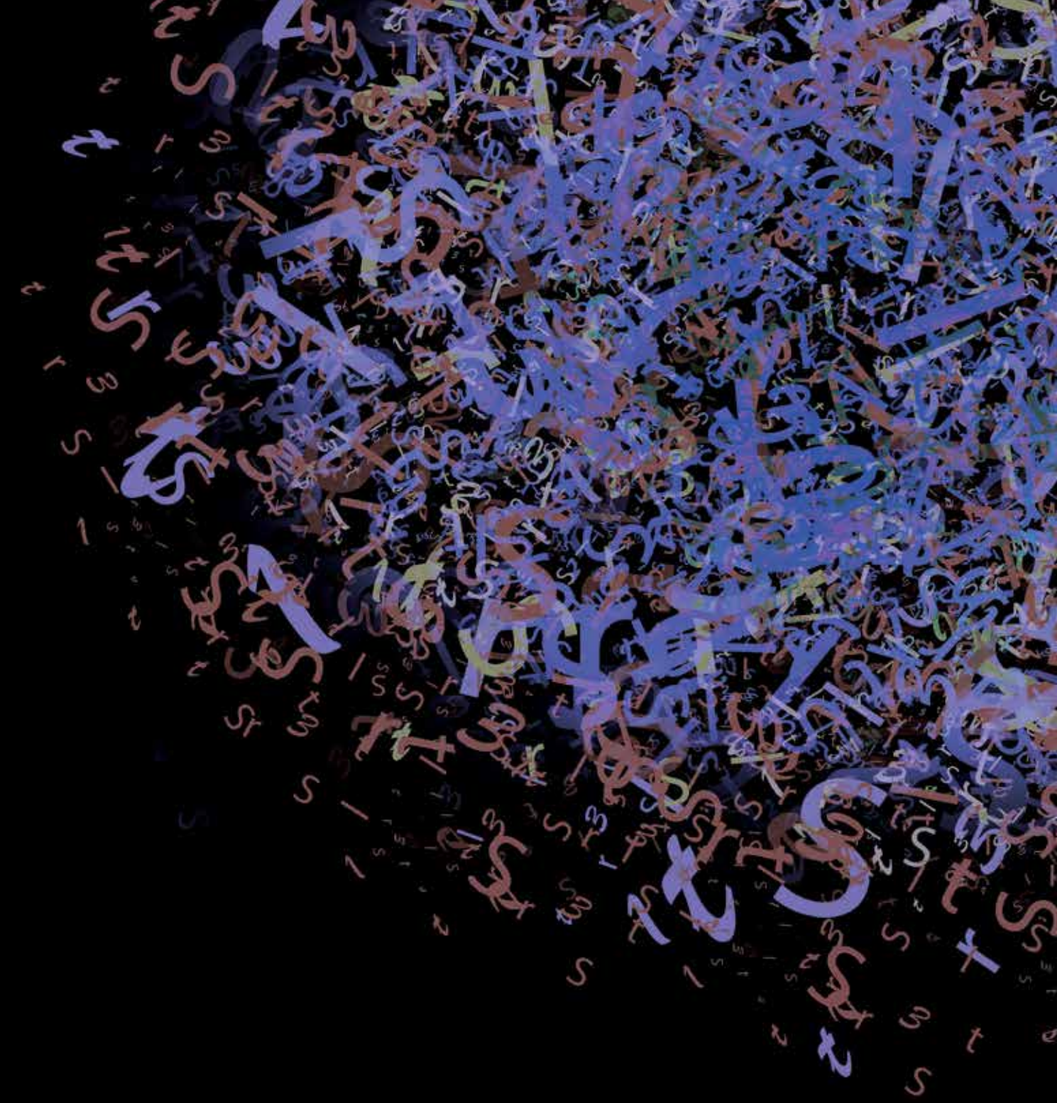


StellrScopε

Eleanor Gates-Stuart

StellrScopE
ACT Chief Minister's Foreword

Canberra artist Eleanor Gates-Stuart's 'StellrScope' is an extraordinarily creative and innovative art work. Its stunning fusion of art, science, and digital technologies is sure to inspire everyone who views it.

This exciting project has come about through the Centenary Science Art Commission, which made it possible for a local artist to work in residence with a nominated science institution to develop a new work for exhibition in Canberra's centenary year.

Eleanor's project is the result of a close partnership with the CSIRO. It explores and builds on the story connecting William Farrer's early research on wheat at 'Lambrigg' near Tharwa to the ground breaking agricultural research currently being conducted at CSIRO.

She manages to tell this story in new and beautiful way, using the latest digital technology to observe the remarkable stages of wheat growth and development.

Recognising Canberra's role in the nation's scientific achievements is an important goal of the Centenary. 'StellrScope' will leave a lasting legacy of our Centenary and reinforce our city's reputation as a world leader in the fields of science and the arts.

'StellrScope' will be on exhibition at Questacon in August this year, coinciding with its 25th anniversary celebrations. An exhibition documenting the 'StellrScope' residency is also being held at the CSIRO Discovery Centre.

On behalf of the ACT Government I'd like to thank the William Farrer Trust for their sponsorship of this beautiful catalogue. I'd also like to express my appreciation to the CSIRO, who have worked in close partnership with Eleanor and the Centenary team to produce this amazing work.

Katy Gallagher
ACT Chief Minister

'Traces of Words Over Time'
Carbon Copy Paper from William Farrer's Field Book.
National Library of Australia

Preface - StellrScopE
The Centenary of Canberra

One of the main aims of The Centenary of Canberra has been to reveal Canberra in a new light; to show a city much more diverse in every imaginable way than the political mono-profile that frequently steals the thunder of the national capital's other splendid achievements.

Scientific achievement has been core to the innovative spirit of this city, and in the history of the CSIRO one can discover a national agenda through its priorities. When I looked at the number of fine Canberra-based artists working, often in intense collaborations, on scientific themes , it seemed that a science-art commission was a good way to illustrate the strengths of both domains.

The expressions of interest drew strong proposals, and StellrScope was appealing to the adjudicating panel because it connected so well with the history of this region – in particular to the experiments here of William Farrer, and the crucial role that the CSIRO subsequently played in following those experiments to develop 100% of Australia's (and 70% of the world's) resilient wheat strains. The relationship of that story to the highly sophisticated technology used today to tackle the challenges of research and experiment towards feeding an exploding global population, is expressed in the kind of media which Eleanor Gates-Stuart has explored in this project.

My thanks to CSIRO, to Questacon, and to all those who have responded generously to Eleanor's requests in the development of the project: I trust it will be a source of great enjoyment to all.

Robyn Archer AO
Creative Director, Centenary of Canberra

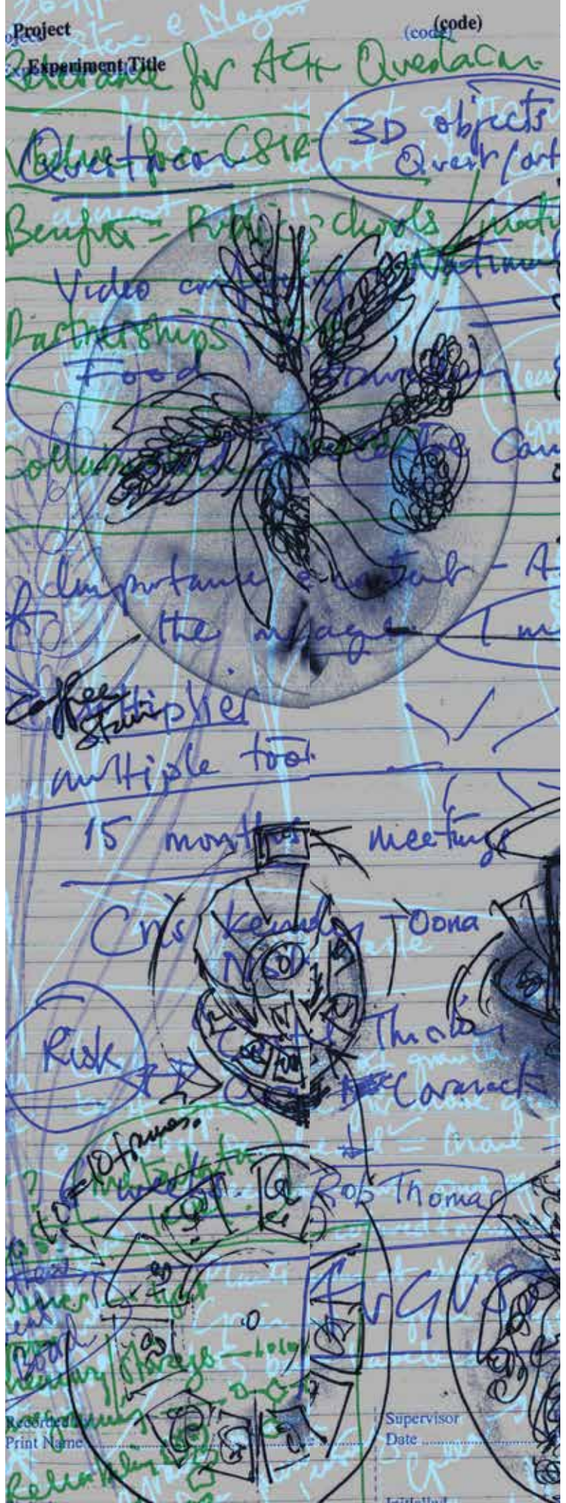
Artist Preface - StellrScopE

StellrScope builds on a story connecting the Canberra region to Australia's major crop to deliver a science artwork for the Centenary of Canberra. It celebrates 100 years of wheat innovation from the days of William Farrer through to the present day research undertaken at the Commonwealth Scientific and Industrial Research Organisation (CSIRO), namely in the Future Foods Flagship and Computational Informatics.

Coining the term, *StellrScope,* to describe *translating information complexity into a simplistic visual rendering of meaning*, is significant in such a project where the volume of scientific information is possibly overwhelming for non-scientists and requires a comprehensive visual interpretation. In tackling such a project, the processes involved are not always predetermined and respond much more to the direction of ideas, content building, researching and an aesthetic understanding and construct for creating the artwork. That being said, the question of "how to represent 100 years of meaningful content in a singular artistic outcome for the Centenary of Canberra as well as an artwork with equal value and understanding for CSIRO?", is the challenge.

StellrScope takes a step beyond the biological fingerprint codes, evident in my previous artworks, and is a deep and intense scrutiny of the remarkable physical and biochemical traits of organisms in physical plant structures. Despite first appearances, quantitative sciences like mathematics, informatics and statistics have long-standing and deep connections to biological science. Statistics owes much to motivating problems in agriculture, such as animal and plant breeding. Modern molecular biology is currently awash with data from instruments that tell us about the DNA of living organisms – informatics, particularly computational science, is an essential part of dealing with this deluge of data. StellrScope simplifies this complexity into stunning images of aesthetic analysis and graphical interface, extracting complex visualisation data with image to construct narrative via interactive hemispherical displays, named *StellrLume Domes* as an installation artwork for the Centenary of Canberra.

This work is a result of collaboration at CSIRO, working with scientific leaders Dr David Lovell and Dr Matthew Morell including many other valued scientific researchers and linkage partners such as the William Farrer Trust. Notably In Canberra, this all ties in to the work of the CSIRO's Food Futures Flagship's Advanced Grains Theme (led by Matthew) which is currently looking at new strategies to understand how the genome of a wheat plant affects its physical traits: its phenome. And this, in turn links to work of the Australian Plant Phenomics Centre which seeks to measure and understand the physical traits of plants as they develop in different environments.



'Notebook'
Eleanor Gates-Stuart

This innovation of national significance certainly extends the early research achievement of William Farrer who no doubt would be immensely proud of this research legacy and inspiration towards to StellrScope. It is interesting to note that William Farrer[1] said, "I find my notes have been kept so unsystematically and that so much has been forgotten which was of principal interest at some stage of the work…if justice where done to it, it would be likely to furnish suggestive information to others who might wish to take in hand work of a similar character, either with cereals or with some other domesticated plants". His work has certainly been taken in hand and hopefully, StellrScope, plays a significant contribution to this through the Centenary of Canberra's foresight to award this science art commission and pay tribute to Australian innovation over the last one hunred years.

