Special Section

Transactions

Editor: Ernest Edmonds

This issue's Transactions section is the second installment (of two) of papers that arose from the UK CREATOR project: New Research Models and Processes for the Creative Industries. (See *Leonardo* Vol. 43, No. 1 for the first installment.) CREATOR is a joint EPSRC/AHRC/ESRC Digital Economies research cluster fostering collaborative research in creative organizations led from Nottingham University. See: <gow.epsrc.ac.uk/ViewGrant.aspx?GrantRef=EP/G002088/1>.

Transactions publishes short refereed papers. It provides a fast track to publishing key new results, ideas and developments in practice. This format is particularly valuable to young researchers and, in particular, Ph.D. students in the later part of their studies. Practicing artists are encouraged to report on new work and new concepts through *Transactions*.

Papers are solicited matching the stated aims and scope of *Leonardo*, but restricted to two pages of published material. A fast referee process is employed in which the result is restricted to "accept" or "reject."

Papers should be submitted electronically in final camera ready form at <www.leonardo-transactions.com>, where formatting instructions and a template may be found. Once a paper has been accepted in *Transactions*, authors will be offered the opportunity to provide mulitmedia supplementary material for posting on the MIT Press web site.

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Transactions welcomes submissions concerning topics listed in the journal's current "Calls for Papers" (see <leonardo.info/isast/spec.projects/spec.projects.html>). In addition, *Transactions* calls for papers in the following areas:

- The integration of practice and theory in art-led research
- Contributions to science and technology from art practice
- Scientific methods used within art practice.

Special thanks to our Transactions reviewers: Paul Brown, Computer Arts Society; Dave Burraston, Creativity and Cognition Studios; Linda Candy, University of Technology, Sydney; Sean Cubitt, University of Melbourne; Ross Gibson, University of Technology, Sydney; Sue Gollifer, University of Brighton; Janis Jeffries, Goldsmiths College, University of London; Mary Lou Maher, National Science Foundation, USA; Lev Manovich, University of California, San Diego; Eduardo Miranda, University of Plymouth; Bonnie Mitchell, Bowling Green State University; Kumiyo Nakakoji, University of Tokyo; Frieder Nake, University of Bremen; Jack Ox, University of New Mexico; Doug Riecken, IBM; Cynthia Beth Rubin, Rhode Island School of Design; Stephen Scrivener, Chelsea College of Art and Design; Jeffrey Shaw, University of New South Wales; Mike Stubbs, FACT Liverpool.

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How Artists Fit Into Research Processes

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Submitted:1/4/2009

Abstract

The study collects, compares and synthesises existing knowledge from specific sources about artists and creative designers working within research processes. The emphasis is on collaboration, evaluation and reflective practice.

Introduction

Artists and creative practitioners more generally are typically involved in research as part of multidisciplinary teams. The nature of these collaborations and the relevant success factors are important to understand. Increasingly, research oriented creatives are incorporating evaluation into their practice, often drawing upon methods familiar in human-computer interaction.

Following Schön [1], reflective practice has been explicitly developed and implemented especially, for example, in practice-based art and design PhDs.

We draw upon a small number of specific sources in which detailed research has already been undertaken. These include:

• the Engineering and Physical Science Research Council (EPSRC) funded projects conducted at Loughborough University, such as COSTART, in which artist-in-residence programs were used to study collaboration between digital artists and technologists [2, 3].

• the evaluation report on the Wellcome Trust's Sciart Program (1997-2007) [4], that surveys the successes and shortcomings of a funding program designed to be a stimulus for collaboration and, "to fund visual arts projects which involved an artist and a scientist in collaboration to research, develop and produce work which explored contemporary biological and medical science."

• the Beta_space collaboration between Creativity and Cognition Studios, University of Technology Sydney and the Powerhouse Museum, Sydney. The thrust of this work has been the development of concepts and methods for incorporating evaluation in public spaces into the creative process [5, 6].

• the recently initiated research programme at FACT, Liverpool, and the outcomes of its 2008 series of workshops.

Description

Credible evidence has been generated over the last decade to demonstrate the synergies and positive outcomes that arise from research processes bringing together diverse skills and expertise from amongst artists and scientists.

The COSTART Project was established on the basis that support for creativity in media arts implied collaboration with technologists. It was the first major research project funded from a scientific source in the UK that explicitly undertook to carry out research into creativity between artists and technologists. A notable realization was that there are many forms of collaboration and different kinds are required for different types of work and people. The nature of the collaboration observed during the project, in all cases studied, varied significantly. One of the key factors in those variations was the allocation of responsibility for different parts of the creative process. Who in the team is in control of what aspect of the work?

The development of a residency study as a vehicle for practice-led action research was the primary mechanism for facilitating creative projects and also gathering data. In this way, a series of investigations into creativity and digital technologies based on the co-evolution of research and practice was put into place.

The first phase of the project selected seven case studies from 20 artists who attended an orientation workshop with a group of prospective technology support staff and researchers. From the COSTART case studies three models of collaborative creativity were derived, reflecting important variations in the nature of collaboration itself. The variants on collaborative creativity were evident even where the participants were the same individuals but matched with different collaborators. The bringing together of different personalities, motivations, backgrounds and skills resulted in a rich set of collaboration models. This enabled the researchers to consider the implications of the different models for supporting creativity and their relationship to success factors.

One of the residents was an artist trained originally as a computer scientist. He characterised these initial collaborative projects: "digital technology offers possibilities for the artist that can be enlightening, but by nature it demands an algorithmic predetermined input where all variables have been considered beforehand. My desire is to reconcile these two very diverse mind sets and explore the possibilities that emerge." Other artists realised quickly that the need was to move on "from the formula of having a technological assistant to one of having a technological equal partner and co-author" of the art in collaboration.

COSTART was concerned with finding ways of supporting artists by giving access to the technology and the people with the technical skills to advance the use of the technology. The project concluded that the idea of supportive environments for art and technology needs to be broadened to include the establishment of on-going collaborative partnerships, fostered by a host organization.

A fundamental requirement of an environment for creative practice, whether in the arts or sciences, is that it supports and enables the development of new forms and the new knowledge that is required to achieve such outcomes—creativity requires circumstances that enhance development possibilities. How do we ensure that both the creativity and the technology development are fostered in tandem? The technology requirements for creativity must be a highly responsive, iterative process where new insights are fed back quickly into the development process. This co-evolutionary process is a form of practice-based research where the existing technology is used in a new way and from which technology research derives new answers: in turn, the use of new digital technology may lead to transformation of existing forms and traditional practices across disciplines.

