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The Scales of Life – A Case Study on an Art-Science Visualisation

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This is paper discusses the underlying research and challenges of a large-scale physical artwork entitled *Scales of Life* – a collaboration between artist Elaine Shemilt from Duncan of Jordanstone College of Art and Design, University of Dundee, Mike Ferguson, Regius Professor of Life Sciences, also at the University of Dundee, with Jo White of BMJ architects. The artwork forms the façade of the new Discovery Centre for translational Research and aims to communicate key areas of Life Sciences research carried out within the building. It utilises printmaking techniques combined with digital visualisation and engineering in metal, and depicts each of the four physical scales – Molecular, Organellar, Cellular and Tissue, that provide the basic understanding of biology and inform the treatment of many diseases.

Art and science. Printmaking. Visualisation. Public art.

1. INTRODUCTION

Through discussions and collaborative workshops with scientists in the College of Life Sciences during January, February and March of 2011 a series of prototype images were developed. Architecturally, different materials and building techniques were considered in order to create 'a breathable skin' for the building which led to the adopted idea of using perforated custom-made anodised aluminium panels rather than solid etched or engraved surfaces. The scientific images were considered and reworked using a variety of traditional techniques and subsequently translated into the digital domain. Cardboard prototypes were made using a laser cutter to test that the images would be legible and appear three-dimensional. Too many perforations and the material would not be structurally sound, too few and the image would not be legible. This artwork would be an integral part of the building and it had to embody the science within the visualisation. However, the restrictions imposed by perforations as a drawing tool posed a problem of how could low-resolution images serve to convey some very profound scientific research and discoveries. This was perhaps, the greatest challenge of the project.

There is a perception that Public Art often sits uncomfortably within the host environment. The art is often 'imposed'. My aim was to overcome that challenge and ensure that even to a passer- by walking past the building there would be a clear impression of the purpose of the building and for the scientist recognisable iconic representations of the shape and form of the molecular, cellular, organellar or tissue structures.

I am a printmaker. I experiment with material, colour and processes. The production of *Scales of Life* was an opportunity to reflect both my interpretive aesthetic approach and also the need to retain scientific recognition and accuracy in image making. By employing digital technology alongside traditional printmaking methods the different scale magnification in each source image was a reference to the different scales of life under scrutiny: molecules make up the organelles, which make up the cells, which make up the tissues.

Our collaboration worked because the scientists were open minded and willing to look at my particular visualisations – my version of their science – and in turn I was willing to be steered on to the 'correct' scientific pathway. Both scientist and artist then faced the challenge of translating this vision in collaboration with the architect and the engineering company who were tasked with the precision cutting of the aluminium panels at a scale not previously attempted.

2. THE BUILDING

Professor Mike Ferguson was the Research Dean of Life Sciences at the start of the project in 2011 and he had very high and well-informed architectural aspirations. The functionality of this new building needed to create a degree of diversity and flexibility in the type of labs with an emphasis on computational based research, along side the traditional chemistry and biology laboratories. In order to maximize the benefits of cross disciplinary collaborations combined with a change in research methods afforded by new technology there had to be a large amount of collaboration space.

These were aspirations that were shared by researchers within the College of Life Sciences.
The scientists viewed the new building as a possible interface between their research in the labs and the public. Added to that it was essential the building integrated and enhanced their existing facilities. Regulations also stipulated that the design must be highly sustainable and achieve a BREEAM minimum score of ‘Excellent’ and the University, together with Dundee City Council Planning Department, sought an architectural response to achieve all these goals. Local Plan Urban Design Policies were also influential in the early design stages and the Architects, led by Jo White established a set of design concepts that became a route map during the design and decision making processes.

The regulation that led to my involvement was POLICY 56: which was the requirement for an element of PUBLIC ART. It was early in 2011 when Prof Mike Ferguson and research officer Dr Morag Martin approached me to work with them on the inclusion of the public art for the building project.

The first consideration was to take an overview of the scientific background to the building. The purpose of a new Centre for Translational and Interdisciplinary Research in the College of Life Sciences (University of Dundee) was to double the capacity in Drug Discovery; also to bring Physics, Engineering and Computational Science into juxtaposition with experimental Biology. Another requirement was to develop quantitative (next generation) proteomics methods and associated analytics. There was the need to provide space for more life scientists and company pre-incubation and in addition to all of these requirements there was to be an environment for networking, public engagement and arts projects.