Making it happen

Rather than a methodological approach of selecting particular years with events, the focus of StellrScope has been centered on various themes, such as growth and development, pest and disease, technology and bioinformatics, including health and future food. Since the project is situated with the department of Computational Informatics it might begin with images using numerical data, or code, as visualisation methods are often extracted from data, such as algorithm or more typically, data sets. Mathematically applying a formula to represent artistic methodology and thus, identifying the process of image making did not equate to the real symbiotic process of the interconnected relationship of the scientist and artist. At CSIRO, there is a unique relationship between the sciences and art. The key to this is importantly around relationships and the mutual respect in sharing knowledge and understanding of the inherent value of research expertise. Confidence and trust go hand in hand as words and images are exchanged, as well as personal insights and stories unfold. As with science, it is not always what appears on the surface that tells the story but the means to explore the evidence, or in this case, the visual narrative within the beauty of the aesthetic.

StellrScope is an opportunity to encompass a visual dialogue and set of references within the artwork itself. Interestingly these results have in fact been encoded into the artwork, embedded as visual layers, accessible via interaction, an informatic and installation that is the intention of artwork. One thing is certain, the visible impact of being the resident Science Art Fellow in CSIRO shows the artist as a creative catalyst amongst researchers and scientists, with evidence and integration of ideas influencing other research directions and public programs.

1 W. Farrer. 'The Making and Improving of Wheats for Australian Conditions',* March 1898. Agricultural Gazette of N. S. Wales. A paper read before the Australian Association for the Advancement of Science, 10 January, 1898.

'In the Field'.
Photograph by Eleanor Gates-Stuart

'Wheat'
Photograph by Steve Jobling

Artist Preface - StellrScopE ...continued

CSIRO is to be applauded for its commitment to science art initiatives[1] and its relationship to the arts in its 80+year history. *StellrScope* certainly provides a topical research project with many dimensions to explore in a multidisciplinary research organisation. The evidence and extraordinary value of this stems from the catalytic growth of network activity across the research of the national science organisation and the collaborative synergy invested in the project. The artworks draw on research participation from the Australian National Insect Collection, Ecosystem Sciences, Food Futures, Plant Industry, Computational Informatics, Material Sciences and Engineering including the Australian Synchrotron, the National Film and Sound Archive and the National Library of Australia. The outcomes extended the StellrScope project for both artist and scientist into research publication, conference papers, multiple exhibitions and media coverage.

The formula is simple:

- willingness to collaborate and openness in sharing information
- respect for research integrity and IP sensitivity
- openness to explore new ideas (recognising independent time constraints of all parties
- commitment to deliver
- say it as it is – questions are helpful
- negative results are only a different method to focus positive alternatives.

Interestingly, David Edwards in his book, *ArtScience*,[2] refers to the three principles that apply to his art stories at Le Laboratoire Artscience Centre in Paris: i. Process matters more than results, ii. Experiments are never repeated, iii. Results are never bad. Truly a creative approach in which the StellrScope project adheres to be like, in that collaborations are new and original and do not impose results to limit process.

Eleanor Gates-Stuart
CSIRO Science Art Fellow
Honorary Research Professor, UCSC
Centenary of Canberra Science Art Commission, 2013

1 CSIRO Science Art: http://www.csiro.au/Portals/Education/Programs/SCIENCE-ART.aspx
2 Edwards, D. ArtScience: Creativity in the Post-Google Generation, Harvard University Press 2008, P181
Le Laboratoir: http://www.lelaboratoire.org/en/who-we-are.php

'Visionary'
Reference: William Farrer's Field Book.
National Library of Australia

The Art of Wheat Improvement – From the Age of the Impressionists to the Digital Era

Wheat is a remarkable crop, grown in a wide range of temperate latitudes across the world. The 600 million metric tonnes produced annually are a major source of calories and protein for humanity, but also form the basis of very important cultural and culinary experiences for people from all walks of life.

The opportunity to work with Eleanor Gates-Stuart in her capacity as a Science Art Fellow with CSIRO, and as awardee of Science Art Commission of the Centenary of Canberra, has been an important collaboration between Eleanor and a wide range of scientists involved in wheat research at CSIRO. As scientists, we marvel at the complexity, the elegance, the utility and the productivity of this most important crop. We see that there is artistic appeal at a variety of levels, from a field of wheat rippling in the breeze, to the regimented architecture of an ear of wheat, to the fascinating structure of a developing meristem, to the sub-cellular architecture of the grain or the leaf. However, as scientists, while we respect the inherent beauty and visible appeal of the plant and the crop, our days jobs are primarily concerned with the understanding and improvement of function and utility.

Wheat has a special relevance to Australia, as it is our most valuable export crop, contributing between $4 and $5 billion dollars in export revenue per year and generating about $2 billion dollars in domestic economic activity, through farming, other rural employment, and the grain accumulation, export, flour milling, and food production industries.

The most extraordinary aspect of wheat is the vast array of end products for which the wheat can be used, ranging from traditional uses such as breads, breakfast cereals, pastas, biscuits, cakes, flat breads, steam buns to the hundreds of variants of each category of end use. It is not as well known that wheat is also extensively used for industrial purposes such as ethanol production and paper manufacturing.

Wheat established a tenuous foothold in Australia through the introduction of wheat strains from India, Europe and the Americas, but these wheats did not thrive in the challenging Australian climate, struggled in our soils, and were susceptible to a variety of devastating diseases. The extraordinary pioneering work of William Farrer set in train a process that continues to this day, using the genetic principles established by Mendel to improve all aspects of wheat productivity and quality.

A remarkable feature of Farrer's early work was that not only did he seek to produce wheats with adaptation to the environment, and resistance to disease, he was also ahead of his time in seeing genetics as a vehicle

to improve the bread-making quality of his wheats. Farrer's collaboration with Frederick Guthrie was critical to initiating a strong tradition in Australia of focusing on the production of high quality wheats that meet consumer needs. Producing wheats that hit the trifecta of productivity, disease resistance and quality remains the holy grail of the wheat industry to this day.

Tremendous advances have been made in wheat genetics, but also wheat agronomy and disease resistance, from the 1960's onwards. The step changes in productivity brought about by the green revolution were based on the recognition by Nobel Laureate Norman Borlaug and colleagues that reducing plant height allowed increases in productivity through converting more of the biomass produced into grain, rather than vegetative mass. Wheat research remains a core focus of the plant science research of CSIRO, where CSIRO scientists are world leaders in understanding the physiology of the crop, studying how the plant copes with water, and understanding how the crop performs in response to nitrogen, to heat, and more recently, to increasing levels of carbon dioxide. These studies have led to tangible outcomes for wheat breeders, for agronomists, for farmers, and ultimately, for the nation.

Over the past few years, the pace of development of the tools for wheat genetic improvement has dramatically increased. Only a few years ago, wheat genetic maps with a thousand molecular markers were state of the art, as was a genetic transformation efficiency of less than 1 per cent. Increases of over 50 fold in both marker density and transformation efficiency have dramatically redefined what is possible. The challenge for the scientists is to now harness these tools to increase the rate of crop improvement to meet Australia's agricultural production needs, while also contributing to the global need to increase food production in the face of food security concerns, climate change challenges, and the need to not only supply calories but balanced nutrition to the world's population.

Eleanor's contribution has been multi-faceted and challenges us to re-evaluate our subject from a range of perspectives. Eleanor undoubtedly relates to the wheat plant and crop as a source of artistic inspiration, reminding us of the beauty and elegance of the underpinning biology. However, Eleanor also asked us questions about the science that required that we articulate the basic drivers underpinning the research. Why are you studying germination? Why are some plants waxy in appearance and other aren't? Why does it matter if there are awns or not? These questions draw the scientist out to articulate to a non-specialist the purpose and value of their work. Eleanor has also

'PlantSeedMan'
Eleanor Gates-Stuart

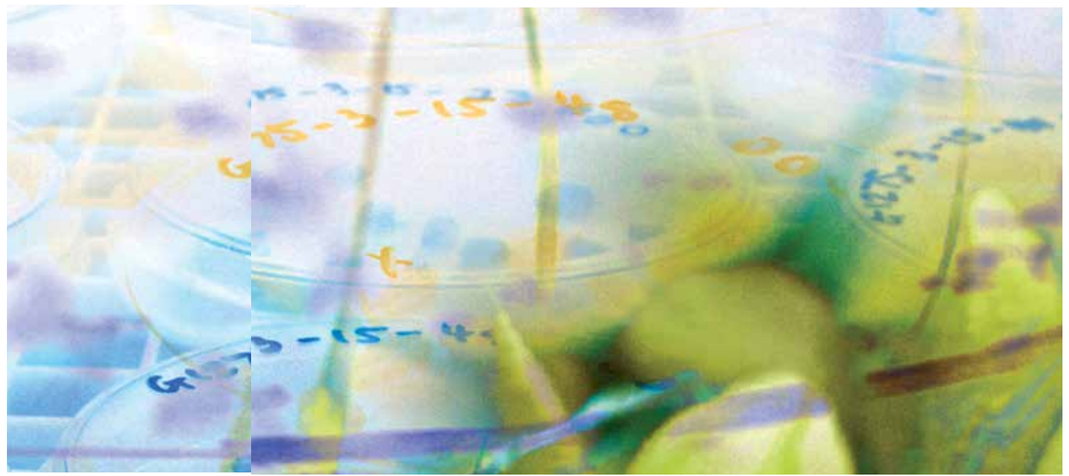
'Willam Farrer'
Photograph: William Farrer Trust

challenged us to explain the more abstract aspects of our work. How would you visualise for a lay audience the processes of genetics principles and statistical processes that allow the association of particular regions of the wheat genome with key production traits? Her images seek to capture not only the concrete but the abstract aspects of our science.

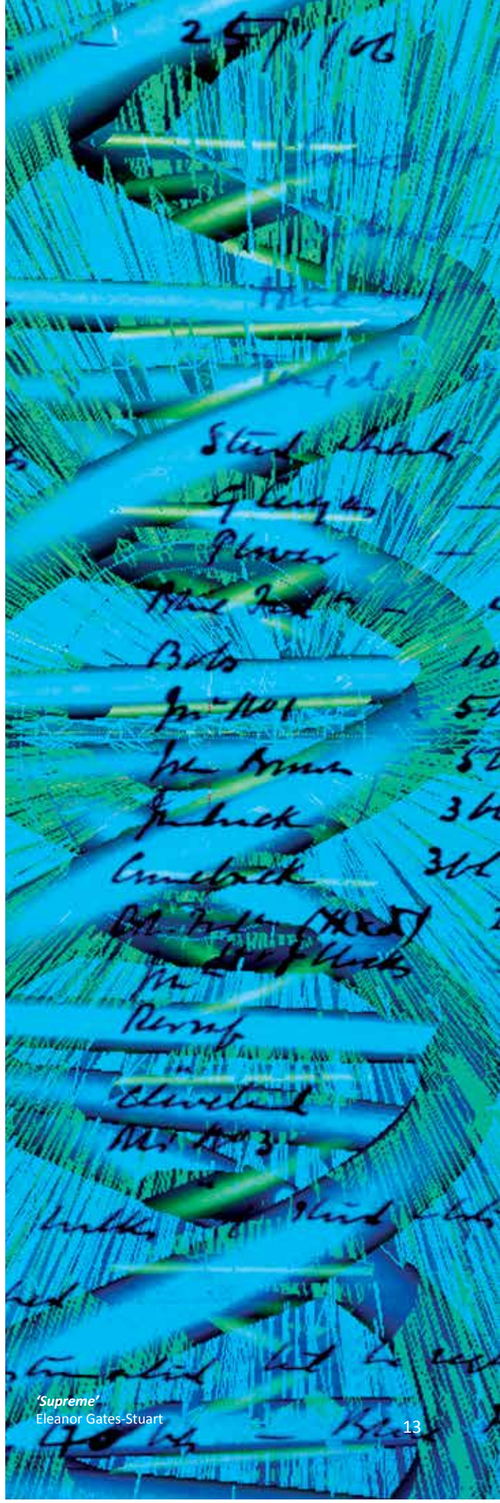
In interacting with the scientific teams, Eleanor has acted as a cross-pollinator, seeing connections between the work of different groups and encouraging them to discuss how they would communicate their work through common threads. The contribution Eleanor has made through her Science Art Commission and time as a Science Art Fellow has involved the generation of tangible outcomes such as those included in this exhibition. Eleanor captures the excitement of the research and of the scientists and makes images that invite enquiry and further engagement. However, in addition to these specific outcomes, an enduring and yet intangible legacy from working with Eleanor has been to explore the similarities and differences between artistic and scientific creativity and expression, and this has been an eye opener for both the scientists and the artist.