The Wellcome Trust Sciart program commenced in 1997, developing partnerships with various government and corporate partners over the decade, before being superseded by the Trust's Arts Awards in 2007. The objective of the grant program was to be a stimulus for collaboration between artists and scientists, in particular those in the medical fields. In a 2008 report following an ethnographic study of the Sciart program, a number of those questioned felt that the lure of Sciart funding had provided a positive incentive and stimulus for artists to enter into either exploratory discussions, or else more focused negotiations, with scientists.

"They are introducing ideas through a new prism of language. Sciart does not fund proposals where the art is illustrating the science, because that is not about collaboration. It is looking at difficult questions that both science and art are asking, and looking at how the two can aid each other in moving things forward" [6].

There was also some evidence that this interchange of resources and ideas had led to the development of new ways of working, innovative use of technology, and a more creative use of facilities and resources.

Of the 10 Sciart case study projects investigated, three had involved very close collaborations in which there was felt to be a high level of mutual commitment and input and a sense that some kind of parity had been achieved in terms of the outcomes or benefits that had resulted.

"'X' had started taking that scientific approach, of questioning his own work, and conversely I had started to work more by intuition and was a lot happier not to ask the question 'Why?' It was the point at which the sense of true collaboration really became manifest and the two worlds crossed over. It took 3 years to arrive at that point. He had become the scientist and I'd become the artist" [4: 86,87].

Sciart's impact on the wider culture of art-science collaboration produced a range of tangible outcomes. It enabled the development of a critical mass of practitioners and of projects, which has helped interdisciplinary work in the art and science field to become widely recognised; the funding consortium was a fruitful and influential experiment in co-operative arts funding; the example set by the Wellcome Trust and by the Sciart consortium encouraged other funding bodies to begin to support projects in the science-art area; Sciart had been valuable in helping to crystallise and to exemplify trans-disciplinary research with projects having acted as a 'seed' for future collaborations; the scheme overall had been a valuable catalyst for many new relationships to develop, at both an individual and an institutional level; it has attracted international attention and is seen to be innovative and influential.

A number of commentators and project participants referred to the practical influence that Sciart funding had had on helping to open up the doors to previously hermetic places of research, particularly within the sciences. A degree of influence was ascribed to Sciart in terms of its having helped—through its alignment of art with themes from biomedical science—the general culture of contemporary art to become, and to show itself to be, more engaged with the public and social concerns of the day. It was felt that Sciart had helped to create an ambience wherein the activities of science could more easily percolate into the public domain.

Other examples of interdisciplinary research are many and varied. In recent papers from the University of Nottingham, a software tool (Digital Replay System) has been developed across computer science and English and psychology programs to allow users from different methodological backgrounds in the social sciences to re-use multimedia data sets suited to the needs of individual research programs [7].

The work in Beta_space, Powerhouse Museum, Sydney, in collaboration with the Creativity and Cognition Studios, has been summarised in a paper by Edmonds et al. [8]. The paper describes a programme of research and practice in which the evaluation of interactive artworks in a public space is undertaken as part of the creative process. The three viewpoints presented, of artist, evaluator and curator, add up to much more than each one can offer on its own. The paper reflects upon the different concerns and approaches and the ways in which they are entwined.

The main findings that emerged from the development of the multiple viewpoint evaluation process were:

- The value of enabling an artist to observe their interactive artwork in action, in a real context, and the need to provide methods that help artists learn from those observations;
- The artist's need to consider the tension between the ease with which the audience can engage with the work and the need to provide a level of complexity that makes it hard to exactly grasp the rules being used;
- Evaluation techniques can help an artist to emphasize, rather than "smooth over," difficult aspects of an experience;
- Artists can be supported, through evaluation methods, in responding to and working with audience experience as though it were a kind of "material";
- Evaluation can support the curator in reducing the gap between the artist's "ideal" and the audience's "real" versions of an artwork;
- That audience experiences with interactive artworks develop through phases, each with their own characteristics, and hence there is no simple single description of audience engagement.

Recommendations

The following points are drawn from the full set of references consulted:

1. Artists should agree to record their creative process, including failures.
2. Each project should have multiple planned outputs so that scientific and artistic goals are visibly achieved.
3. Observation and evaluation of the collaboration process should be explicitly included in the outputs.
4. New relationships and extended networks are common benefits of long-term commitments.
5. Team selection and team building are important. It cannot be assumed that a good artist and a good scientist will necessarily form a productive team.
6. Where artworks produced are interactive, provision should be made to undertake 'beta-testing' with audiences in realistic contexts.

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SENSORY THREADS

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Submitted: 23/2/2009

Abstract

Sensory Threads is a pair of interlinked experiences, which explore the way in which sensing can give us insight into how our bodies are a part of their wider environment. Sensory Threads seeks to investigate what happens when wearables move beyond being technologies designed for individuals and are transformed into tools of 'collective sensing'. It aims to stimulate participants' behaviours through their own emergent and unpredictable actions in an environment, not by pre-defined choices determined in advance by the project's makers or by 'interesting' geographic sites. This article describes the design of this artwork, which is currently in prototype form.

Introduction

As we move through our environment, we are bombarded by a mass of sensory information such as sound, light, smells, and also other less perceptible things such as high and low frequency sound and non-visible light. The Sensory Threads project considers our bodies as a vital part of this environment, by using both environmental and body sensing technologies, to allow us to explore how we are part of our environment, and the complex patterns and rhythms that occur in the reactions between our bodies and their environment.

Sensory Threads comprises of two elements, firstly a group expedition through a city, using wearable technology and real-time audio feedback in order to allow participants to explore this combined environment. Secondly, a gallery based installation allows for the replay of the sensory experience, using a combination of tactile feedback, visuals and audio.

Exploration

Groups of 4 people are sent out on a mission to explore the city using a set of 4 wearable sensing devices. Each of these is worn by a single person, and records data from one type of sensor. Each person's individual sensor stream is sent to a 'heart' computer carried by one of the explorers. The 4 sensor streams are then used as input to an interactive soundscape which is produced by the heart computer, and then output on wireless headphones to each of the explorers. The heart computer also records a GPS track of where the explorers are going.