3. THE SCIENCE BRIEF

Initially we discussed the possibility that artistic expression, communication might help the wider community understand the complex scientific discoveries within the College of Life Sciences and at the same time generally raise awareness about the research. For my part, I was particularly interested in looking into the question of whether a science-art fusion could ‘move the boundaries of visual interpretation’, (Shemilt 2009).

It was agreed that the art project provided an opportunity to express the research work of the college. Consultation with the members of the College of Life Siences was essential to ensure the research was reflected appropriately and it was decided therefore, to hold an ideas competition based around the concept of the four scales of life. Scientific research at the level of each of the four physical scales - Molecular, Organellar, Cellular and Tissue – provides both basic understanding and informs the treatment of many diseases.

A brief description of the four images that were chosen to reflect the scales at which life scientists work goes someway to illustrate the importance of the research that is done in the College:

Molecular: A molecule of ATP in the active site of a protein kinase

Molecules are often called the building blocks of life. Most aspects of cellular life, such as immune responses, the decoding of genes and the control of metabolism are regulated by the attachment and removal of phosphate from proteins, which is performed by enzymes called kinases and phosphatases. Abnormalities in this process cause many diseases, such as arthritis, cancer, hypertension, lupus and Parkinson’s disease.

The molecular image (magnified about 3,000,000,000 fold) is based on a molecule of adenosine triphosphate nestled in the active site of a protein kinase.

The College of life Sciences is world renowned for research in protein kinases and this has greatly helped protein kinases becoming one of the most important class of drug target for the pharmaceutical industry.

Organellar: Traverse section of cilia

Organelles are to cells what organs are to the body. The image (magnified about 5,000,000 fold) is based on a cross-section of cilia, the hair-like organelles that provide cellular motion.

The cilia featured are characterised by a typical ’9+2’ architecture with nine outer microtubule doublets and a central pair of microtubules.

Cellular: Trypanosome in host blood cells

Cells are individual living units. The image (magnified about 100,000 fold) is of round blood cells next to a trypanosome cell, which causes African sleeping sickness. Sleeping sickness is a vector-borne parasitic disease that the World Health Organisation estimates affects around 50,000-70,000 people in Sub-Saharan Africa.

The disease, which is spread by the bite of a tsetse fly, is endemic in regions of Sub-Saharan Africa covering 36 countries and 60 million people. Researchers in the College of Life Sciences are studying fundamental aspects of parasite biology to identify new therapeutic targets and discover new anti-parasite therapeutic agents for clinical intervention through the Drug Discovery Unit.

Tissue: Early embryo

Tissues, like liver, heart and skin, are made of millions of cells. The image (magnified about 10,000 fold) is based on one of the most 'primitive' tissues, the eight-cell embryo, from which all tissues develop. Researchers across

the College of Life Sciences investigate the biological processes that underpin the function of a whole range of different tissues. Examples include investigating the mechanisms of differentiation in developing organisms, the identification of genes involved in human skin disease.

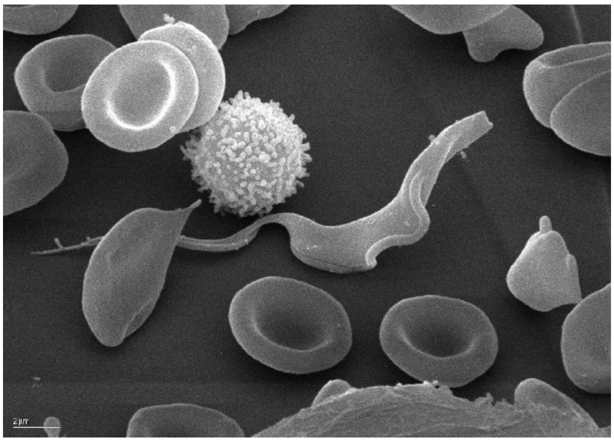

***Figure 1:** Trypanosomes in host blood cells (Thanks to Professor Michael Duszenko, University of Tübingen for providing the original source image)*

I found the scientific images from the College of Life Sciences very beautiful and without a doubt, they lent themselves to artistic exploration, interpretation and. Immediately, however, a question arose: Could my particular visualisation really enable the production of works of art with high impact and resonance and more generally, what are the effects of artistic expression, communication and methodologies on our understanding of complex scientific discoveries?