I am sure I can speak for all of the wheat scientists involved in this project who have found it an absolute privilege and pleasure to have interacted with Eleanor. The images that have come from this work will help us to convey both the purpose but also the spirit of our work for many years to come. We look forward to continuing to develop the connection between science and art, as both continue to enrich people's lives.

Dr Matthew Morell
Theme Leader,
CSIRO Food Futures Flagship



'Multiple of Blue'
Eleanor Gates-Stuart



'Supreme'
Eleanor Gates-Stuart

Farrer Memorial Trust

When William James Farrer set sail for Australia he could not have imagined that he would one day be referred to as the 'father of the Australian wheat industries' for his pioneering work breeding new varieties for Australian conditions.

More than a century since his legacy lives on – not only in the Australian wheat fields – but in science's pursuit of excellence.

He was born the son of a farmer in 1845 at Docker, Westmorland, England and began studying medicine at Pembroke College, Cambridge, but at the age of 25 he contracted tuberculosis and migrated to Australia.

Working as a surveyor with the Lands Department of New South Wales in the Dubbo district, Farrer saw many failed crops. He believed the Australian conditions were unsuitable for the current types being sown.

In 1886 Farrer settled at Lambrigg on the Murrumbidgee River near Queanbeyan and commenced his private experiments of cross-breeding wheat with the idea of producing high yielding, high quality rust and drought resistance wheat.

Farrer joined the Department of Agriculture in 1898 working mainly at the Experimental Farm at Wagga Wagga also at Cowra and other experimental farms.

Farrer's first crosses were between the Indian and Canadian Fife wheats, but he soon realised for Australian conditions the productivity of Purple Straw was required. The triple cross of these three wheat types produced his most notable achievement 'Federation' wheat, the leading variety throughout Australia from 1910-1925.

Farrer's early maturing wheats established a rapid expansion of wheat growing in Australia. He was Australia's first durum wheat breeder.

Following the death of Farrer in 1906, a committee was formed to raise subscriptions for the establishment of a Memorial Fund, control of which was transferred to a Trust.

The Farrer Memorial Trust was established in 1911 to perpetuate the memory of William Farrer and to encourage and inspire agricultural scientists.

The first Farrer Memorial Research Scholarship was awarded to W.F.L. Waterhouse who undertook research into the effects of superphosphate on Australian wheat in 1912-1913.

Initially the Trust awarded scholarships and later it included the delivery of an annual oration.

The first oration was delivered by the Prime Minister of Australia, the Rt Honourable Joseph Lyons MP on

'SuperStrain'
Eleanor Gates-Stuart

3 April 1936 at Queanbeyan when a silver medallion was presented to him by the children of the Queanbeyan Intermediate High School as a memento of the occasion.

This medal has been donated to the Adolph Basser Library, Canberra, where it is on display.

In 1944 the Farrer Memorial Medal was presented to John Pridham who had lived and worked with William Farrer.

Many past Farrer Memorial Medal recipients have acknowledged the work of Farrer in their oration speech.

The Farrer Memorial Medal and oration have continued to be presented annually to a distinguished agricultural scientist for service rendered in the fields of research, education or administration.

The medallist is chosen by the Trustees of the Farrer Memorial Research Scholarship Fund.

In addition the Trust established the Farrer Memorial Travelling Scholarship which is designed to support overseas travel by post-graduates enrolled for a PhD on any aspect of field crop research. This can include attendance at an international conference where a paper or poster is being presented.

The Chairman of the Farrer Memorial Trust, Dr Richard Sheldrake AM Director General of the Department of Primary Industries said the Farrer Memorial Trust has a long history promoting the valuable innovative research, activities and contribution of the Australian agricultural industry.

"Through the leadership and dedication of distinguished agricultural scientists in research and development we can be sure Australian agriculture will thrive," Dr Sheldrake said.

"This year's Farrer Memorial Medallist, Andrew Inglis AM is a grain producer who has made a significant national and international contribution to the Australian grains industry through agricultural research and to Australia's quarantine policies.

"Mr Inglis is the current presiding member of the South Australian Natural Resource Management Council, Chairman of the Future Farm Industries Cooperative Research Centre and Chair of the Biosecurity Advisory Council.

"To support grains research and development Mr Inglis has chaired a wide variety of Australia's grain and agricultural bodies including Plant Health Australia, the CSIRO Stored Grain Research Council and the Grains Research and Development Corporation.

"The Farrer Memorial Trust will continue to perpetuate the memory of William Farrer in recognition of distinguished service in agricultural science in Australia," Dr Sheldrake said.

The legacy of William Farrer's work continued with the establishment of the Wheat Research Institute and the Wagga Wagga Agricultural Institute, with many achievements in wheat research and development.

Some highlights include:

- the introduction into Australia of the semi dwarf wheats
- the release of the first wheat cultivar with Agropyron based disease resistance
- extensive research on Septoria tritici and resistant varieties
- the establishment of the 'Southern Hard' wheat grade.

Today, NSW DPI works in partnership with the University of Adelaide and the Grains Research Development Corporation (GRDC) on the Australian Durum Wheat Improvement Program at the Tamworth Agricultural Institute.

The national program looks at new varieties for early sowing, reducing the impact of crown rot, improving yield, drought resistance and quality.

Grain from durum is used to make pasta and semolina products. The quality of Australian durum wheat is regarded by Italian durum millers and processors as among the world's best.

With projected climate change the challenge is to breed varieties that will show improvement in yield and disease resistance.

Currently Australia produces between 400,000 and 500,000 tonnes annually, with Australian wheat exported to the Middle East and many South East Asian countries.

It is anticipated that Australia's durum wheat production will rise to bring substantial income benefits to Australian growers and rural communities.

Past winners of the Farrer Memorial Medal and copies of their Oration are available on the Department of Primary Industries website
http://www.dpi.nsw.gov.au/aboutus/about/farrer-memorial-trust

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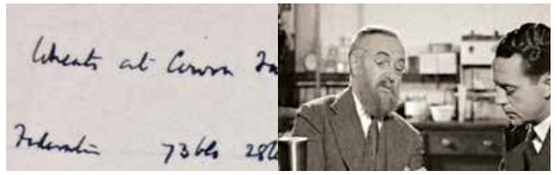
Durum wheat production, Published by the NSW Department of Primary Industries November 2008
Wheat and Wheat Quality in Australia, D.H.Simmonds, CSIRO Australia 1989
www.dpi.nsw.gov.au



'Willam Farrer Notes'
Field Diary
National Library of Australia

'A Nation is Built'
Film Clip: National Film and Sound Archives

'Willam Farrer and his wife, Nina De Salis'
Photograph: William Farrer Trust

'Willam Farrer's Lab at Lambrigg'
Photograph: National Library of Australia

William Farrer – Father of the Australian Wheat Industry

It is not widely known that the success of the Australian wheat industry had its origins in the 1890's near where Canberra is now located. This is where William Farrer conducted his pioneering wheat breeding work at 'Lambrigg' on the banks of the Murrumbidgee River. The property that he and his wife acquired could not provide an adequate living and so Farrer worked as a surveyor in northern NSW. During this time he wrote letters to newspapers about dealing with rust diseases in wheat. The newspapers challenged Farrer's views. Incensed, Farrer returned to Lambrigg and started breeding wheat. His impact was profound. Farrer's breeding work resulted in a four-fold expansion of the wheat industry between 1897 and 1915 and this resulted in Australia moving from a wheat importer to an important exporter. His wheat varieties have been important in their own right in other countries such as the United States and as parents in breeding programs around the world.

William Farrer was an extraordinary observer and innovator. For example, he defined and bred for crop and grain characteristics that are still being actively selected today by wheat breeders and are still widely studied by wheat scientists. Farrer advocated traits such as short, strong stems, sparse tillering, earliness to ripen and narrow leaves all of which can improve the adaptation and yield of wheat to Australia's tough environment. He also advocated hard grained wheats with a high gluten content to improve the quality of the grain to make better bread. He was instrumental in selecting more disease resistant plants with improved rust resistance and for wheats that may escape rust damage. Farrer also recognised the importance of broadening gene pools and recognised that crossing Indian, Canadian and English wheats as well as making wide crosses to other species were important. All of these are still practiced by contemporary breeding programs and continue to be studied at a more fundamental basis. Farrer was a remarkable pioneer who transformed the wheat industry in Australia and whose legacy continues to inspire wheat scientists today. Without Farrer it is possible that the Australian wheat industry and wheat research community would not be the envy of the world.

Dr Richard Richards
Fellow,
CSIRO Plant Industry

Bioinformatics and the Life Invisible

"Bioinformatics" probably doesn't mean much to you unless you work in the life-sciences… in which case, there's a good chance that it means a great deal.

Bioinformatics is the basis of how we understand, analyse and interpret the massive amounts of information that we can now measure about living organisms—including ourselves and the life forms we depend on to survive.

Packed in each of our cells is around three metres of DNA, the biomolecule whose sequence and associated (or epigenetic) modifications provide our "body code"[1]: the instructions for our cells to develop, differentiate and respond to our environment.

Our bodies consist of around one hundred trillion cells, of which around ten trillion are human. In numerical terms, the vast majority of "us" is "them"—the microorganisms on us or in us—challenging our innate anthropocentric worldview.

Even our genome is far from the "biggest". At around three billion bases, our haploid genome[2] is dwarfed in comparison to the DNA of wheat. Triticum aestivum—the staff of life—has not one, but three distinct genomes to which each parent donates 17 billion letters' worth of DNA.

On an individual basis, these biomolecules and the information the carry are invisible to us. Collectively, they make up life on Planet Earth.

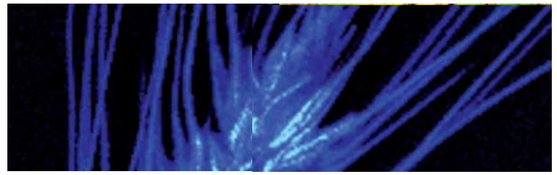
Bioinformatics helps us understand how.

Life, the Universe and everything are layered: the things that we can sense directly are but a scintilla of the things that are. But through human ingenuity we can build tools that allow us to extend our perception into these invisible realms, and through mathematics, statistics and computing we can create imaginary models from this information of how these invisible entities behave and interact.

Bioinformatics helps us see beneath the surface of life.
How apt that the Centenary of Canberra Science-Art Commission has engaged Eleanor Gates-Stuart, an artist whose practice deals in layers of information, meaning and understanding.

And as if the overwhelming volume and complexity of modern bioscience wasn't enough, researchers face a further challenge in finding ways to integrate data from different scales to form a holistic understanding of life as a system.

1 Body Code is the title of Drew Berry's groundbreaking visualisation of life at the molecular and cellular scale: http://www.wehi.edu.au/education/wehitv/body_code_drew_berry_2003
2 Haploid refers to all the nuclear DNA that one parent passes on to their offspring.