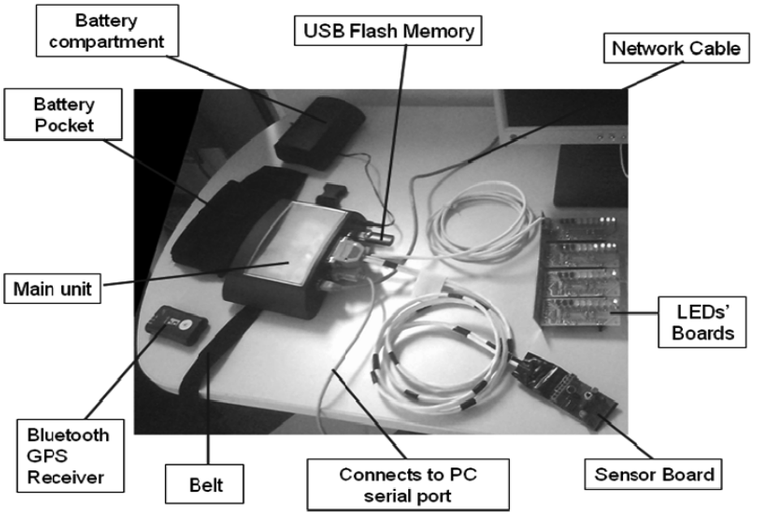

Fig 1. Snout Sensing Platform (© Proboscis Ltd.)

Each of the sensors influences a different aspect of the generated soundscape. This means that people are able to experiment with how their sensors affect the sound being created.

As each sensor responds to its environment differently, a complex group dynamic is created; each explorer is more motivated to explore things that their sensor responds to, but will have to move with the rest of the group and negotiate between each other where to go, as all explorers must stay close together (within 5m) or the soundscape fades out.

The Sensors

This section describes the sensors carried by each of the explorers. These are mounted on specially made costumes. These use a version of the Snout Sensing Platform [1], a specially designed Linux based hardware sensing platform for participatory sensing (see Figure 1). The way in which the sensors are configured is described below.

One explorer,designated the heart, wears a heart rate monitoring strap and carries a special heart computer (a small netbook style laptop in a backpack). The heart computer records the sensor data from each costume and creates the soundscape, which is then output to the explorers via wireless headphones. This creates a feedback loop, with the explorers able to move around with the sensors and hear how the soundscape responds.

The heart computer also records the position of the group, and all the sensor data, and transmits it to a server, for use in the installation experience.

The heartbeat of a person is intimately linked to their speed of movement and the terrain they are moving over and so creates an interesting bridge between the heart's body and the environment in which it is moving.

One of the explorers has a noise meter on their costume, which detects ambient noise levels around the explorer. This is affected by many things, such as crowds, traffic, or conversation with the others.

The light meter detects levels of light falling on the costume, with a light sensor mounted on a hat. This is affected by people passing by, changes in the weather, being covered by one of the explorers, overhanging buildings or shadows, and also by changes in posture of the explorer, which may alter the shadowing of the sun or other light sources.

Four ultrasound rangefinders are attached to the front, left, right and back of the suit. These use reflected ultra high-frequency sound to detect the distance of the closest object and can determine how cramped a space the person is exploring or can provide a rough estimate of the density of a crowd surrounding them. It also gives a very directional signal, which can differentiate between situations such as being in a narrow empty corridor (left and right sensors give close readings), and walking amongst a group of people in single file (front and back sensors give close readings).

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Soundscape

The Soundscape for Sensory Threads is an algorithmic composition, generated by a program running in the SuperCollider realtime audio synthesis system [2]. The design of the soundscape involves a careful balancing of clarity of response and the creation of musically interesting sounds. If the soundscape purely responds simply to the sensors, it is very easy for people to play with their sensors and make it change. However, this kind of soundscape soon becomes limited and monotonous. Similarly, if the soundscape is affected in more subtle ways by the sensors, it can be hard for people to interpret it, especially when they are just beginning the exploration. Because of this, Sensory Threads begins by making the soundscape highly responsive, and adds in more complex themes and less direct responsiveness as time goes on.

Playback Interface

The playback interface has two purposes, firstly, it provides a real time stream of explorations as they happen, transmitted from the heart computer via a 3G network. Secondly, when no explorations are ongoing, it provides an interface for exploring the data recorded by all previous explorers, and allowing gallery based visitors to go on their own virtual trips through the mass of sensory data.

When designing the interface it was intended to provide a multi-sensory experience. The current design uses a combination of sound, visuals and touch to replay the explorer's experiences.

The core of the installation is a large box (made from a tea crate). This box has a video screen on the top, which shows a map, displaying the position currently being explored (see Figure 2). The box also contains a large subwoofer speaker used to create very low frequency sounds, which make the box resonate. When the box is touched, it creates a nuanced set of vibrations. This large shaking and booming box also acts to attract people's attention. Additionally, four smaller resonators made from computer game control pads with variable rumble support are also part of the installation. Each of these mini-resonators vibrates based on the sensor readings from one of the explorers, allowing for an individual to experience a direct connection to the sensing of one explorer. Finally, a set of speakers in the exhibition space provide an audio playback of the soundscape itself.

In streaming mode, the box is non-interactive. The map display moves to the position of the latest sensor readings (which are displayed as dots on the map), the large and small resonators can be felt to respond to the sensor readings, and the soundscape can be heard.

In exploration mode, the box itself becomes an interaction device. Tilting the box causes the map to move in the direction of the tilting. This allows for the exploration of new paths through the previously recorded sensor readings. The large box means that multiple people can tilt it at once. It is also the case that in order to feel the individual sensor experiences from the miniature resonators, two or more people must collaborate, with one tilting the large resonator whilst the other feels the mini-resonator. This is designed to encourage groups of multiple people to perform their own explorations of the sensor data, in a manner analogous to the outdoor explorers.

Design Process

Sensory Threads is part of a research project exploring the value created by inter-disciplinary collaboration. It involves a highly inter-disciplinary team, from several university departments, working in tandem with Proboscis, an external arts organisation.

Proboscis specialises in publicly authored work. Members of Proboscis were the primary drivers of the conceptual side of the project, and also created the physical costumes and interfaces.

The custom electronics and hardware for the wearable sensors were developed by computer scientists from Birkbeck College, in collaboration with the Centre for Digital Music, Queen Mary, University of London, where the soundscape was developed.

The installation and the software to run it were designed at the Mixed Reality Lab, University of Nottingham, again with physical design and construction being done in collaboration with members of Proboscis.

The study of the value created by this collaborative work (by the University of Southampton Business School) is currently ongoing. The key result identified so far by this study is the wide range of added values created by this collaboration, beyond the purely financial aspects. In particular, the coming together of several very different organisations and backgrounds has inspired all those involved to consider design and evaluation outside the traditional areas in which they work, and to work in ways which differ from their existing habits and ways of practicing. It has added considerable value in both the practice, and reflection on truly trans-disciplinary collaboration.

Acknowledgements

Sensory Threads is part of EPSRC Creator (EP/G002088/1): New Research Processes and Business Models for the Creative Industries, http://www.creatorproject.org/.

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Fig. 2. Map on the Resonator Showing Recorded Sensor Data Points (© Proboscis Ltd.)