Science-art projects have become commonplace and there are various debates on their effectiveness and the tension between aesthetic goals and scientific usefulness. This refers back of course, to C. P. Snow, who proposed the existence of 'two cultures'. However, encouraged by our particular combination of expertise and what became firmly established and empathetic teamwork, I believe that our collaboration and the resulting ' *Scales of Life* artwork contests Snow's view of an unbridgeable gap.

4. COLLABORATION

I embraced the collaboration with the intention that it should reach beyond the initial objective of illustrating the research being undertaken within the building into deeper research issues on the possible usefulness of artistic methodologies. For this to be effective it is important to consider the role of the artist in the visualization of complex data, and the subsequent impact of this visualization upon scientific understanding and insights. Although I make paintings, sculpture and installations, I describe myself as a printmaker and for this project the years of developing the craft of printmaking proved essential and relevant. For example, the process of printmaking is indirect, which means that the artist has to be capable of thinking through an idea in reverse. Contemporary printmaking should really be described as a group of media, which utilize both ancient and modern techniques and technologies. I am also used to placing images into different environments other than the gallery/museum as well as working on or with, a variety of materials from latex to metal to paper to concrete.

Beyond the technique however, my approach is always to identify an original concept and to make a visual interpretation that will engage the viewer. The hope being that the viewer will see the concept through my eyes – in other words, my way of seeing.

My first experience of collaboration on a large scale was with the Military. I was commissioned by the M.O.D. to respond to the 'traces of conflict' in the Falkland Islands twenty years after the war (Shemilt 2002). Researching the various events that had taken place and translating that into art required a distillation of my responses down to an essence of my relationship with the conflict. A war being fought thousands of miles away tends to evoke feelings that are somewhat abstract in terms of daily life and yet for those personally involved it is all consuming and involves life and death. My role as the artist was to ensure that the relationship of the artwork to the facts was reflected and maintained. Simultaneously however, a successful artwork must go far beyond the obvious interpretative factual frameworks.

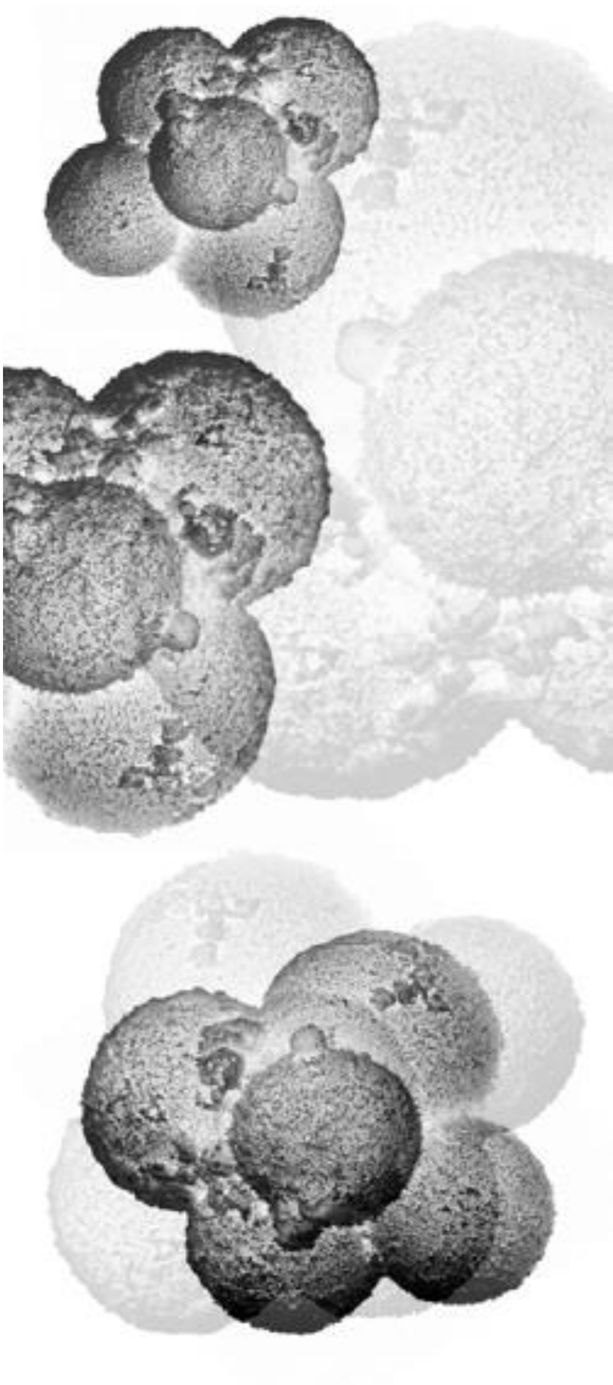

Figure 2: *Drawing based on early embryo (We are grateful to Yorgos Nikas, Wellcome Images for granting us the original source image)*