'Chlorophyllx4'
Eleanor Gates-Stuart
Wheat Ear captured with
Chlorophyll Fluorescence
Imaging at CSIRO Australian Plant
Phenomics Facility

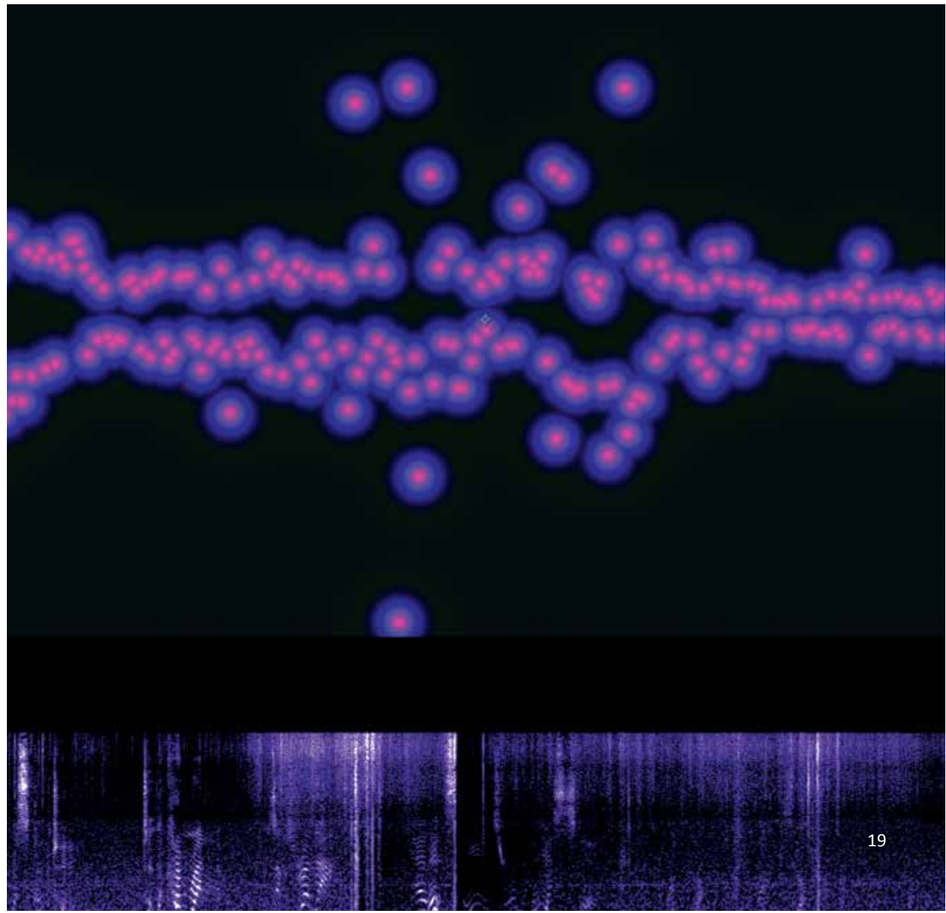
But just as Art has provided an avenue for us to express awe and wonder in the face of a Universe in which we are utterly insignificant, so too can it offer a means to address relationships beyond our ability to comprehend.

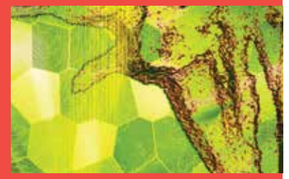
StellrScope speaks to a broad network of relationships. From Watson and Crick's "central dogma" that "DNA makes RNA makes protein"; to the roles that wheat and humans have played in each other's survival and evolution; to the science and technology , the researchers and farmers whose efforts give us our daily bread.

StellrScope reminds us that things in life are connected, even if we cannot fully grasp how.

Dr David Lovell
Leader
CSIRO Transformational Biology – Bioinformatics and Analytics
Australian Bioinformatics Network Director

'Visualising the Sound of Wheat'
Eleanor Gates-Stuart





StellrScope: A Techno-Tapestry of Art and Science

The artworks in this exhibition have been produced by Eleanor Gates -Stuart as part of the Centenary of Canberra Science Art commission. In one respect they play an important role in terms of visualising complex scientific discoveries, and in another they communicate in a way that pays homage to the cutting edge technologies that have enabled us to understand our natural world on a micro scale. Science has often been criticised for not communicating itself other than to itself, a view often shared about contemporary art, so it is interesting to see how both of these often misunderstood forms of practice can communicate complex ideas while sharing the same stage. In this respect it is important to note that the function of art in this collaboration goes well beyond just visualising science. Art too, is partly experiment, a test of creativity that attempts to find its own language and voice, a discovery of new worlds, both real and imaginary. In these special moments of discovery, art language touches poetry and through this can stimulate heightened responses in all of us, emotions that are not always quantifiable in scientific terms but are recognisable all the same.

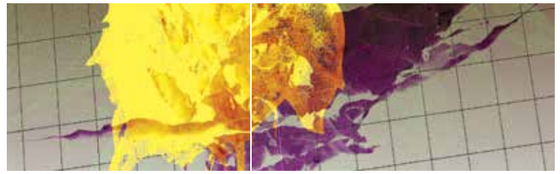
Eleanor has worked in close collaboration with a number of scientists from the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in Canberra. Based on a story of wheat innovation involving genetics, bioinformatics and historical artefacts, StellrScope[1] is an emerging body of work connecting the Canberra region to Australia's major crop science, from the times of William Farrer's pioneering wheat breeding through to the scientific achievements of the modern era.

Eleanor manipulates data in the creation and deconstruction of 3D objects towards the making of a print or moving image, starting from rendered files, point clouds, scans and screenshots using software such as MeshLab, Maya, and Photoshop. The technology assists in the formation of visual content and production, but it is the synergy between artist and scientist that really drives the formation of new languages communicating both science and art, and at best the fusion of the two. Works such as Hot Seeds and Grains utilise an electron microscope to generate the information detail for the artworks. However, the purpose is often twofold in that it supplies base information for the process, but at the same time presents a challenge when working across three and four dimensional spaces. The opportunity to test out 3D scanning of insects at the Australian National Insect Collection, and volumetric data from the Australian Plant Phenomics Facility were the catalyst for Eleanor's Bugs and Grassland series, both of which were remodeled and transformed as architectural projections for Canberra's Enlighten 2013[2] public art event.

While the collaboration between scientists and artists might seem an invitation for disaster, design and architecture have always been regular bedfellows with the material sciences, as the development of new materials and processes constantly refreshes the fundamental relationship between function and aesthetics within our built environment. In comparison, the interplay between science and art has been more sporadic but one in which at particular points in history, the science art nexus has formulated a way of thinking, nurturing dynamic and unique expressions of language, many of which have changed our lives for the better. These rare moments of collision where science and art feed each other have proven as significant as the inter-dependent relationship between art and religion in 16th century Europe, or the manifestation of art and consciousness as seen through surrealism or expressionism, the impact of which has affected post modern culture in all its forms. It is when scientific discovery in conjunction with public art succeeds that we start to understand the potential of our future, not just a representation of our past.

Great public art engages the viewer intellectually, emotionally and spiritually, all of which are far more important than mere information itself. It is how we interpret information and project it that stimulates creative thought in all of us, how we decode the signs, how we re-think our histories and how we might imagine our futures. Art opens up new thinking because the art itself, however simple it might appear, presents a multi layered tapestry and one in which our assumptions, prejudices and beliefs are unpicked and examined. Art places demands on the viewer to see beyond what can be seen and to question the nature of our history and philosophy through the tiny threads that are presented to us. For instance, the science underpinning this series of artworks attempts to prove a particular position in terms of the origins of life on earth. From a thematic position and through their sourcing of scientific data surrounding insects and plants, these works propagate and support our assumptions about the Darwinian theory of evolution. Interestingly though, the ambient and ephemeral quality of their resulting 3D and projection technologies propose a more temporary line of enquiry, one that might place doubt on our fundamental belief systems that rely so heavily on acceptance of scientific evidence and the permanency of knowledge.

The works in this exhibition also refer indirectly to a significant point in our history where art, science and communication was most eloquently displayed, in the botanical copperplate engravings of Joseph Banks and Daniel Solander, more commonly known as Banks' Florilegium. These prints play an important part in our colonial history, standing as a marker of both artistic and



'Wheatear3y'
Eleanor Gates-Stuart

scientific process. Using the technology available at the time, these scientific illustrations attempted to transmit information about new worlds and new knowledge, a lasting testament to our understanding of how we came to be. With the advances in technologies available to us today, the need for the transference of new knowledge has presented us with a more interactive form of communicating and one in which the viewer can play a more interpretive role.

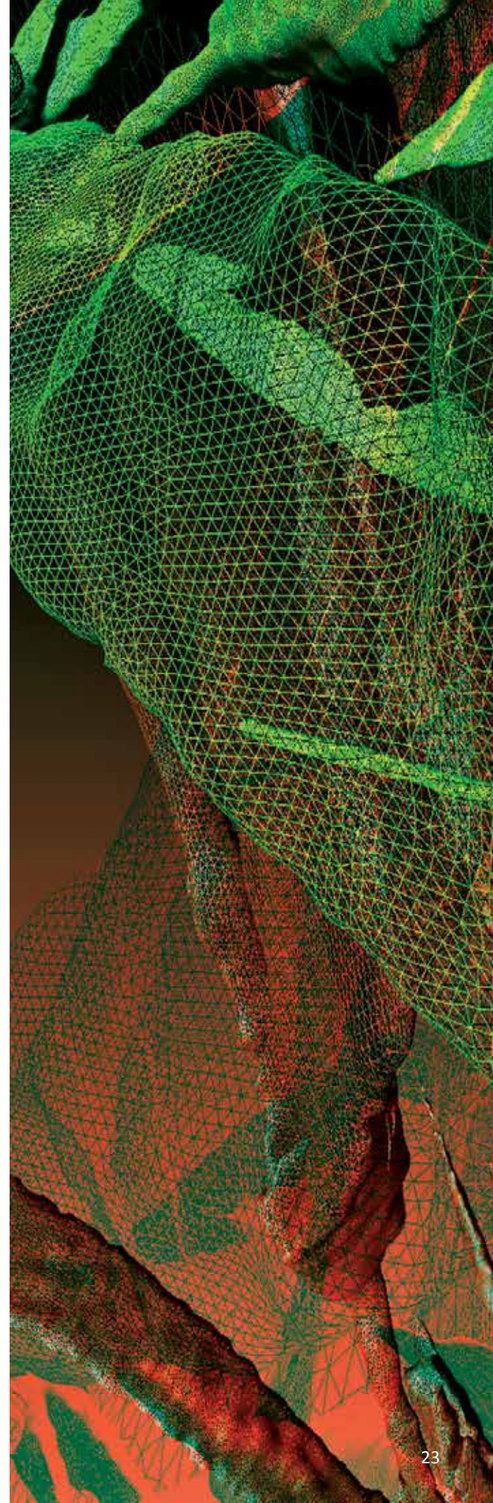
The commission is ambitious for both the Centenary of Canberra and for the artist herself. Her approach is experimental and unrestricted, the technology is cutting edge, and the response will be unpredictable. In this sense it is a true artistic and scientific process, an open-ended investigation of both discovery and enlightenment in which unpredictability can be shared and celebrated. I hope you enjoy the artworks in this exhibition, as much for what they propose as for what they represent.

Clive Barstow

Clive Barstow is a practicing artist and writer, Professor of Creative Arts at Edith Cowan University Perth and Honorary Professor of Art at the University of Shanghai Science and Technology China.