GESTURE AND EMBODIED INTERACTION: CAPTURING MOTION / DATA / VALUE

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Submitted: 27/2/2009

Abstract

Gesture and Embodied Interaction is a five-month practice-led scoping project which explored motion capture development perspectives from artistic, technological and business innovation standpoints. It convened an interdisciplinary community from the arts, sciences and business studies, experienced in practice-driven collaborative research. Effort was focused on two prototyping workshops in Newcastle and Cambridge, bridged by an interim work session to optimize collaboration. A final creative industries seminar in Cambridge allowed debate with a wider stakeholder community. This paper provides an overview of our activities, findings and future directions.

Keywords: motion capture; patterns of behavior; value creation, capture and transfer.

Introduction & Goals

Interest in motion capture for film, video games and live performance challenges and extends technical expertise originally acquired in the bioengineering and orthopedic sectors, testifying to a potentially vibrant development area for the digital economies. Breadth and diversity of the motion capture user base make it a rich locus for interdisciplinary collaboration and novel work models. Through engagement with practice partners diversely involved in ICT development procedures and imperatives, we aimed to glean fresh insights into creative knowledge transfer processes.

The project took as its starting point several distinct strands of research into motion capture: the *AMUC* eScience project led by Sally Jane Norman in Newcastle [1,2], *Will.0.w1sp* and *Swift Traces* media installation projects developed by Kirk Woolford from Sussex [3,4,5], and a range of motion capture experiments by the Cambridge Graphics & Interaction "Rainbow" Group, which is led by Peter Robinson, together with Alan Blackwell and Neil Dodgson [6]. These partners' investigations of gesture and embodied interaction represent complementary approaches and a valuable starting point for seeding and scoping practice-led research collaborations.

Gesture and Embodied Interaction was a dynamic, innovative and somewhat unorthodox undertaking, typical of the creative industries, whereby numerous actors convene for the duration of a project, then disband to perhaps form new partnerships for the next project. It combined hands-on research and design with a specific focus on motion capture experience and resources, projecting business model frameworks for transferring interdisciplinary creative prototyping work into potentially viable projects and services. An iterative "do-show-discuss" model was implemented, whereby prototyping experiments were subject to regular, steered discussion sessions to identify broader economic implications associated with emerging communities of practice [7]. The latter moderating role was ensured by Lorraine Warren from Southampton's School of Management, joined for the second workshop and final seminar by Ted Fuller, from the University of Lincoln Business School [8,9].

Central to the project were PhD students in performing arts, computing, and business studies, working alongside research assistants specialized in motion capture and digital sound and imaging. The hierarchical divisions between academics, technicians and students often encountered in traditional teaching institutions inhibit the growth of collaborative models that are relevant in a world of online skill sharing and social networks. Moreover, knowledge transfer at its best is a uniquely inclusive research driver that can weld generations, professional categories and disciplines. By identifying common motivation and stimulating collaboration amongst our group of a dozen individuals, we hoped to gain a sense of the deeper dynamics underlying the shaping and sharing of values in complex technological development processes.

Methodology

The project was articulated around two week-long workshops held in Newcastle (November 08) and in Cambridge (January 09). Sharing of expertise and language across disciplines was initially favored by the fact that both sites use Vicon optical motion capture systems and by the earlier experimentation undertaken at Culture Lab by Kirk Woolford, in collaboration with Dave Green, to develop motion capture elements for *Swift Traces*. A two-day interim hands-on session (Cambridge, December 08) refined outputs from the first workshop to prepare for the second.

Given time constraints, we chose to base our collaboration on existing assets (know-how, technical resources) and initiatives. A preliminary show-and-tell session identified research strands apt to mobilize participants over the project's brief duration, and yield more lastingly useful outputs. This session familiarized us with the wide range of motion capture approaches embedded in the group's existing research, and with disparities in terms of language, work methods, and notions of value. Platforms for development of these applications were specified in terms of competencies and technical configurations, these requirements being compared with available workshop resources to devise a realistic program.

Shared enthusiasm for developing unconventional, creative motion capture applications to support novel kinds of embodied interaction led to an emphasis on performance-type, real-time affordances [10]. Objectives were set and subgroups given specific tasks, including writing code to allow live exploitation of Vicon motion capture coordinates.

Daily discussions served to monitor progress and set intense pragmatic effort in the context of reflection on technological innovation and values. Records of this exchange were stored on the project wiki along with other shared media.

At the second workshop, observers invited to demonstrations also attended the final seminar. We presented and discussed our work with a dozen regional and national players from public arts and technology development bodies, regionally-sited industries (games, special effects etc), neighboring Anglia Ruskin University and the associated higher education regional visualization technologies work group, and Cambridge University's Knowledge Transfer office.

Findings

As befits a technology-focused, practice-led project offset by prospective thinking on the dynamics of creative innovation, our findings were essentially twofold.

On the one hand, concrete results were achieved in terms of computing breakthroughs, notably in response to the challenge to make motion capture data streams interoperable with other

programs, building libraries to support such developments with a widened user base. More specifically, Java code was authored to connect Vicon streams to Max MSP, and patches, samples and interfaces were devised to open this hybrid platform up to various kinds of gestural control. By subjecting the system to playful experimentation that went way beyond conventional benchmarking, it was possible to generate robust, reproducibly responsive, multimodal interactions, allowing gestural control of visual and sonic outputs. Obvious potential marketable products include interfaces for Wii-type game environments, predictably valuable in therapeutic contexts (e.g. for patients with motor or sensory deprivation disorders) as well as education and leisure applications. In its present form, the software is a multipurpose toolkit offering good scope for students exploring interactive systems.

On the other hand, by framing ongoing practical experimentation in broader reflection on innovative collaborative work, we became aware of the spectrum of values that can emerge within, then spur, motivated, interdisciplinary developer teams. While it can be awkward to tear people away from urgent tasks on which collaborative problem-solving depends, collectively articulating and contextualizing the value of experimental processes through reflective dialogue can become an integral, enhancing component of technological development effort. In a diverse stakeholder community like ours, constant renewal of dialogue is a socially vital counterpart to the iterative prototyping principle adopted in technical design. Theoretical findings bore on the differentiation of values as a function of the multiple time windows that are simultaneously at work in complex processes, and as a function of the level of resolution applied in a given analysis. For example, knowledge transfer occurred in sometimes ostensibly minor yet decisive ways within the broader project, while apparently dramatic breakthroughs might appear as the foreseeable outcomes of simple earlier stage development work.