Having established something of the research that was being undertaken in Life Sciences, I had to get to grips with the scientific essence of the four main scales of life and attempt to deal with the intangible notion of their size. For example, I had to determine a visual abstraction of what is meant by, “ tissue”. How could I describe the essence of an organelle so it did not become a self indulgent abstraction based on my own personal view of life? That problem with the ego is a very important consideration when one embarks on collaboration.

The next stage was to pull my abstractions back into something that the scientists could recognize but that still retained my own interpretation. ‘The tissue concept’ was particularly challenging. I travelled further and further with this. I drew it and twisted it all the time imagining it being seen both as a negative and positive.

This both negative and positive readability became the catalyst for the final result. My role, as I saw it was not to provide a mere description of the Scales of Life.

5. PANELS & PERFORATIONS

For the architecture of the building Jo White was creating a long transparent block, which formed a new atrium, a ‘street’ connecting the new building with the existing college buildings. Combining this atrium at the heart of the new complex, with full height internal and external screens allowed for wonderful views out, and a lot of daylight deep into the building. This had a direct influence on the external façade where the artwork would form an integral part. The linear paneled façade was required to be perforated to allow for ventilation to the window behind, but they also needed to screen the column, service risers, heaters and lower ceilings all located behind them.

What if these panels with their perforations became the art installation? The Public Art could become something that was space efficient, permanent and even functional. Our subsequent research revealed that the technology was available to offer many possibilities for working with sheet metal. However the need for ventilation meant that we quickly discarded the idea of etching the metal and decided to explore the possibility of drawing by means of a series of perforations.

6. TRANSLATION

My intricate and precise studies proved difficult to translate into something that was essentially low resolution, because it was to be created out of a series of holes. My research assistant Scott Hudson and I rendered my drawings, prints, photographs and paintings into holes on cardboard by using a laser cutter in the printmaking studio.
Over and over again the images just didn’t work. More often than not all that was being achieved was a visual disaster. It was necessary to over

emphasize some ugly passages in an attempt to outsmart a process would dictate it's own aesthetic back through the process of turning a positive into a negative and vice a versa.

We tried many permutations with different tissue images. The practical problems of drawing with a series of holes punched into a sheet of metal required a process of drawing in reverse.
In order to stay on top of the three - dimensional quality, at every stage we cut out templates on the laser cutter. This public artwork had to be more than a series of pictures - the scales of life had to become sculptural forms. As an artist I to keep my feet on the ground, I was also thinking through processes of low tech solutions in order to create something that would eventually be created by way of a very sophisticated high tech solution.

When I really felt as though I could not find a solution to the problem, I drew on my experience of collaborating with scientists from The James Hutton Institute on a previous artwork *Blueprint* (Shemilt 2009). They had pioneered the software 'GenomeDiagram', which enables simultaneous visualization of billions of gene comparisons of hundreds of fully sequenced bacterial genomes, including those of animal and plant pathogens. I worked with the crop research scientists on the bacteria known as Erwinia - a potato pathogen. Genome diagrams, even in their scientific context, are fairly abstract figures. These 'maps', after all, represent biological concepts that do not really exist as visualised. Most of the processes and entities with which modern microbiology is concerned with are invisible. In order to come up with a reasonable abstraction I had to completely clear the image of any scientific coding or representational colours. However, I also had to accurately describe the DNA sequence so that by de-contextualizing scientific data, a complementary viewpoint to the scientific interpretation was obtained. The advantage of my profession as an artist and my relative ignorance of the scientific coding is that my imagination is uncluttered by scientific language and I am free to develop with visual cognition. For *Scales of Life*, I went back to that experience and to the essence of what we were dealing with. When I felt that I had got to the essence of the scales of life, I reasoned that I could gradually pull back an image that was coherent scientifically and would also blend sufficiently with the aesthetic of the building enough to satisfy the architect's vision.
My intention was to create something that was literally and visually three-dimensional. In other words as you walk past the building the viewer should get an impression of the shape and form of a molecular structure, or a cellular structure - indeed a tissue or organellar structure. These sculptural forms should work from different angles both by day in daylight and at night with the lights in the building shining from behind.