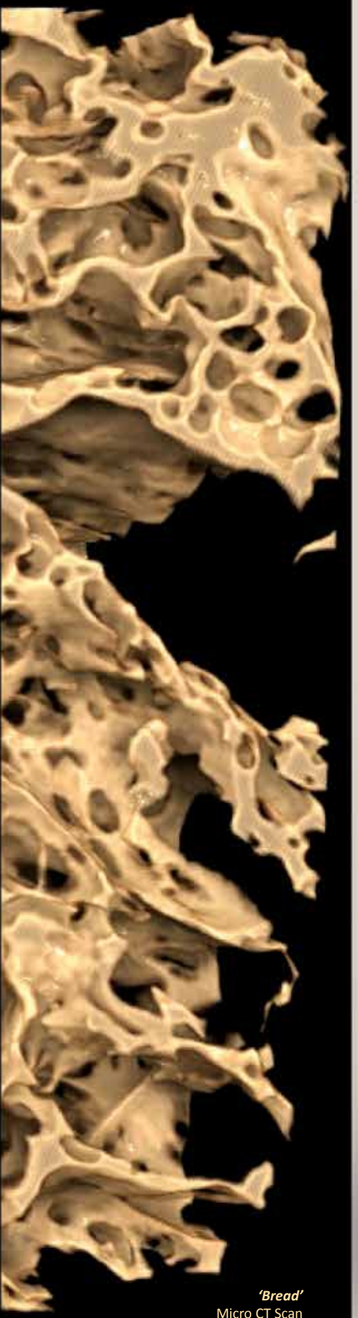
'The Measure of Volume'
Eleanor Gates-Stuart

1 StellrScope: http://stellrscope.com/
2 Enlighten 2013: http://enlightencanberra.com.au/event-info/architectural-projections/

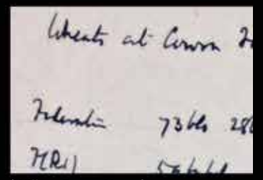


‘StellrLume‘

StellrLume Domes are two hemispherical projections based in an installation setting that allows people to interact with the display delivering content to the viewer(s). An overhead Kinect depth camera relays information about objects (e.g., hands) placed over the hemisphere and ‘virtual shadow’ data is used to mask one video stream projected onto the inside surface of the hemisphere to reveal a second different video stream. In effect, people can cast shadows onto the hemisphere yet, instead of causing an absence of illumination, these shadows reveal a new layer of imagery and form the basis of the StellrScope visual narrative, reflecting wheat innovation over the century. A collaboration made achievable with Pufferfish, an Edinburgh based company specialising in interactive spherical displays.



‘Bread’
Micro CT Scan
Dr Sherry Mayo

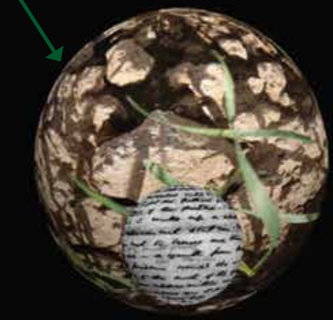


‘Willam Farrer Notes’
Field Diary
National Library of Australia

2

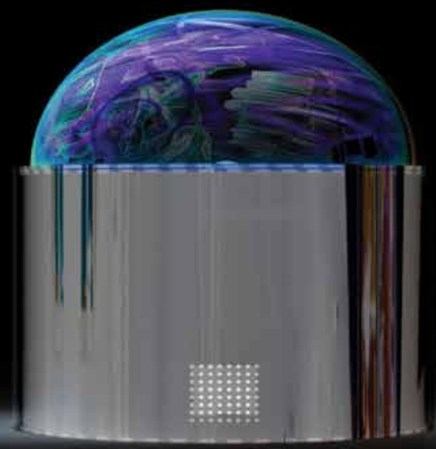
‘A Nation is Built’
Film Clip: National Film and Sound Archives

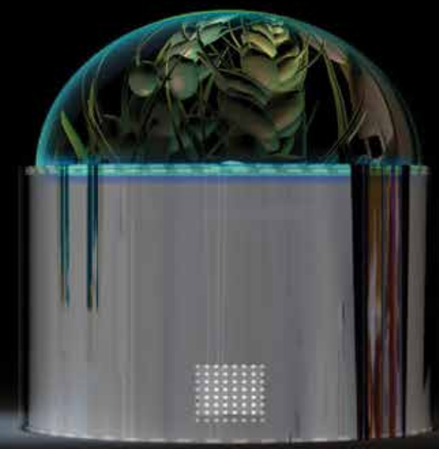
‘Inner’ Image revealed when hand is held over dome

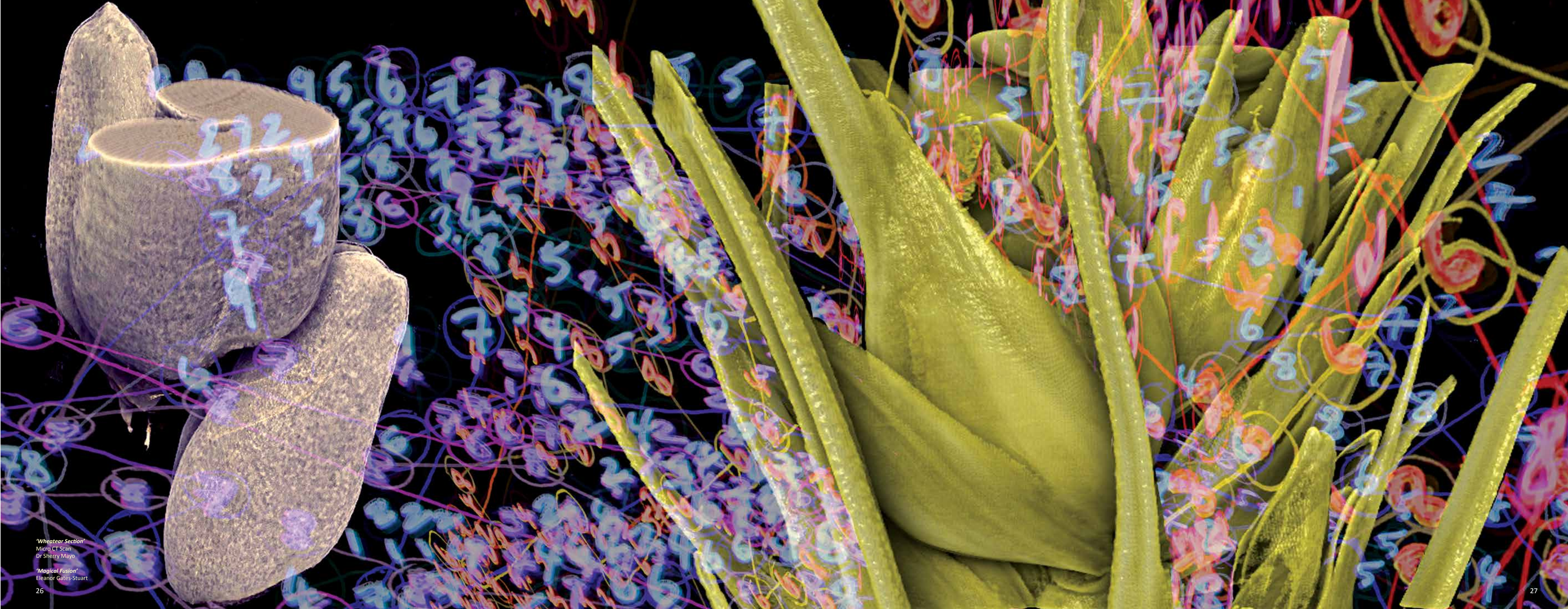


Videos consists of rendered animation, artifacts, film archives and digital images

‘StellrLume‘ Domes







'Wheatear Section'
Micro CT Scan
Dr Sherry Mayo

'Magical Fusion'
Eleanor Gates-Stuart

'Wheatear Section'
& Vessel
Micro CT scan
Dr Sherry Mayo

'MAGICal B'
Eleanor Gates-Stuart

Art, Science and Science Communication

Genuine partnerships between artists and scientists represent a new form of interdisciplinary practice that can have a significant influence on the public's engagement with science. Such partnerships, with respectful exchange of ideas and perspectives, can also help both artists and scientists see things in new light. It is for this reason that I was excited when Questacon was presented with the opportunity to host an art-science commission to help celebrate the Centenary of Canberra.

The chosen topic of wheat improvement to feed Australia and the world is highly significant in a Canberra context with a strong history of research and significant current innovation. Visualising this scientific experimentation and creating art works that engage and communicate to multiple audiences has been the challenge of this ACT Government Centenary Commission. The artist Eleanor Gates-Stuart has worked closely with CSIRO scientists to interpret and conceptualise the theme of wheat experimentation.

Questacon is a busy hands-on science centre with a predominantly youthful audience and some interesting but difficult spaces for exhibits. Creating a work of art for such a challenging environment has influenced the output of the work. It has led Eleanor in some new directions that embrace Questacon's hands-on philosophy using digital media. It has been fascinating to see her ideas emerge as the project has proceeded through a deepening understanding of the science, the history and the technology used. Eleanor has remained true to her approach of visualisation of scientific themes seen in previous works such as **'FingerCodes',** displayed at CSIRO Discovery in 2011, that link scientific understanding with artistic interpretation.

Science has always relied on artistic skills to communicate ideas. Whether it is the sketches of Leonardo, the illuminated manuscripts of medieval lapidaries and herbals or the 16th century rhinoceros drawing of Durer, the early history of exchange of scientific ideas relied on illustrators. Before the advent of photography, drawings and paintings were, with the printed and spoken word, the principle means of scientific communication. Oil paintings, drawings and water-colour paintings gave life to landscapes and plant and animals specimens. An 18th century Stubbs painting of a Canadian moose was used to demonstrate that the giant elk antlers found in Irish peat bogs were in fact from a large extinct animals and this in turn helped unpick the notion of a great 'chain of being' and opened up thought to imagine a theory of evolution. Natural history artists recorded newly discovered species and landscapes during the voyages of discovery around the world.

'GrassLand Series'
Eleanor Gates-Stuart
Scanning by Dr Chuong Nguyen

19th century artists were drawn to natural phenomena and many to Vesuvius as part of their grand tours for inspiration. There are many oil paintings of Vesuvius in eruption including one by Joseph Wright of Derby who amongst his works also illustrated the practice of science and science communication. His paintings of the discovery of phosphorus, the explanation of an orrery and the use of a vacuum vessel to demonstrate properties of air provide insights into the world of science before it became institutionalised with professional scientists.

The advent of photography created a new medium for exchanging ideas and for the practice of science. Images from telescopes and microscopes brought new worlds and discoveries to a wider audience and allowed greater involvement with scientific subjects.

Models such as those produced to teach anatomy, glass models of flowers and sea-creatures or wooden models of molecules required creative ability as well as understanding of the science. Such well-crafted models played an important role in knowledge transfer from expert scientist to trainee. New materials and techniques facilitated and improved such teaching aids. The development of plastination techniques to preserve animal tissue has created a controversial new art form from preserved human and animal bodies mounted in exotic poses.

Film, photography and the medium of television changed the relationship between science and the public forever, allowing the growth of popular science magazines and natural history film-making that has opened up the world. Photographs from space have transformed how we see our planet. Time-lapse and slow motion photography has changed the ways we see the world around us. Both artists and scientists have been able to exploit photographic media to interpret and share scientific ideas.

Science and technology continually create new media for artistic expression. The development of paper, printing technology, photography and acrylic paint have all created new opportunities for artists. Computers, enhanced computing power and software development have opened up digital imagery as a new medium for art. Digital media is powerfully transforming the communication of science and creating very fertile ground for collaborations between artists and scientists. Computer generated imagery and visualisation software have created a new dynamic pictorial language for science and science communication.

From cave paintings to digital visualization, science has needed a pictorial language for communication. Artists have drawn inspiration from science, and scientists have

turned to art for illustration. The new fusion of art and science moves beyond these basic relationships to a new partnership and a new respect for the work of both artist and scientist alike. It is this coming together of science and art, artist and scientists that is at the heart of this Canberra Centenary Commission by Eleanor Gates-Stuart.

The theme of the development of wheat is particularly relevant at a time of mounting concern about food security. Plant scientists in Canberra have made major discoveries of global importance over the past 100 years and continue to do so. Improving wheat strains to improve yields and feed the world is a critical task for science. 100 years ago when Canberra was named, the world's population was around 1.6 billion. Only a second green revolution can sustainably feed a world with a population projected to rise to over 9 billion people.

Science generates new knowledge and works towards solving problems for the nation and for the people of the world. Art generates new ways of looking at things and presents fresh insights into the world around us. It can challenge and provoke. It can also inspire and inform. This exhibition should make you think about the role of science in society. It should make you think about some of the important science being undertaken in the nation's capital.

Stelrscope is the product of genuine collaboration between Eleanor Gates-Stuart who is exploring new media and CSIRO scientists who are working at the leading edge of discovery. It is an exhibition that uses the latest computing technology to capture, generate and manipulate images of relevance exploiting new digital artistic media. Questacon is proud to be able to display this exhibition as part of our Centenary of Canberra program.