Conclusions & Future Directions

The workshop offered a rich model for reflection through the sheer range of technical and creative skill sets involved, and enhanced our understanding of the social processes on which their synergies depend. The eminently cultural questions raised by human-computer interactions demand strongly interdisciplinary response, raising further issues in terms of sector-specific languages and terminologies [11], and in terms of systems and patterns of behavior in the creator/ developer community which are likely to radiate outward to impact the consumer sector. These complex dynamics seem to be inherent to interdisciplinary collaboration and related business models, where the core team structure actively informs and reflects the shape of the final product or service. In the long run, disruptive innovation stemming from small players and projects like this might conceivably impact mainstream business and industry in terms of behavior patterns as much as technical outputs.

This modest scoping exercise has yielded a wealth of material, both technical and conceptual. We plan to consolidate the software toolkit by using and enriching the associated libraries to build an original, customizable interactive gestural control system, working closely with students and graduates, and enlisting interested partners from the performing arts. At the same time, dialogue initiated with industrial and institutional partners will be upheld, to optimize visibility of our research for the wider community, and to monitor development opportunities. Finally, we shall continue to seek out and define novel, salient features of our research processes, to see how these might be accommodated by or adapted to business development tuned to innovative knowledge transfer.

Fig. 1. Daniel Bernhardt, Catriona MacInnes, Dave Green and Andrew Duff testing motion capture sound and image control. (© Kirk Woolford)

Acknowledgements

This project was funded by the joint RCUK Digital Economies program through the Creator cluster, launched by Steve Benford (Nottingham), Jonathan Foster (Sheffield) and Kirk Woolford (Sussex), coordinated by Nottingham University (www.creatorproject.org). Participants were:

- Culture Lab, Newcastle: Sally Jane Norman (principal investigator), Dave Green, Catriona MacInnes, Jamie Thompson, Nick Williams.
- Cambridge: Alan Blackwell (co-investigator), Daniel Bernhardt, Ian Davies, Chris Nash, Peter Robinson.
- Southampton: Lorraine Warren (co-investigator).
- Sussex: Kirk Woolford (co-investigator), Andrew Duff.
- Lincoln: Fizza Alamdar, Ted Fuller.

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CAPTURING THE DYNAMICS OF CO-PRODUCTION AND COLLABORATION IN THE DIGITAL ECONOMY

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Submitted: 26/2/2009

Abstract

In the digital economy, the creative industries revolve around dynamic, innovative and often unorthodox collaborations, whereby numerous large, small and micro-businesses come together for the duration of a project, then disband and form new partnerships for the next project. Research designs must therefore address multiple contexts and levels presenting an analytical challenge to researchers. In this project we extend work that investigates the significance of emergence in theorising entrepreneurship into an exploration of how to articulate the creation and flow of value and effective ontology in a creative landscape.

Keywords: Entrepreneurship, emergence, creative landscape, value creating systems

The Project

Studying the creative industries in the Digital Economy presents challenges from a research point of view, because of the multifaceted nature of the domain, which embraces:

- a diverse range of increasingly cross-linked industries (e.g. arts, culture, heritage, gaming, performance, sports)
- the potential for many inter-related (aesthetic) artefacts and services
- the potential that digital technology can establish new resonances between social practices and the techno-creative milieu
- the need for continually (re) organizing entrepreneurial & innovative team collaborations around new projects
- the emergence of novel, sometimes unorthodox, combinations of people and technologies for which there may be no precedent
- the potential for values issues to cause clashes regarding interchange of artistic, cultural, social capitals (particularly where creative output is critical or challenging of powerful groupings).

These activities take place in a business environment that is fast-moving, has high market uncertainty and has indeterminate outcomes, as new technologies continue to evolve and standards and legislative practices surrounding their use are unclear. Better understanding of how new value creating systems emerge in such landscapes can give us a better insight into how such processes can be managed and supported, thereby contributing, in a small way, to the sustainability of the creative industries overall. Yet the very diversity and fluidity of such ecosystems presents a considerable challenge to traditional models of research into business innovation and entrepreneurship. Inevitably our research designs must address multiple contexts, locations (virtual and physical) and levels of analysis presenting a methodological challenge to management researchers as Pettigrew has argued [1].

An obvious approach to dealing with this fluidity is to simplify research designs by focusing on one level of analysis, in most cases the individual, the firm or the industry. Yet this can only lead to partial, impoverished pictures of what is surely a far more rich and vibrant milieu.

Thus, we used this Troubadour study to develop workable methods for capturing the dynamics of such systems, based on some earlier work we had carried out applying complexity theory to the study of entrepreneurial firms. The assumption is that traditional methods such as cross-sectional analysis and retrospective narratives do not capture either the richness, or processes of emergence in such a way that enables knowledge transfer to new projects in the same milieu.

Our approach was to work with actors in live projects in order to examine how novelty emerges over time in dynamic, fluid domains where uncertainty is high and outcomes are indeterminate. Firstly, we carried out an internet-based case study of Blast Theory/Rider Spoke, to generate understanding of concepts such as pervasive computing, ubiquitous computing, urban sensing, and the ecosystems surrounding them. Secondly, we carried out interviews and discussions with staff at IT-Innovation, a company involved in developing a new business model for a portal in the post-production rendering industries in Soho. Thirdly, we carried out participant observations of interactions in Proboscis' Sensory Threads project and the Gesture and Embodied Interaction workshops at Newcastle and Cambridge. We explored how novelty emerged through interactions between the actors in the projects, and how novelty was related to value creation and the possible engagement of [new] external stakeholders.

Agility & Sustainability

As entrepreneurship researchers, we have asked questions concerning how entrepreneurs maintain agility, the ability to see ahead, to strategise in an innovative manner, to act at the right time to repeatedly achieve and maintain competitive edge in such uncertain and unpredictable environments. Our previous research, based on complexity theory [2][3] has shown that entrepreneurs who are successful over long periods of time are continually organising and reorganising in anticipation of new products, new services, new business models, and new value creating systems not only reflecting, but shaping new patterns of consumer behaviour, that may be some way ahead in the future. To achieve sustainability over time, they are practising anticipatory behaviours that can be learned or developed in others. A key part of that behaviour, is that they are engaged in a pattern of continuous experimentation that repeatedly generates new strategic options, some of which, in time, become 'the firm', when the time to act is right. We have identified four key, highly interrelated processes, which result in the emergence of novelty over time in entrepreneurial firms:

1. Experiments: small scale models testing for fitness in the landscape
2. Reflexivity: the continuous reshaping of the meaning of what the owner and the business 'are' in relation to others
3. Organising domains: the breaking and reforming of everyday patterns of doing business
4. Sensitivity to conditions: the detection and evaluation of environmental change and the motivation to respond.

