ARTIST'S ARTICLE

Model & Metaphor

A Case Study of a New Methodology for Art/Science Residencies

NOLA FARMAN, MATT BARR, ANGELA PHILP, MIRANDA LAWRY, WARWICK BELCHER AND **PAUL DASTOOR**

ABSTRACT

Traditional artist-in-science-residency schemes have tended to focus on artists using scientific tools and technology as a medium for their art. What kind and quality of work might occur, however, between scientists working on cutting-edge solar energy research and a visual artist (a sculptor) when they are integrated in a truly collaborative environment? Is it good for the art? Is it good for the science? The authors describe a new methodology for art-science interactions whereby they have integrated arts practice within a scientific environment. A critical aspect of the methodology for the residency was the development of an interaction framework that ensured that both artist and scientist had equal voice in discussions involving the art *and* science of the project within an environment of mutual respect. The integration led to the development of outcomes that would not have occurred otherwise.

Historically, much has been written about the qualities of Renaissance Man, who was expected to be both versed in the arts and concerned with the advancement of science [1]. However, by the 19th century, an artificial divide, as described by C.P. Snow, had developed between so-called literary intellectuals and scientists. This divide created an environment in which nonscientists believed scientists to be "shallowly optimistic," while scientists thought the others to be "totally lacking in foresight" [2].

Within this environment, the original purpose of the artist-in-residency, which arose around 1900 as a new kind of patronage [3], was to allow the artist a creative and productive time away from ordinary life. Subsequently, the concept of an artist-in-*science*-residency emerged. An early model was the Gregory Fellowships of the 1950s, which placed artists in the University of Leeds with the intent of humanizing what was then primarily a technical institution. These fellowships helped to set the typical format for subsequent artist-in-science-residence schemes, with fellows being free to move around the university without being tied to any one department. As the concept has evolved, more opportunities to place artists in scientific environments have sprung up, funded by a variety of governmental, industrial and private sources. Within this climate, the artist-in-science-residency has enabled a new spirit of artistic experimentation and has provided a bridge across the divide described by Snow.

Given the convergence of science, technology and everyday life that has occurred since the mid-20th century, the scientific tools with which the contemporary artist can experiment (and therefore the opportunities) seem limitless. The artist-in-science-residency model [4,5] has become a kind of laboratory for the artist to draw on the expertise of scientists and technologists. Gradually the artist's technological skill base has broadened to encompass a range of materials and techniques beyond the conventional.

It is increasingly recognized, however, that there is an urgent need for art-science interactions to evolve beyond the traditional pattern of scientists serving artists by creating new instruments to make art, and artists serving scientists by creating artworks to represent scientific concepts for the public [6]. Work by David Edwards and others has highlighted examples of individual researchers who have crossed from the arts to the sciences (and vice versa) to translate ideas between the two domains [7]. Exciting new cross-disciplinary institutes have recently been established to encourage cross-fertilization of ideas and creativity [8]. Yet despite these exciting developments, the predominant flow is still from science to art rather than from art to science [6]. Of particular note, there is no established methodology for creating an environment in which individuals trained as artists can contribute to the creative outcomes of a scientific research team. This

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observation raises the question [9]: In what ways can art-science interactions be beneficial to both parties?

To address this question, the Australian Network for Art & Technology (ANAT) has sponsored a new type of artist-in-science-residency called the Synapse Residencies. ANAT was established to integrate artistic and creative practice into research and development across science and technology. An explicit goal of the Synapse Residency program is to explore ways in which the arts can benefit science [10]. In 2012, Nola Farman was awarded a grant for collaborative work with the Centre for Organic Electronics (COE) at the University of Newcastle, Australia [11]. In this paper, we discuss the outcomes and benefits of this new art/science collaboration from both artistic and scientific viewpoints. Significantly, we observe beneficial outcomes for both artist and scientist.