Graham Durant
Professor Graham Durant AM
Director,
Questacon

'Wheatear Series'
Eleanor Gates-Stuart
Scanning by Dr Chuong Nguyen

Invisible Bubbles

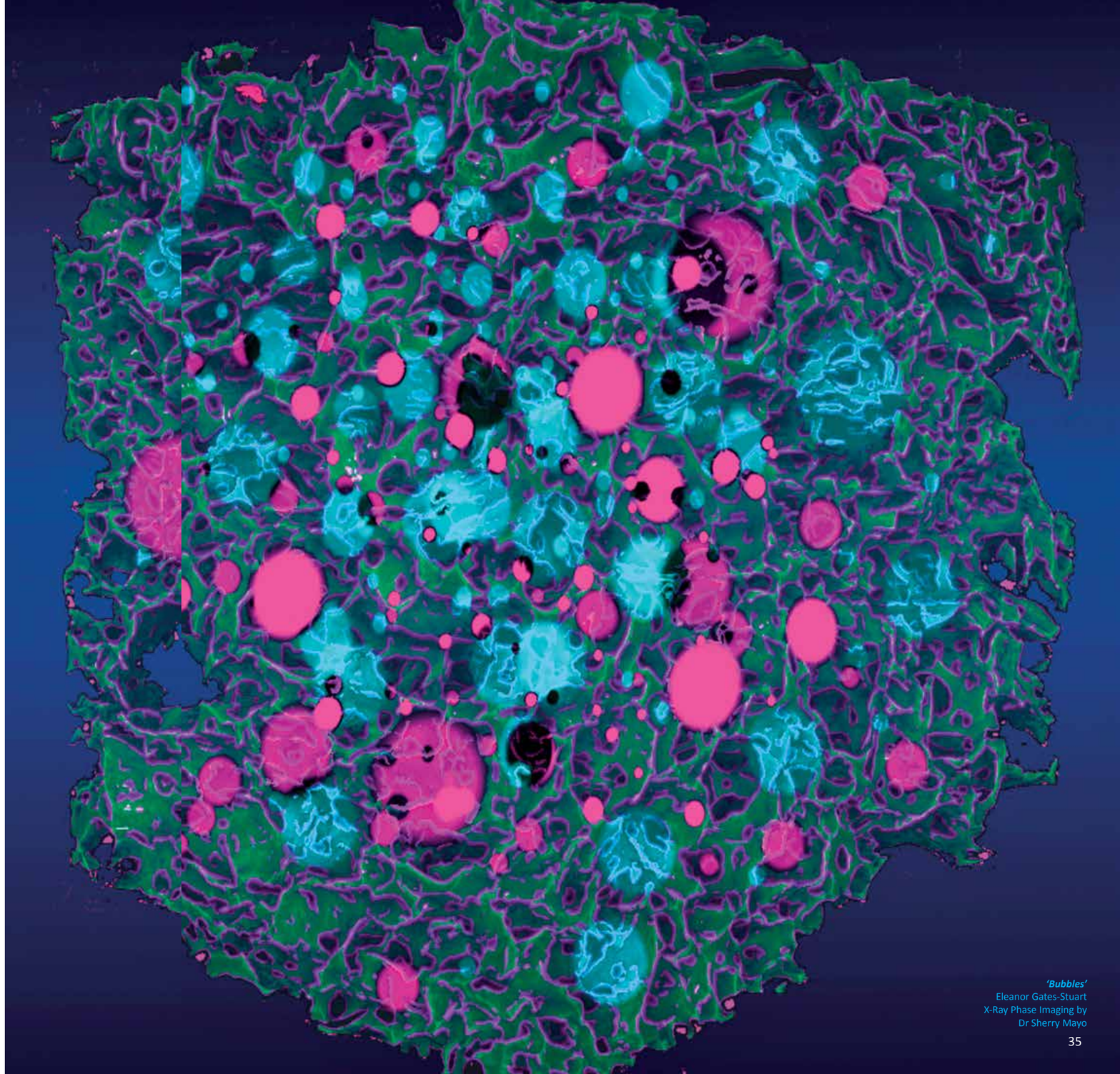
Breads are a staple in most people's diets and the bread wheat is more highly priced than any other wheat. Thus selling wheat for breads is profitable for farmers. The rule of thumb for bakers in selecting flour has been to use flour with high amounts of gluten protein for making breads. A lot of wheat grown in Australia is not high in gluten proteins and thus, are not suitable for making high quality breads. At this time, the gold standard bread wheats grow only in North America. There could be many reasons for this including the soil quality and the climate in the respective countries. We are working to improve the technology for making breads using low protein Australian bread wheat and plan to compete in the export markets with North American flours.

Our approach is to understand how structure develops in breads and cakes and how it affects the texture that consumers experience. Texture is a global word that is used to convey the experience of handling and masticating foods. For example, we know breads and cakes are highly porous, but cakes are crumbly, which means pieces come off easily. For breads, pieces have to be torn off. During mastication, breads are soft and chewy while cakes are also soft, but not chewy.

Visually, breads and cakes are porous substances. While one cannot see air bubbles in the dough (and batters) when they are mixed, there are numerous air bubbles in doughs. When yeast (or the leavener in cake batters) produces carbon dioxide, the gas collects in these pre-existing bubbles which then expand, i.e., the dough rises. It is then baked in the oven when the bubbles expand further and the starch gelatinises imparting solidity to the structure. Ultimately, the bubbles start to coalesce with each other. If most of them have coalesced completely then one gets a large puff, as in Indian Chapattis. If most of them coalesce, but only partially so a solid wall separate portions of each bubble, then one gets the crumb like structure of breads. In breads and cakes, the solid walls will ultimately fracture, which is an essential step as it helps to stabilise the internal pressure of bubbles with that of the atmosphere, a critical requirement for maintaining the expanded structure when the products are taken out of the oven. Thus, if a cake collapses when taken out of the oven, it means the bubbles had not expanded far enough and the porous structure had not permeated the solid phase.

Having identified that elasticity is the key to imparting functionality of doughs, we are developing techniques to control bubble structures in doughs and expand the use of flours in making specialty products. We are also researching how composition of flour and wheat affect the elasticity of doughs and thereby develop gold standard wheat in Australia.

Dr Sumana Bell
Research Director, Centre for Grain Food Innovation
CSIRO Food and Nutritional Sciences
CSIRO Animal, Health and Food Sciences



'Bubbles'
Eleanor Gates-Stuart
X-Ray Phase Imaging by
Dr Sherry Mayo

X-Ray Phase-Contrast Imaging

Conventional x-ray imaging, such as the x-ray scans taken in a hospital, rely on the absorption of x-rays by an object in order to form an image. Phase-contrast makes use of the refraction or bending of x-rays to form an image, and results in x-ray images in which edges and fine features of the object are particularly highlighted. We soon extended this technique to three-dimensional or tomographic imaging with x-rays, enabling us to make beautiful 3D images of samples which do not strongly absorb x-rays and which would have been difficult or impossible to image using conventional methods. We use this technique for 3D microscopy, essentially like a CAT-scan but on a tiny scale.

One of the particularly gratifying aspects of working in this area is the ability to take our three-dimensional scans and to use them to produce beautiful imagery and movies of our samples using rendering software. Using such software we can open the sample up to reveal internal features and highlight different aspects of structure. These kinds of images and movies are also much more accessible and easy to understand than many other types of scientific data, and are a great way to communicate science to the wider community. For this reason I was very excited to be asked to collaborate on the StellrScope project.

In highlighting science relating to wheat, we have imaged samples including wheat ears and grains, wheat pest insects and an end-product, bread. All are low-density samples with intricate fine-scale structure, so x-ray phase-contrast imaging is an ideal method for bringing out the structure and beauty of these specimens. All the samples were scanned using our x-ray microfocus source scanning system in Melbourne. The rendering of the three-dimensional data we produced was done using Drishti and Avizo software packages. In many cases the three-dimensional data were converted into surfaces or other formats which could be further manipulated by Eleanor for incorporation into different elements of the exhibition.

It is especially gratifying that scientific methods like x-ray phase-contrast and 3D printing have been able to contribute to the image-making and 'art' component of a project highlighting wheat science. It has been very interesting to see how the raw material of 3D scans has been transformed into different types of imagery and artefacts by Eleanor and other collaborators. I hope that members of the community who visit the StellrScope exhibition are encouraged to think about science in a different way by seeing elements of scientific work visualised in a variety of forms, from beautiful images and movies to the solid reality of titanium three-dimensional prints of insect forms.

Dr Sheridan Mayo
Senior Scientist, CSIRO Materials Science and Engineering

'BugDome'
Eleanor Gates-Stuart

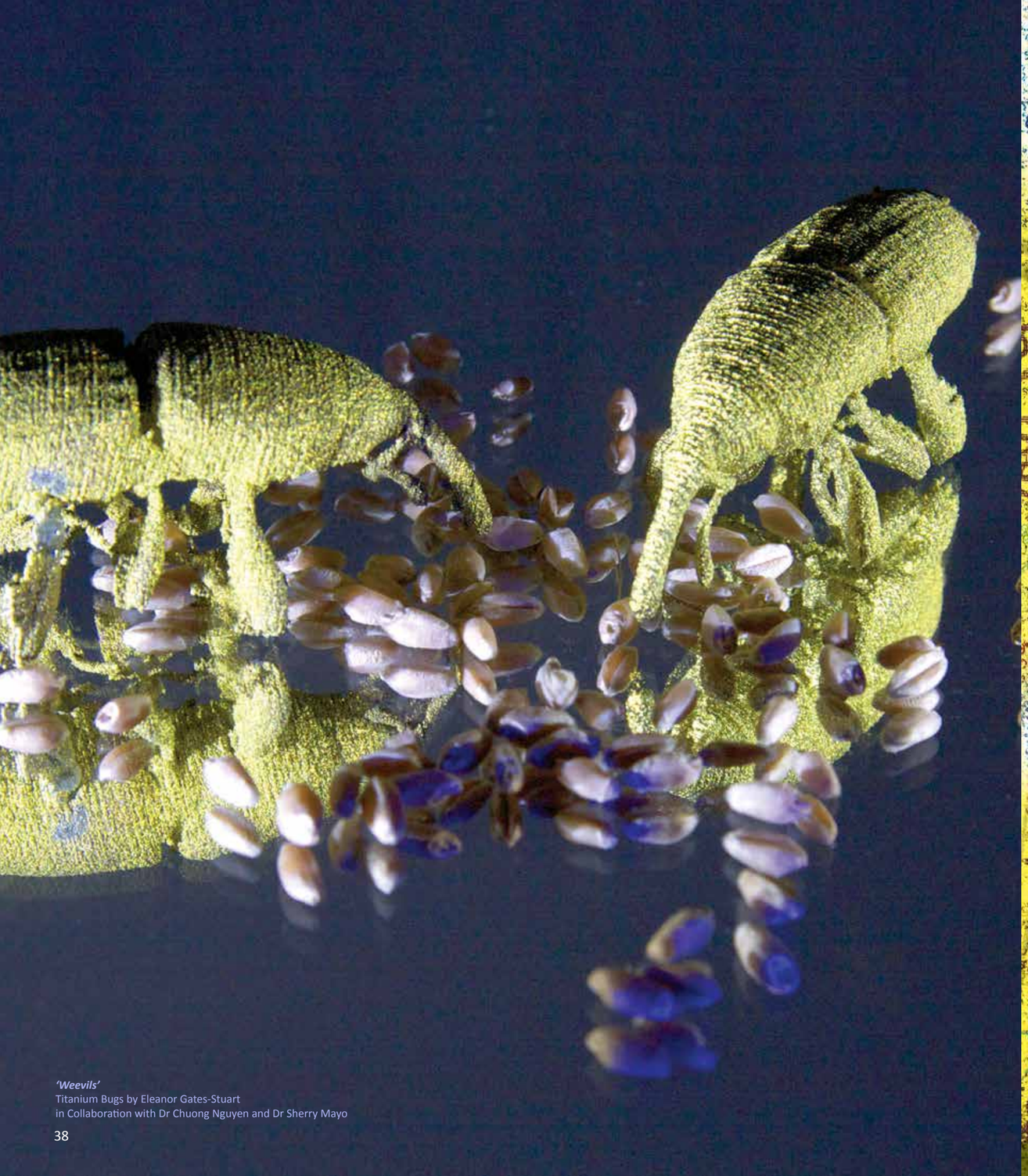
3D Wheat and Weevils

3D vision plays a crucial role in enabling us not only to interact with the physical world everyday but also to perform measurements for scientific research. Normally the role of scientists is making sense of the raw scientific data, however it has been found that science art emerges. In biological research, automatic 3D reconstruction is a new tool to digitise the living things such as plants and insects. Such 3D digital information is revolutionising our understanding of the nature and how best to manage and maintain our ecosystems. Living creatures are very complex biological systems, so creating their accurate digital copies and extracting meaningful information are both challenging topics. While researchers try to make sense of their data in their narrow field of research, science artists such as my collaborator Eleanor Gates-Stuart has been investigating new ways to make sense of scientific biological data from public and artistic perspectives.