These processes are not planned or formalised. Rather, they are a 'way of being', the essence of agility and foresight for the entrepreneurs we have worked with. We argue that it is the multi-dimensional concentration on these patterns of behaviour that is at the heart of entrepreneurial competence through effective strategising over time to produce a *sustainable* endeavour. Over time, the four EROS processes interact to produce new emergent structures; yet not all structures persist to the point where they are fully implemented or developed. Instead temporary structures that might persist reflecting Sawyer's 'Emergence Paradigm' of social structures [4] that posits a hierarchical model of individual, interaction, ephemeral emergents, stable emergents, and social structures.

We have identified such temporary structures in our early empirical work in this domain. They seem to include particu-

lar business models, particular identities, particular dominant logics, particular triggers for change etc. Within that milieu, some are more stable than others and became part of the business; others initially commanded intensive resource and attention, but were not developed through to fruition. Nonetheless, even ephemeral and unstable structures that did not persist, exhibited ontological status and considerable causal power – at least for a time, as the firm explored whether value could be extracted from these resonant structures in the face of highly uncertain environments. The continual construction of such temporary structures thus represents a form of 'anticipatory strategising' on the part of creative individuals, who, in their identification and exploitation of new and expanding niches, seek not to merely react to, but also to shape new forms of consumer and/or participant behaviour as industries change.

From this conceptual base we have derived a framework [5] (too big to reproduce here) that we posit captures how novelty arises as emergent order over time through the development of ephemeral, and then stable emergents over time– a significant achievement as thus far, there has not been a methodological approach that has taken advantage of the possibilities offered by rigorous theoretical conceptualisations of emergence.

An empirical testbed?

We used this project as an empirical testbed for our framework. We asked the following questions:

- Does the framework coherently and comprehensively theorise the linkage between entrepreneurial processes and emergent ontologies produced in the creative industries/digital economy context?
- Does it support effectively the collection of data and the ordering and categorising of empirical observations concerning how different phenomena, such as new products, services, firms, networks, patterns of behaviour, careers, identities, emerge over time across multiple levels of analysis?
- How are these observations best linked to improving practitioner competence and sustainability of the firms overall?

Our assumption was that the projects we investigated from a Troubadour point of view were analogous in certain key ways to the entrepreneurial firms we had studied in the past, in that the emergence of novelty was not limited to local change or value, but had the potential to grow, to produce or capitalise on new markets, or maybe even to shape new patterns of consumer behaviour. Of course, we are all familiar with acts of individual creativity that result in artistic, social or cultural capital that may not in themselves realise economic value, or be widely available, reproducible or disseminated as products or services outside the initial act of creation: a unique artwork or a performance for example.

Yet new digital technologies have thrown up innovative new possibilities that can challenge, disrupt and may even overthrow existing revenue streams and industry patterns. It is this indeterminacy of outcome, the dynamic and unpredictable, the unknown shape or character of scalability in new industries, and how it will be achieved, that resonates with the tenets and underpinning assumptions of complexity theory. And it is here that we believe our framework has the methodological potential to capture and make sense of multiple observations across different levels of analysis and show linkages between levels as new phenomena (products, services, business models) emerge over time. We argue that in identifying and linking the unstable and ephemeral emergents that inevitably arise during creative collaborations – the twists and turns, unformed explorations, failed experiments, discarded and retained ideas -- to entrepreneurial processes that preserve artistic and creative value, we can gain much improved insight into how creative individuals operate and achieve sustainability in conditions of high uncertainty.

Outcomes

Clearly, being involved with projects as rich as those presented by Sensory Threads, Gesture and Embodied Interaction, and IT-Innovation has afforded us a rich stream of data and connections that will take many months to analyse. In this limited space, it is only possible to identify some preliminary outcomes that are nonetheless highly promising. Using our conceptualisation and our framework, we were able to identify and track the emergence of 'stable emergents':

- Sensory Threads: the 'Rumbler' a novel interactive soundscape device
- Gesture: a unique combination of skill-sets in the sound/motion capture domain, supported by robust code
- IT-Innovation: a potential business model as yet untested.

These 'stable emergents' arose during the period of the projects from very early stage ideas that were not well articulated at the outset of Creator. As discussions in the rich interdisciplinary milieu progressed, possible trajectories were identified and tested out, either as thought experiments, shared mental models, or sometimes as rough working prototypes. At some point, these 'ephemeral emergents' were narrowed down to the most promising variant: at this point the transition from ephemeral -> stable occurs. We would moot that this is the point at which discussions shift from value creation to value capture. This is a significant outcome that with in-depth discussion can be developed into a significant contribution to the entrepreneurship & innovation literatures.

Final thoughts

This Troubadour project has in the short term enabled us to test a framework that enables and supports experimental design, data collection, data analysis and reflective evaluation of the emergence of novelty, with very promising results.

More significantly, it has enabled the development of a methodological agenda for capturing social value and social resonances for future projects in the creative industries/digital economy milieu. By developing insight in this area, we hope to better articulate how leading edge creative firms and groupings contribute to the creative industries ecosystem overall – and correspondingly, we hope, improve their sustainability.

Acknowledgement

This project is part of the EPSRC cluster project, <www.creatorproject.org/> (EP/G002088/1).

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CRAFTING A CRITICAL TECHNICAL PRACTICE

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Abstract

In recent years, the category of "practice-based research" has become an essential component of discourse around public funding and evaluation of the arts in British higher education. When included under the umbrella of public policy concerned with "the creative industries", technology researchers often find themselves collaborating with artists who consider their own participation to be a form of practice-based research. We are conducting a study under the "Creator" Digital Economies project asking whether technologists, themselves, should be considered as engaging in "practice-based" research, whether this occurs in collaborative situations, or even as a component of their own personal research [1].

Keywords: Critical Analysis, Practice-Based Research, Collaboration, Computer Science

Creative Technologists

The recent upswell of interest in "creative technologies" has moved many technologists into realms more traditionally populated by artists working with technology. This has led to an explosion of novel uses of technology. However, many people trained in the fields of Art and Design claim the work created by these creative technologists lacks depth or critical enquiry. It is more a celebration of novelty, gizmos and gadgetry than any meaningful exploration of technology or creativity. They feel true enquiry has been hijacked by the "demo-or-die" culture of the MIT Media Lab [2].

Many in the creative technology community feel the initial creative spark is the most important aspect of any work and they jump from spark-to-spark before giving any idea enough time to fan into a flame. In the meantime, designers and artists continually struggle to give more depth to their work, to find appropriate contexts, to make something bold which is more than purely decorative or does more than show off their virtuosic technical skill. Within Design and Art, this approach to making work has become known as "critical practice", and is intimately connected to notions of practice as a form of research. Both these notions of critical practice and the relation between practice and research are highly debated within Design and the Arts, but there are few parallels amongst technologists. Instead, technologists debate whether their form of making is purely technical or whether it can be viewed as a form of craft.