EXPERIMENTAL

The residency program ran for a period of four months, during which Farman was immersed in the day-to-day life of the COE laboratories. During this time, she also discussed the project with Lawry and Philp to establish the theoretical, cultural and conceptual aspects of the project. Together, the coauthors composed the collaborative research team that worked on the project. Farman spent the first month as a researcher in the laboratories, learning how to fabricate organic (plastic) solar cells and familiarizing herself with the materials and techniques used by researchers. Farman then developed a series of maquettes—small-scale prototype sculptures that explored the ideas of light, dynamic motion and the materials available (Fig. 1). The process culminated in the production of a kinetic sculpture (Color Plate B) with the working title *Model & Metaphor*. The sculpture was first shown at an associated exhibition at the University of Newcastle and later at the Powerhouse Museum, Sydney, with ANAT in association with the International Symposium of Electronic Arts (ISEA).

RESULTS AND DISCUSSION

Model & Metaphor: An Art/Science Case Study

Nola Farman was one of the first artists in Australia to use solar power in sculptural work [12]. Indeed, this background in solar power acted as the catalyst for the initial interactions between Farman and the COE. However, as a progression of her previous work, this residency forced her to think of solar power as a starting point as well as the basis for an

Fig. 1. *Model & Metaphor* or *Animating Solar Technology*, first scale model, 1:20. Kinetic sculpture made of balsa wood, glue, cotton thread, springs, sticks and plywood. (© Nola Farman)

artwork—not just as a means for the provision of power to something she would have made anyway.

Model & Metaphor takes the form of a large kinetic sculpture suspended some meters above the ground. It is composed of a collection of triangular shapes that appear to be tenuously connected and randomly juxtaposed, as if the shards had been frozen in a moment of collision in some accidental event. The sculpture is suspended between stylized stainless steel and natural tree trunks. During the course of the day, the sculpture lifts and rolls toward the sun. Its idiosyncratic movement is a result of this new art-science collaboration exploiting specific knowledge of contemporary materials such as steel, plastics, organic solar cells (OSCs) and shape memory alloys (SMAs).

From the artist's perspective, these contemporary materials (which have both constrained and facilitated the sculptural form) have been the most significant point of exchange and have enabled the artwork to be kinetic without mechanical effort. In addition, they also enabled the transformation of sunlight into electricity. As such, the contemporary sculpture does not simply reflect on nature but also integrates and interacts with nature. Thus, *Model & Metaphor* conveys that we are not mere bystanders in natural events but are rather participants who are implicated in the landscape. Indeed, this implication is emphasized through the use of the electricity generated by the OSCs. This project would not have been possible in its particular form with conventional art materials; it necessarily requires the new materials that the artist was able to access and experiment with in this collaboration.

Model & Metaphor: A Science/Art Case Study

The COE was one of the first academic research groups to fabricate organic solar cells in Australia [13]. The presence of an artist in the group provided members of the COE with the opportunity to step outside the usual barriers that constrain scientific thought. This unusual collaboration has given the scientists the freedom to be more creative with their solutions, because these pertain to an artistic endeavor. In particular, the development of *Model & Metaphor* during the residency allowed the scientists to envision OSCs as kinetic rather than static structures.

Model & Metaphor is also a suspended geometric scaffold for OSC modules that incorporates a passive solar tracking element. From the scientific point of view, there are two major aspects to the project: The first are the materials around which the entire structure is based (printed OSC modules); the second is the development of a mechanically passive but physically dynamic aspect to the sculpture that conforms to the underpinning theme of the interaction of light with the materials.

In essence, solar cells are devices that absorb light and produce electricity. Whereas conventional solar cells are based on inorganic materials such as silicon, organic solar cells are an emerging technology based on semiconducting plastic materials. Consequently, OSCs can be fabricated on light and flexible sheets of plastic [14].