As the images regained the original shapes I was gradually doing a push and pull from this to this – always listening and watching to see the reaction from the scientists and the architect.
There was a lot of body language involved. I began to recognise the difference between a polite but hesitant endorsement and the real enthusiasm shown when I had actually got to a point where my image matched the scientist's understanding of the scales of life.

The next problem arose when that the architect informed me that the overall budget was extremely tight and I must restrict my drawing tool to three sizes of holes. …Having imagined the luxury of a range of tiny holes and huge holes – my brain was a turmoil of creative crisis management. Mike Ferguson emailed me sympathetically to explain, and I quote " More Holes – More Wonga!" I have to say that such was the strength of our collaboration that somehow or other he negotiated for more resources and eventually five sizes or diameters were agreed.

Always my concern was that the concept should have a strong feel and presence. It should pose questions without being in danger of resulting in a loud visual interruption imposed on the sides of the building. Towards the latter stages of the final proofs there seemed to be points when we were fiddling with what in retrospect seems like minutiae. Perhaps this was the most crucial stage however. The scientists were correct to stipulate that the image had to be scientifically correct whilst I was also correct to balance that with the need to retain my concept. When we finally finished our proofs and we raised a glass, it was as much to the final drawings as to the completion of a meaningful and successful art science collaboration.

7. MANUFACTURE

Figure 3: *The Panels being installed*

The engineers then had to then translate the digital drawings and maquettes into instruction- sets for the laser cutting process of the metal sheets that formed the cladding panels, The cladding panels are 1.5m wide x 3.6m high were made from a high quality anodised aluminium and are arranged vertically into 17 groups of 4 panels, 14.4 meters high. The full height glazed screens and panels offer visual connections that extend across the floor plates to the Dundee townscape beyond. All of which promotes everyday interaction and recognition between staff. New collaborations and programmes were borne from this process including the creation of the *LifeSpace* gallery, which is a new research-driven gallery space. *LifeSpace* creates an opportunity to stage the best collaborations in contemporary visual art and science from both the University of Dundee and internationally. The idea for LifeSpace arose as a result of the work forged through the interdisciplinary collaboration which created The Scales of Life.

Every stage of this project was achieved as a result of joint decision making between myself as artist, along with my research assistant Scott Hudson and the scientists particularly Morag Martin and Mike Ferguson, the architect Jo White and her team.

Figure 4: *The panels installed on the north side of the building*

8. COMPLETION

The Discovery Centre for Translational and Interdisciplinary Research was completed in August 2014 and was officially opened in October 2014, by Nobel Laureate Sir Paul Nurse.

It forms the latest addition to the College of Life Sciences Complex at the University of Dundee and the core aim of the Centre is to break down barriers between scientific disciplines to facilitate innovative discovery and translation.

Located in front of the College of Life Sciences, at the western entrance to the City Campus, the building not only provides a new front door for the College of Life Sciences but also responds to its prominent location, engaging with the Dundee townscape and its populace, whist also providing a high quality architectural addition to the University's City Campus. The new annexe provides over four storeys of laboratories, associated office and meeting space, including a state-of-the art Drug Discovery High Throughput Robotics Laboratory and the Laboratory for Quantitative Proteomics, one of the largest and best-equipped proteomics facilities in the world.

The Discovery Centre for Translational and Interdisciplinary Research was awarded a BREEAM 'Excellent' rating.

9. REFERENCES

Shemilt, E. (2002) Artist's Notes. In (eds), Shemilt E. Traces of Conflict. Imperial War Museum, London.

Shemilt, E. (2009) A Blueprint for Bacterial Life; Can A Science-art Fusion Move the Boundaries of Visual and Audio Interpretation? In (eds), A. Bentkowska-Kafel, T. Cashen, H. Gardiner. *Digital Visual Culture: Theory and Practice, Computers and the History of Art*, Intellect, Bristol.

Shemilt, E. (2009) Limited edition-unlimited image: can a science/art fusion move the boundaries of visual and audio interpretation? In Gardiner, H. & Gere, C. (eds.) *Art practice in a digital culture*. Ashgate, Farnham, Surrey.

Internet resource

http://www.lifesci.dundee.ac.uk/discoverycentre/sites/ctir.aegir-prod-6.lifesci.dundee.ac.uk/files/Scales%20of%20Life%20Slideshow%20final.pdf