These perspectives can be usefully contrasted with Phil Agre's 1997 critique of fundamental ideas and methods of artificial intelligence research [3], which brought currency to the phrase "Critical Technical Practice" within Computer Science. Agre's work offers craft and practice as methodological perspectives from which to address concerns with technology and criticality. However our own investigation highlights practice – asking how a fundamental concern with practice might form bridges between technique and criticism.

Our own project consists of a series of interviews exploring these debates and the relationship between practice, criticality, and craft. This Transactions paper presents a short overview including comments from the interviews conducted to date.

Critical Practice

Notions of criticality vary widely between disciplines and communities. Designers, when asked about criticality, are likely to launch into discussion of contemporary French Philosophy whereas engineers will normally jump to timing, fault-tolerance, and life-support.

Joseph Hyde provided an interesting view of criticality as a feedback loop, whereby he continually questions why he does things. He said he doesn't necessarily reach any answers, but it doesn't stop him from asking the questions. Rosy Greenlees, Executive Director of the UK Crafts Council, offers a more formal description of a critical practice as one where the maker questions what s/he is making, its aesthetic value, how it fits in the world, how it develops, how one writes about it, debates it, and engages with the rest of one's community. Greenlees stated that much of the Craft Council's work focuses on teaching makers to critically analyse their work and articulate their process.

Nick Tandavanitj of Blast Theory offered a more social view of criticality by stating how important it is to have a coherent sense of positioning himself in relation to trends outside his control – to not just accept or roll with them, but to actually take a position. "The thing that stops me from becoming someone who just plays with new technologies or creates novelties is that those little loops of curiosity are always in the context of a larger goal, the goal of making an experience or a piece of work. I'd characterize it as bringing all our experiences to bear… on what we want to make, as opposed to me being just someone who has a curiosity about computers and it's always informed by working with others…"

Downie, Mansoux, Biggs, and nearly all we interviewed agree. As Hyde said, "I don't think you can do anything in isolation. I'd find it very hard if I couldn't find any relationship between my practice and that of others. I suppose that's the way I critique what I do". They all think of their work in the context of others', in the context of a community. Or, as Tandavanitj so eloquently stated, "I suppose it's like writing… only when it's uttered to someone does it become meaningful. The utterance, the speaking or doing it in public makes it meaningful… it's actually about us as a group of people…"

Communities of Practice

Dominic Smith who works in open source developer communities, emphasizes the crafting of social behaviours over technical virtuosity and, "making sure that what we do has a lasting impact both for ourselves and for the community we work within". He spoke not just of our geographic communities but other organizations and creative people, who "may not be aware of the processes we're working with but whom we'd like to encourage to engage".

All these comments about criticality being linked to community connects to Etienne Wenger's notion of *Communities of Practice* as groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly[4, 5] .

Critical practice is intimately linked to community, but even though many creative technology communities can be thought of as Communities of Practice, they are not always critical. As Mark Downie commented, the community

which has grown up around the Processing development environment includes very little evaluative comment, only unfocused enthusiasm for the fact that the community is growing and there is more (code, libraries, discussion) today than there was last week.

Programmers in the Craft Community

Some of the oldest communities of practice are the Crafts Guilds, set up to share bodies of knowledge, debate about merits of work, and act as early forms of peer-review. Most of the programmers we spoke to would not refer to themselves as members of a guild, but they are comfortable in describing their work as "craft". Many were intrigued by the connection we drew to the work of the Crafts Council, and happy with the juxtaposition of contemporary technology with traditional, even pre-industrial, craft skills. As Nick Rothwell told us, software is always re-appropriating older words for its own purposes, and this use of language is both essentially creative and an essential part of software construction which constantly involves assigning existing names to new abstractions. Other metaphors might be equally generative, as when Simon Biggs refers to programming as a "poetics".

Skilled engineers and craftspeople are both reliant on tools and, often, able to invent, customize or fashion their own. Reflection on process results in construction of new tools, and skilled tool use requires a reflective response to the tool itself. This is a natural component of skilled software practice that was recognized by many of those we interviewed.

They were very conscious of, and critical about, their tools, and regularly engaged in making new tools. They commented on other tool-makers, in part because of the way in which communities grow around particular tools, but also in making their own judgments regarding the quality of others' work.

However, it is necessary to draw a distinction between personal tools and "commodity" tools. Those we interviewed were dismissive of members of their community who they feel are overly reliant on mundane or prescriptive tools, and also somewhat dismissive of the exaggerated respect given to those who have developed tools used by large numbers of less skilled artists. As Rosy Greenlees said of craft practitioners in general "the tool is always just a means of creating an end product". However, she admitted that Master craftsmen wouldn't pass on their tools to others, because the tool leaves a personal imprint of itself in the final product. If they give away the tool, they give away some of their distinctiveness.

Certainly, for the software craftsperson or artist-engineer, the external appearance of a work, especially in a static archive, does not adequately reflect the quality of skill that it incorporates. S/he is concerned that critical discourse around their work therefore fails to recognize the true achievements – the craft and technical skills of the maker, which Chris Rose describes as contributing to the "internal aesthetic" of a work.

With regard to their own standards as reflective practitioners, they have a private commitment to take risks, to "mutter to themselves", and undertake exploratory experiments and investigations with new tools. However, this is not like scientific research, and it is not purely driven by curiosity. The craftsperson has a commitment to a client, and to the pragmatics of a commissioning situation. It is not ethical to take risks with a client's money, and deadlines must be honored. In experimental artforms, or those lacking appropriate critical apparati, there is a great deal of reliance on well-informed, often, publicly funded, commissioning bodies to provide opportunities for innovation.

Collaborative Conclusions

In speaking about the Music Technology Community, Joseph Hyde stated, "there is a real malaise in music – of not having any kind of critical practice". He feels the attitude of "oh, we'll do it because it's cool" is very easy to fall into with music because it can be such an abstract form. "If you've got really pure music with no programmatic or narrative, it's easy to argue, 'well, it's just music, dummy'. I'd probably be exactly like that if I hadn't worked outside of music and realized how much other people question, frame, and critique their work".

Almost all the people interviewed in this project spoke of the need to be able to speak critically about their work when working with collaborators – particularly when collaborating with people from different disciplines. Working in collaboration with others, according to our interviewees, forces us to reposition our thinking and leads to new insights.