Early in the project, the artist and collaborating scientific team decided that OSC plastic sheets would provide an ideal material for the sculpture. As such, the artwork could inherently act as a source of electricity. In addition, an initial thesis of the project was that the sculpture should be kinetic. Scientifically, this dynamic aspect resonates with solar energy generation since it could provide a mechanism for optimizing the alignment of the solar cell with the incident sunlight. One method to achieve this alignment would be to use the electricity generated by the OSCs to drive motors that tilted or twisted the sculpture. However, this approach was viewed as both artistically and scientifically inelegant. In particular, from a scientific point of view, the use of motors would necessarily mean that some of the energy generated would be lost in the alignment process. The use of a passive alignment system allows all of this energy to be freely used. For example, the public could recharge devices such as mobile phones and laptops, and the artwork could produce its own lighting at night.

Previous work has shown that bimetallic strips [15] and shape memory alloys (SMAs) [16] can be used as simple, passive alignment materials in solar tracking devices. However, our initial investigations showed that bimetallic strips had insufficient movement for the artwork, and thus focus turned to the SMA materials. The latter typically consist of metal alloys (such as nickel and titanium), which can be easily deformed at relatively low temperatures [17]. The alloy returns to its original shape when heated above a particular transformation temperature, producing mechanical work. (In this case, the heat would be from the sun.) These materials can be made as wires, rods and sheets and are increasingly used in a wide range of small- and large-scale applications, including robotics [18], dental braces [19], arterial stents [17,20], bone surgery [17], glasses frames [21], bra underwires [22], bridges [17] and aircraft wings [23].

Figure 2 shows a schematic of the SMA-containing armature that Farman constructed. The design is based around a series of SMA springs that contract upon heating to 25°C (through exposure to direct sunlight), together with a counterbalance that re-extends the springs upon cooling. The armature is connected to the sculpture such that the SMA spring contraction produces a rotation of 45° of the module surfaces. This rotation has not been maximized and could easily be increased. Indeed, typical solar trackers are designed to provide 120° of angular rotation [24,25].

The results of this work have led to the establishment of a new research project investigating the use of these materials in solar tracking combined with studies of the effect of the incident angle of light on OSC efficiency. In particular, the use of SMAs to align lightweight OSC modules with the sun has proven to be particularly fruitful and offers the possibility of a low-cost passive alignment technology. This project has led to the recruitment of a new joint research student, whose work spans the arts and science disciplines, working directly with Farman and the COE. This project is currently exploring new SMA materials and architectures for the movement of both large kinetic sculptures and solar cell installations; a corresponding scientific paper is in preparation.

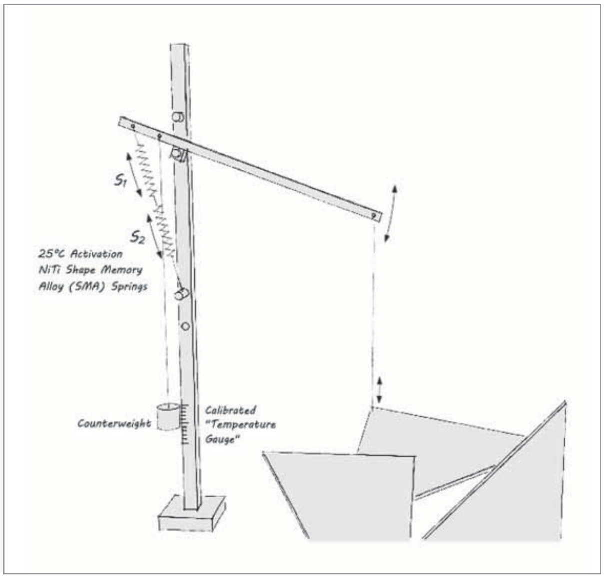

Fig. 2. Detail of the lifting armature (NTS) to assist SMAs in *Model & Metaphor*. (© Nola Farman)