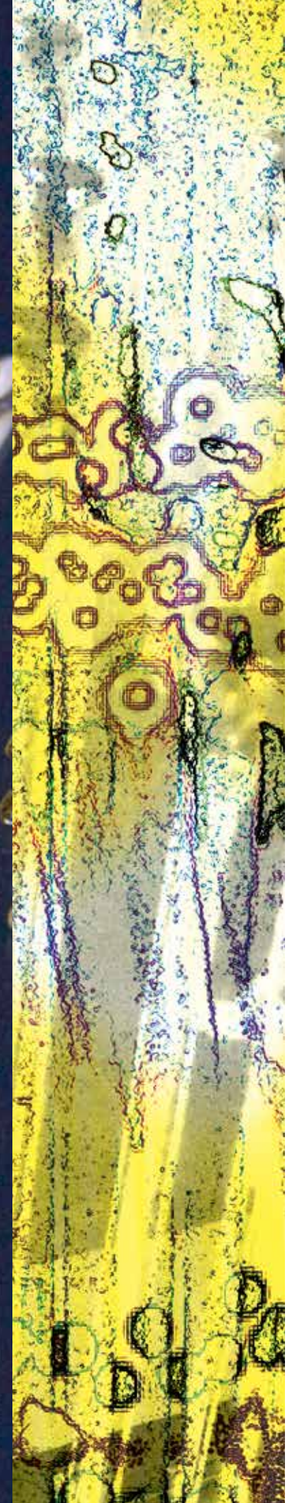
At CSIRO, it is very important to collaborate with other researchers to solve multidisciplinary problems. This also applies to my research in developing systems for scanning plants and insects and creating their 3D models at high quality and high speed. With support from CSIRO Transformational Biology and the Australian National Insect Collection (ANIC), I developed a 3D insect scanning system. I initially worked with Eleanor to share my research data and create 3D models of bread and wheat for her StellrScope project and together we started a new collaboration bouncing off ideas to push the limits of both of our domains. Among several topics in our collaboration, Eleanor's insect artworks caught the most attention and interest from wider range of people.

Eleanor expanded her search to environmental effects on wheat productivity such as climate change and wheat pests, i.e. wheat weevils, leading to further collaborations across several CSIRO divisions. As found by Dr Megan Hemming, high temperature strongly affects early development of wheat spikes and consequently reduces the final number of wheat grains. On the other hand, wheat weevils can survive extreme pressure under grain silos and spoil the grains. Due to millimeter size of wheat spikes and wheat weevils, researchers need to examine them under microscopes. As Eleanor and I wanted to create holograms of these specimens, creating models of these tiny specimens was the first step to overcome. That started my investigation of 3D reconstruction of wheat spikes using Scanning Electron Microscope images in collaboration with Dr Mark Talbot. On the wheat weevil side, Eleanor expanded her connection to Dr Rolf Oberprieler and Dr Eric Hines at who provided weevil specimens to create 3D models. These connections initiated my new scanner developments to scan insect specimens of millimeter sizes. This 3D modelling of tiny specimens continued to evolve and led to connection to with Dr Mayo Sherry for Micro CT, Dr John Barnes and Mr Chad Henry for 3D Titanium printing.

Dr Chuong Nguyen
CSIRO Computational Informatics (CCI)



'Weevils'
Titanium Bugs by Eleanor Gates-Stuart
in Collaboration with Dr Chuong Nguyen and Dr Sherry Mayo



Interactive Narrative

In the late Seventies and early Eighties, Michael Naimark created a number of artworks at MIT that explored the idea that a movie projector might be able to move around a physical space in just the same way as a movie camera. Naimark was inspired by the Haunted Mansion from Walt Disney World in which "a movie of a woman's talking face was projected onto a mannequin head in such a way that the eyes, nose, and lips line up" thereby giving the impression of a full colour hologram. Naimark referred to this as "relief projection, where an image is projected on a screen whose shape is the same as the image."

In 1991, Naimark briefly experimented with projecting imagery that could be digitally altered in real time. This was the genesis of what we now refer to as Spatial Augmented Reality (SAR), also sometimes known as Projection Mapping. Essentially, this involves taking a projector, like a classroom data projector, and precisely overlaying computer graphics onto objects in the physical world.

The 'in situ' nature of SAR displays results in a number of benefits. They allow the user to keep their eyes directly on whatever physical task they are concentrating on, without the mediation of a screen, and they provide a consistency in stereo depth perception between the real and virtual elements of the scene. SAR also usually permits any number of viewers without the need for additional hardware and leaves those viewers free to interact with each other without 'containing' each of them within a Head Mounted Display (HMD) or a smart phone.

In StellrScopɛ we use SAR techniques to bring computer graphics into our human-scale physical environment. In order to facilitate interaction between the graphics and as many people as possible, we use overhead depth cameras – that sense Red, Green, Blue, and distance for every pixel. Custom software then extracts the forms of hands, heads, handbags, … - whatever is passed over the top of the projection surface. Elements of the digital content are selected based on where 'virtual shadows"'land. In this way, the audience must become an active participant, in order to experience the entire narrative.

In our research at CSIRO, we have made use of interactive SAR in a variety of application areas. We have designed prototypes to allow scientists to 'beam' into a quarantined virus lab, medical specialists to examine a patient hundreds of kilometers away, and remote maintenance workers to help troubleshoot a problem with some machinery. The StellrScopɛ project has provided a chance to consider our research from an alternative perspective, and we have already formed new hypotheses and devised new techniques as a result of this wonderfully collaborative Science+Art experience.

Matt Adcock
Research Engineer
CSIRO Computational Informatics

'WheatWave'
Eleanor Gates-Stuart

Pufferfish

Pufferfish are delighted to have been able to collaborate with Eleanor, the Centenary of Canberra Science Art Commission and CSIRO on a project that lies close to our hearts in its ambition to articulate a complex narrative through visual media; melding history, cutting-edge science, technology and art to offer access and understanding through experience.

Farrer's concern with the 'experience' of his Wheats; the importance to him that they should not only be viable, resistant crops, but also suitable for the purposes of baking, optimised for the experience of human consumption, distinguished him amongst his scientific contemporaries. And so with this project; Eleanor and the CSIRO team focussed not just on the scientific and historical facts behind the messages, but on the experience of those messages.

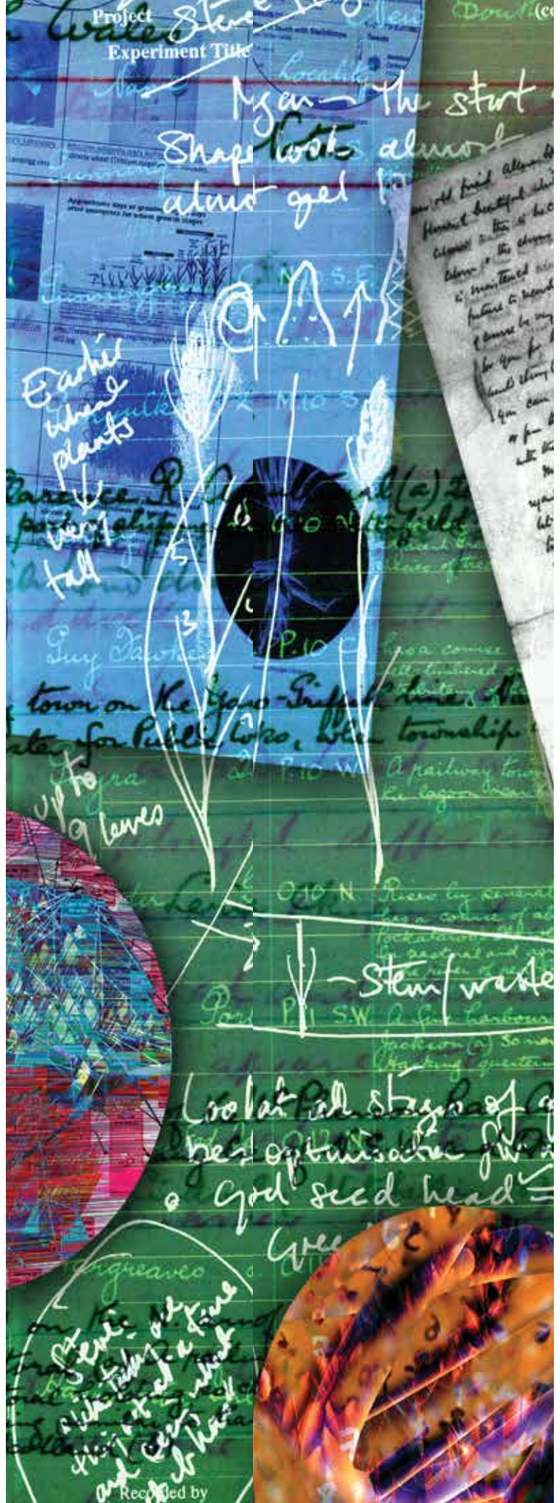
Eleanor's vibrant visual style and her desire to realise a physical manifestation of otherwise ephemeral digital media, saw her harness the latest in optical design and screen manufacture to create dynamic interactive artworks bespoke to the Centenary Commission. Designed to float at crop height, the domes invite visitors to discover an intriguing artistic perspective on the work, using technology and art to entice a new appreciation of Farrer's legacy through StellrScope.

When Eleanor approached Pufferfish, she already had a strong concept of how her "StellrLume Domes" should look and feel as artworks, so our role was really to support and advise as to the technical means of realising her vision. It was important to the team that the experience of meeting the StellrLume domes should have a magical quality to it, so the technology deployed should facilitate this without becoming an end in itself.

A simple yet precision set of optics was employed to map the light from a single hidden projector onto the inside surface of a specialist acrylic dome. This method neatly harnesses the beauty and suppleness of projected light in covering the organic shape of the StellrLume Dome. Allowing it to glow from within and be approached from all sides as an object in its own right, rather than simply a screen to be watched.

We examined with Eleanor and her colleagues at CSIRO how interaction might be introduced to the piece, exploring ways a sense of magic might be created by deploying an on-sphere touch surface. The route that seemed to offer the most magic was to introduce a gestural interface via a Kinect sensor, so that users might push through layers of video as hands through a wheat field. This familiar technical route, along with the development of the visual elements in Eleanor's native Maya, allowed the team access to a design and programming process, adaptable and for application.