If we return to Agre and his conclusion that "a critical technical practice will, at least for the foreseeable future, require a split identity – one foot planted in the craft work of design and the other foot planted in the reflexive work of critique". We believe, we've made some progress since 1997. Cross-fertilization between disciplines is helping to heal these split identities. Those technologists exposed to the forms of critical and contextual thinking so prevalent in Art and Design find it difficult to continue working without asking why as well as how.

Acknowledgements

This project was funded by the joint RCUK Digital Economies program through the Creator cluster, launched by Steve Benford (Nottingham), Jonathan Foster (Sheffield) and Kirk Woolford (Sussex), and coordinated by Nottingham University. (www.creatorproject.org). Toward a Critical Technical Practice is located at http://www.criticaltech.org

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BLENDING ART AND SCIENCE TO CREATE *COLLAPSE (SUDDENLY FALLING DOWN)*

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See <www.mitpressjournals.org/toc/leon/43/2> for supplemental files related to this article.

Submitted: 31/4/2009

Abstract

Understanding the collapse of natural and social systems is a key artistic and scientific endeavor. By collaborating on a multimedia dance-theatre production, we contributed individual approaches, techniques, and insights to a performance that captured both cultural and scientific aspects of collapse in an aesthetically meaningful way.

Keywords: LiDAR, dance, collapse, motion capture

The multimedia dance-theatre production *Collapse (suddenly falling down)* [1] emerged from collaborations among scientists and artists exploring the collapse of systems. It began with parallel discussions about creating a work addressing social and ecological collapse, and exploring how 3D visualization techniques could be used for artistic purposes. A commission from the Mondavi Center for the Performing Arts for the Sideshow Physical Theatre company provided an opportunity for these nascent collaborations to see fruition in production. The commission was part of the UCDavis Creativity Project explor-ing the nature of human creativity and included a week-long residency by the Merce Cunningham Dance Company.

Much like the work of Cunningham, diverse elements of *Collapse* were developed largely in isolation, including T-LiDAR [2] imagery of disasters, a motion capture-based interaction system, music, sound and lighting designs, dance vocabulary and spoken text. A pre-show piece coupled visual representations of chaotic attractors and sound [3]. The dynamic set design echoed the theme of collapse, with a tree that slid across the stage, a reconfigurable island stage, and a wall of two foot white boxes that tumbled down during performance. Breaking with the Cunningham tradition, the artists and scientists used ten intense days of tech rehearsal to integrate these diverse elements into a cohesive whole.

Three art-science collaboration themes emerged during the production: 1) theatre-scale display of 2D and 3D images; 2) aesthetic exploration of natural hazard T-LiDAR data sets; and 3) integration of optical tracking for interaction between performers and visualizations in a Theatre-scale display.

Theatre-scale Display

Shared artistic and scientific goals for *Collapse* were to fill the audience's visual field with scientific imagery, some of it in 3D. Two high-power projectors, a 16' x 9' polarizing preserving screen, and polarized glasses for the audience provided a 3D display environment. Because the screen did not fill the audience's visual field, two additional projectors were used to extend 3D images in 2D across the rest of the stage, using the stacked white boxes as a screen. This provided a total image that was approximately 60' x 20'.

T-LiDAR Projections

T-LiDAR data represent point reflections from a laser precisely located in 3D space. We visualize each reflection as a small placard [4]. When viewed from a distance, objects appear solid, but they break into a cloud of individual placards when viewed closely, yielding a pointillist effect. The scans also contain holes where foreground objects cast laser shadows on the objects behind. This fractured feel contributed significantly to the aesthetic of *Collapse*. Specific T-LiDAR scenes were chosen from USGS studies of collapsing natural systems.

Movement enlivens the 3D nature of the scenes, providing stunning visual design. Camera "fly-throughs" of each scene were choreographed to highlight key elements, provide insights into collapse and match the desired emotional and aesthetic feel for their positioning in the production. These fly-throughs were co-designed by artists and scientists, and the scientists were struck with how artistic views of their data changed their understanding of the scenes.

Interaction

Scientific work in KeckCAVES [4] has revealed that real-time interaction with data promotes insights that would be otherwise missed. To share this with the audience and to provide a tangible connection between performers and the visualizations, an optical motion tracking system was developed for real-time interaction. It tracked markers held by performers in two scenes.

In the first scene, a dancer walked out to the front of the stage and opened her hands to reveal a reflective marker in each. These allowed her to control a T-LiDAR image of Waikiki Beach. Moving them in unison panned the scene, and moving them around each other rotated the scene. Slowly, she lifted the scan of Waikiki Beach showing the front half-shell of a lone bather. Gently she rotated the scene back and forth, gradually building to a frenetic dervish dance, spinning the entire beach around the silhouetted woman, creating a dizzying sixty foot wide display across the theatre (Figure 1). The second interactive scene provided a moment of stillness. A dancer used a marker attached to his hand to draw a house and tree on the 3D projection screen behind him, echoing key motifs in the show.

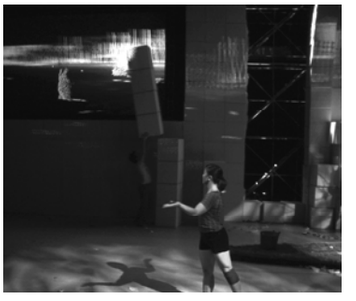

Fig. 1. A dancer manipulates visualized LiDAR scans. (Photo © Michael Neff.)

Conclusion

Collapse was a complex production and bringing various elements together required collaboration, goodwill and understanding from all involved. In turn, it showed how scientific insights could be used to strengthen artistic ends without dominating them. It also led both the scientists and artists involved to understand their work in new ways.

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Smart Textiles: Science and Technology of Textile Art

Leonardo is pleased to announce a new special project in the topic area of Smart Textiles. This project expands upon Leonardo's archive of textile art documentation by focusing on textile artists and scientists around the world who work with smart textiles or the new textiles science and technology.

Artists and researchers interested in writing about their work involving the science and technology of smart textiles and clothing arts are invited to view the Leonardo Editorial Guidelines and related information at <leonardo.info/Authors> and send in a manuscript proposal to <leonardomanuscripts@gmail.com>.

To view a list of papers published in *Leonardo* and *Leonardo Music Journal* on topics related to textile arts, please see: <leonardo.info/isast/journal/calls/smartextiles_call.html>.

This project is supported by the Marjorie Duckworth Malina Fund, which honors the memory of a key longtime supporter of Leonardo/ISAST. The project recognizes Marjorie's dedication to the ideals of international cooperation by emphasizing the participation of artists throughout the world. For information on making a donation to Leonardo/ISAST in memory of Marjorie Duckworth Malina, please visit <http://leonardo.info/isast/donations.html>.