THE PROCESS OF COLLABORATION

A key part of this residency was the development of a methodology to observe and reflect upon the process of establishing an art-science collaboration with the explicit goal of developing beneficial outcomes for the artist and the scientists. This reflection was facilitated through the establishment of pseudo-external observers through engagement with the discipline of fine arts at the University of Newcastle and fortnightly meetings that were audio-recorded. Interestingly, the participants and the observing team noted early on in the collaboration that both the artist and the scientists were able to engage rapidly on both the artistic practice and the scientific concepts that were being explored. This engagement was two-way, with both the artists and the scientists contributing to the development of both the art and the science. We hypothesize that this engagement was facilitated by: (a) the initial immersion process, which allowed the artist to assimilate the science, technology and culture of the research group efficiently, and (b) the common experience of both the artist and the scientists in designing, manipulating and fabricating materials. They thus already shared much common language through which they could communicate effectively.

Throughout this engagement, it also became apparent to the participants that both artist and scientists in this project shared the common concept of light. In many respects the development of a sculpture follows a process similar to that of a scientific theory—both involve the creation of models that allow ideas and theories to be tested. The solar scientist is concerned with the science of light and works with materials that direct and utilize the energy of light. On the other hand, it can be argued that the sculptor models light and works with materials that anchor and manipulate the visual/illumination effect of light [26]. Critically, the shared use of materials in this residency produced a convergence of perspectives and the creation of common ground. Consequently, this new art-science collaboration, which involved contemporary materials, science and art, was able to produce beneficial outcomes for both parties. In particular, this new methodology has led to both the creation of the artwork *Model & Metaphor* and the establishment of a new research program exploring the potential for SMAs to act as passive solar trackers for OSCs. Work is currently under way to design and build the full-scale version of the artwork subject to securing funding. In the meantime, research is being carried out into the use of a lens apparatus to optimize the focus of the sun's rays on the SMAs.

CONCLUSIONS

This new methodology for art-science residencies has resulted in tangible outcomes that have benefited both the artist and the scientists involved in the collaboration. For the artist, the residency has expanded her horizon via the range of materials that can be used to realize ideas, especially in terms of kinetic sculpture. For the scientists, the residency has led to scientific creativity in areas where it could not have been expected and that came about as the result of an equal collaborative endeavor. More broadly, the mechanisms developed during this case study have laid a solid foundation for the development of a new process for creating art-science linkages, which is so urgently required. The key feature of this new approach is that it establishes an art-science collaboration wherein the artist is embedded in the scientific environment with the explicit goal of developing a process whereby artistic practice contributes directly to scientific research.

Acknowledgment

We gratefully acknowledge the Australian Network for Art & Technology (ANAT) for providing funding for this residency program. This work was carried out in part at the Materials Node of the Australian National Fabrication Facility, a company established under the National Collaborative Research Infrastructure Strategy to provide nano- and microfabrication facilities for Australia's researchers.

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10 The Australian Network for Art & Technology (ANAT) is Australia's preeminent network and advocacy body for artists working with technology. The role of ANAT is to advocate, support and promote the arts and artists in the interaction between art, technology and science, nationally and internationally. Since its inception in 1985 ANAT has been at the forefront of the movement to position artists as active participants in the "information age." See <www.anat.org.au/>.

11 The Centre for Organic Electronics (COE) is one of the key Priority Research Centres at the University of Newcastle. Professor Paul Dastoor and his team have an international reputation in the area of organic electronics and devices. The COE's primary focus is on the development of new electronic devices at the intersection between semiconductors and plastics. The Centre focuses on the scientific challenges in the development of organic photovoltaics, with massive potential for the next generation of environmentally friendly energy sources, photonics and biosensors.

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Manuscript received 3 March 2014.

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COLOR PLATE B: ***MODEL & METAPHOR***

Nola Farman, *Model & Metaphor* or *Animating Solar Technology*, current work-in-progress scale model, 1:20. The colored panels indicate possible locations of the OSCs. Note that the final form of the kinetic sculpture has not yet evolved. (© Nola Farman. Photo: Tim Buchanan.)