Pufferfish UK



'Collection'
Eleanor Gates-Stuart

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Marcus Newberry
Steve Swain
Steve Jobling
Jose M. Barrero
Sumana Bell
Shou Wang
Richard Richards
Rosemary White
Mark Talbot
Kerrie Ramm
Rachel Fitzgerald
Arwen Cross
John La Salle
David Yeates
Beth Mantle
Rolf Oberprieler
Eric Hines
John Taylor
Frank de Hoog
Simon Barry
Bronwyn Harch
Annette McGrath
David Lovell
Sean O'Donoghue
Christian Stolte
Sherry Mayo
Tomasz Bednarz
Con Caris
Christine O'Keefe
Bob Anderssen
Chuong Nguyen
Matt Adcock
Benita Vincent
Warren Muller
Alec Zwart
David Feng
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Candace Culyer
Kathryn Zaraza
Karen Barndt
Daphne Bruce
Francis James
Bob Furbank
Xavier Sirault
Jiaming Guo
John Barnes
Chad Henry
Jonathon Roberts
Elliot Duff
Cris Kennedy

Questacon
Professor Graham Durant AM, Sally D'Addio, Jared Wilkins and team

Farrer Memorial Trust
Phil Anquetil
Harriet Skinner

National Library of Australia

National Film and Sound Archive of Australia

Australian National Insect Collection

PufferFish UK and all the team

Paul Bourke
Research Associate Professor
Director, iVEC @ University of Western Australia

Andrew Squelch
Senior Research Fellow
Curtin University

Ajaye Limaye
VisLab, ANU Super Computing Facility

Prof Sue Stocklmayer
Director, Australian National Centre for the Public Awareness of Science, Australian National University

Prof Clive Barstow
Head of School
School of Communications & Arts, Edith Cowan University

George Weston Technologies

Tip Top Bakery

Peter and Kate Gullett

Denise Holehouse

Roger Hausmann

Emily Hungerford

Iain Stuart

Translation by Bing Han

StellrScope Artwork Production
StellrLume:
Eleanor Gates-Stuart , Chuong Nguyen, Matt Adcock, David Feng, David Lovell, Sherry Mayo, Pufferfish UK
Lumarca:
Eleanor Gates-Stuart, Matt Adcock, Dulitha Ranatunga, Jose Jimenez-Berni,
Credits: Lumarca - Matt Parker, Albert Hwang and Elliot Woods
Holograms:
Eleanor Gates-Stuart, Chuong Nguyen, Sherry Mayo, Zebra Imaging US

StellrScope Composition by Marlene Radice

'Excerpts from *A Nation Is Built* 1938 (Frank Hurley, Australia 1938), NFSA title ID 7586. Courtesy of the National Film and Sound Archive of Australia'.

William Farrer Archives, Courtesy of the National Library of Australia and the William Farrer Trust

Filming at Lambrigg, Courtesy of Peter and Kate Gullett

Eleanor Gates-Stuart

Present
Science Art Fellow, The Commonwealth Scientific and Industrial Research Organisation (CSIRO) (2012-present)
Artist-in-Residence - Special Research Project: 'StellrScope', the Centenary of Canberra Science Art Commission, awarded by Australian Capital Territory Government, Chief Minister's Office and the Australian Federal Government
Research Professor, Art Department, Division of Arts, University of California, Santa Cruz (UCSC) US (2011-present)
Honorary appointment.

Education
PhD Researcher. Science Communication, Faculty of Science, Australian National University (ANU) (p/t)
Graduate Certificate in Higher Education, ANU (2006)
Master of Arts, Printmaking: Chelsea School of Art, The University of the Arts, London, UK (1982)
Bachelor of Arts (Honours), Fine Art: Printmaking - Sheffield Hallam University, UK (1980)

Recent Research Positions
International Visiting Artist Residency, Leeds Metropolitan University (LMU) UK, (2011)
International Visiting Professor, UCSC, US (Fall 2010)
Visiting Researcher, National ICT Australia (NICTA) Australian Research Centre of Excellence, (2010-2007)
Academic Fellow, Research Sabbatical, ANU (2009 – 2008)
Visiting Taiwan Scholar, Taiwan Ministry of Education Award (2008)
International Curator-in-Residence, (New Media), National Taiwan University of the Arts & Kuandu Museum (2007)

Current Exhibitions
'StellrScope', Science Art Commission, Questacon, Part of the ACT Government Centenary of Canberra (2013)
'Hot Seeds: the Scithetic Dimensions', Discovery Centre, CSIRO, (2013)
'Embracing Innovation Volume 3', Craft ACT: Craft and Design Centre, (2013)
33rd MiniPrint de Cadaqués, Taller Galeria Fort, Cadaques, Spain & Galerie L'Etangd'Art in Bages, France, (2013)
'Enlighten', Architectural Projections, the National Library of Australia, the Museum of Australian Democracy (Old Parliament) and Questacon (2013)
'Finger Codes', Discovery Centre, CSIRO, (2011)
'DS01', 'Born Digital – New Materialities', Curated by Paul Thompson, Grays School of Art, UK, (2011)
'Finger Codes', Mary Porter Sesnon Art Gallery, Santa Cruz, US (2010)

Recent Publication
Barstow, C and Gates-Stuart, E. ***'StellrScope, the Centenary of Canberra's Science Art Commission'*** (Article) Imprint -Vol.48 Number 1 2013. Print Council of Australia Publication

www.eleanorgatestuart.com

'Compositional Extract'.
Eleanor Gates-Stuart

Supporting Text

Eleanor has been one of those 'secret treasures' that you come across in CSIRO. I met her when she was applying for her Centenary of Canberra Science Art Commission. At the time she had a role in communications with a collaborative project that CSIRO was overseeing – I still have some of the posters that she designed. I had oversight for the agribusiness part of CSIRO, the science of which is very strong in our Canberra laboratories. Eleanor and I explored a number of project ideas that came to form the basis of her StellrScope. I was excited by the possibilities that she brought to showcase great science through art and design.

Science can be a bit inaccessible to the broader community with its jargon and specialist knowledge. Researchers are often very careful to present their work in a considered and objective way. What is often not projected is the deep passion, creativity and insight that researchers bring to their discoveries. Eleanor's work Stellrscope bridges the gap between the objective and the passion; it communicates the beauty and power of scientific endeavour.

I have been inspired by Eleanor's work. I get a great sense of excitement and pride about what CSIRO has achieved when I look across Eleanor's developing work. It has been great to highlight the achievements that have come from our Canberra-based work over the past 80 years. I wanted to put more and more activities into her scope, although common sense has prevailed.

My greatest lesson? While the products seem very different: an installation versus a new plant variety, science art and scientific research are built on common foundations of insight and innovation; of beauty of design and execution well done.

Dr Joanne Daly
CSIRO Strategic Advisor, Environment Group

Eleanor is a lecturer and Honorary Research Professor in the Art Department at the University of California, Santa Cruz. Her latest work takes place at the border of science and art, as she explores how pressing scientific problems and their solutions can be visualized.

Eleanor's work is incredibly timely, as we are at a difficult crossroads in terms of society facing extremely challenging scientific and social problems and a general lack of scientific knowledge in our community. It is critical that we share rigorously researched information with the general public and our policy-makers in a way that is both easy to understand and palatable. By translating research results into a variety of "languages" visual language being an amazing key for understanding, we change the way we understand the world around us.

The interplay of science and art is something we in the Arts at UCSC are actively engaged in, particularly as we work towards launching our Institute of the Arts and Sciences. Our students have benefitted from Eleanor's creative approach, both in the classroom and from her own research.

David Yager
Dean, Arts Division
Distinguished Professor, Art, UC Santa Cruz

Plant Phenomics seeks to attack the problem of feeding a burgeoning global population by bringing digital imaging, robotics and computing to bear to find the highest yielding wheat varieties for our farms of the future. Converting a wheat plant or a crop in the field to an 'in silico' digital representation which can be quantified and modelled is an art form of itself. The breeders eye has long been the 'spectrometer which chooses the best of the best, while now we have new tools to delve into the growth and workings of wheat in 3D. Where art meets science at Stellrscope is in visualising the beauty of these models, rendering the complex dynamics of plant development over time and the creative spark which can kindle a feast for the eyes or a feast for the hungry bellies of a growing world.

Dr Bob Furbank
Scientific Director and Group Leader
High Resolution Plant Phenomics Centre, CSIRO

Being involved in this unusual Science-Art project has been a wonderful way to share and communicate my area of science. I research how very early stages of plant development influence grain yield in wheat. Hidden deep inside the leaves of a wheat plant are tiny organ primordia that develop to form the flowers and grain. These beautiful, miniature structures evolve through a number of mysterious and unusual shapes as the wheat flowers and grain develop. I have spent many hours examining this process under a microscope, in order to understand how early developmental events contribute to final grain yield, and have always found the structures beautiful and interesting in a visual as well as a scientific sense. It has been a privilege to discuss this work with Eleanor and fascinating to see her work with my images, and with mature wheat spikes, to create artworks. Although science may often be thought of as rather dry and numerical, in fact research often involves working with objects that are visually interesting or beautiful, and with things that that evoke an emotional, rather than factual, response. StellrScope has been a great opportunity to share this aspect of plant science through Eleanor's unique art.

Dr Megan Hemming
Research Scientist and MAGIC Projects Scientific Co-ordinator
CSIRO Food Futures Flagship

I still recall quite vividly the first meeting I had with Eleanor to discuss what area of science I was involved with as I was struck with her interest in obtaining a real understanding of my work. I have been fortunate enough to be involved with Eleanor's work, in particular, through the MAGICal series which reflects the scientific work I have developed in MAGIC (Multi-parent Advanced Generation Inter-Cross) wheat. Eleanor and I had a number of discussions regarding what MAGIC is and what the scientific ideas behind the project were. What became very evident as Eleanor began working on the MAGICal series was how many alternative artistic interpretations she was able to generate which in turn gave some alternative perspectives on the work I do, each interpretation with a slightly different perspective on the subject matter. Wheat MAGIC was developed as a genetic resource for understanding the genetics underpinning wheat performance; central to this is the idea of using natural breeding methods to both break up parts of the wheat genome and bring other parts together, which she illustrates in an abstract form through 'MAGICal_Fusion'.

Some of the wheat varieties used in developing MAGIC are descendants of varieties first developed in Australia by William Farrer and hence provide a nice link between the era of Farrer and the genomics era of today where sequencing and computational biology play an important role in understanding the make-up of our wheat varieties, again depicted through Eleanor's series MAGICal9 series reflecting Eleanor's take on the use of sequencing and high dimensional data integration.

In addition to Eleanor's MAGICal series I was also fortunate enough that Eleanor, through photography, created some amazing images of wheat spikes and grain, one of which 'Beauty of Grain' was used on the front cover when we published the first paper describing our MAGIC research in the *Journal of Plant Biotechnology.*
It has been a great pleasure in sharing in a small part of Eleanor's journey in putting together an amazing collection that brings art and science together.

Dr. Colin Cavanagh
Wheat Functional Genomics
CSIRO Food Futures Flagship

The projects led by Eleanor speak to me straight away - they always present clear vision of connecting science and art in a beautiful way. Last year, we had exciting discussions about hemispherical domes and way of visualising 3D models on them using fisheye projections, etc. It is always very interesting for me to observe the design and development process of such projects. It is always great to discuss and exchange ideas with passionate people, very inspiring - positive vibes, and positive impact. Looking forward to collaborate more with Eleanor and team in the very near future.

Dr Tomasz Bednarz
Research Scientist
CSIRO Computational Informatics

I would like to express a huge “thank you” to everyone who has supported this wonderful project, *StellrScope*, and to acknowledge the collaboration, expertise and time spent together in making StellrScope happen… including contribution at all levels, here in Australia and around the world.

Eleanor Gates-Stuart

My first impression was that mixing art and science from the perspective of wheat quality improvement would not be an easy task!

I must say that I was blown away by the first image of Eleanor’s that I saw on ‘StellrScope’ – I just wasn’t expecting that kind of image. The pictures of the wheat that had been taken in the lab and field were transformed into complex colourful images and you really had to look at the image for quite some time to try and work out what the original image was and how it had been manipulated electronically. Not only that, but the images all had names, I guess trying to convey what the artistic message was behind the composition.

I look forward to seeing how all these various images will be put together in the final presentation and how they will be used to tell a story of discovery and exploitation of the properties of the wheat grain. I certainly know that looking at the images makes you think about what has gone into making it look the way it does and hopefully it will give non-scientists a different viewpoint of the discovery process and what we are trying to do with modern biotechnological approaches to crop improvement.

Dr Steve Jobling
Research Scientist
Food Futures Flagship
CSIRO Plant Industry

‘BioWheat’
Eleanor Gates-Stuart

StellrScopE
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