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NEWCASTLE

OPTO-PHONO-KINESIA (OPK)

Opto-Phono-Kinesia (OPK) is a body-based audio-visual performance piece.

CONTENTS

SUMMARY

Opto-Phono-Kinesia (OPK) is a body-based audio-visual performance piece. The title is a play on the possible synesthetic state involving connections between vision, sound and body motion. Using the Gesture and Media System 3.0 (GAMS) motion tracking system, the performer can dynamically manipulate a complex audio-visual environment using two small infrared trackers. This enables the performer to be a virtual conductor, conjuring an immersive environment with the body itself. OPK exists as both a performance output and a driver for technical developments of the GAMS system. The latter of which will have broad value for interaction designers, motion specialists, and composed theatre performers.

The main video documentation of the project demonstrates how the GAMS motion-tracking system works, and illustrates the audio-visual results of the body-based performance: https://vimeo.com/228634638

The research aims of OPK expand on my 25-year project working with motion-based systems for the control of mixed media elements in real-time (see page 9/10 for more detail). The goals are as follows: to develop an interaction strategy for expert users, rather than the general public; to create and theorise a formal system for the multi-modal matching of audio, visuals and movement; to create an interactive system that requires intense physical activity from the user.

OPK is framed within the context of body-based performance and builds on insights by Atau Tanaka (SensorBand) and others regarding the formal application of physical controllers to audio-visual performance. It extends the context of previous work by applying this to more than two mediums and by developing a precise strategy of formal mapping based on synesthesia (see my "Simulating Synesthesia In Spatially-Based Real-Time Audio-Visual Performance" (http://www.leoalmanac.org/vol19-no3-simulating-synesthesia/).

I have pursued a coherent formal strategy of mapping sound parameters to logical visual and movement analogues. In its simplest application, floor-ceiling (z-plane) movement is mapped to sound volume and light/image opacity. A database of relations between the three mediums is established which provides formal coherence for the performers and audience. This method can be replicated in different contexts by other designers and artists.

The piece was disseminated through performances at national and international venues, including TEI 2018 Stockholm, with an accompanying paper, "Opto-Phono-Kinesia (OPK): Designing Motion-Based Interaction for Expert Performers."

The project has also been disseminated on Vimeo. Studio recordings and live audience performances at Northumbria, TEI 2018 and Northern Dance are archived at https://vimeo.com/showcase/5176262

OPK was initially developed as part of the Creativity Works / CREATIVE FUSE programme (AHRC/EU ERDF FUND), 2017-18, 40 days of my time, £39k.

His ongoing extensive experimentation, testing, and resultant suggestions continue to shape our innovations.

"Dr. Gibson was an early adopter and beta tester of the GAMS 3.0 system…. He often pushed the system to its limits, making some of the most elaborate and complex interactive GAMS environments ever created…. His recurring needs for additional features/functionality significantly drove the technical development efforts of the GAMS 3.0 engineering team…. His ongoing extensive experimentation, testing, and resultant suggestions continue to shape our innovations.

Will Bauer, P.Eng. President, Moment Research Corporation
(makers of GAMS 3.0)

Right: Documentation Video at Northumbria University, May 2018.
Photo credit: Liam Hardy, Northern Dance.

TIMELINE

2002-2008
New Opportunities Grant, Canadian Foundation for Innovation/BC Knowledge Development Fund, PI, Ca$440,000. U Alberta, U Washington State -partners.

2002
GAMS 2.0 (Infrared) developed by APR and Licensed to Martin Lighting. On-going beta-testing and UX design by Gibson.
https://www.martin.com/en/products/martin-lighting-director

2002-2007
Virtual DJ By Steve Gibson
https://www.telebody.ws/VirtualDJ/

2007
Grigar, D., and Gibson, S. (2007). "Motion Tracking, Telepresence, and Collaboration." *Hyperrhiz: New Media Culture,* volume 3.
http://media.hyperrhiz.io/hyperrhiz03/essays/grigar/mtc_page1.html

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2011-2013
Virtual VJ
By Steve Gibson & Stefan Müller Arisona.
http://www.telebody.ws/VirtualDJ/virtualvj/virtualvj.html

2013
Gibson, S. (2013). "Simulating Synaesthesia in Real-time Performance," in Aceti, L., Gibson, S., and Müller-Arisona. S., co-editors, *Live Visuals for Performance, Gaming, Installation, and Electronic Environments,* Leonardo Electronic Almanac, pp. 214-229.
http://www.leoalmanac.org/vol19-no3-simulating-synesthesia/

JANUARY 2015
Virtual VJ Performance at G-VERL launch event, University of Hertfordshire.

JUNE 2016
GAMS 3.0 (100 fps Infrared) developed by Moment Research and Limbic Media. Two copies in extreme beta-testing stage: UCLA, and Northumbria.

Beta-testing and UX design of GAMS 3.0 and associated FlashTrack mapping software begins.

OCTOBER 2016
Production of *Opto-Phono-Kinesia (OPK)* begins.

OCTOBER 2017
Creativity Works / FUSE programme (AHRC/EU), Named academic on a Project with Northern Dance, 2017-18, 40 days of my time, £39,713.33.

Ephemera dance-based total media performance - development begins with Northern Dance

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JANUARY
OPK complete Interactive sound, light and video performance, with all media controlled by GAMS 3.0.
https://www.telebody.ws/OPK/OPK.html

MARCH
Gibson, S. (2018). "Opto-Phono-Kinesia (OPK): Designing Motion-Based Interaction for Expert Performers," Twelfth International Conference on Tangible, Embedded and Embodied Interactions (TEI 2018).
https://dl.acm.org/authorize.cfm?key=N43393

OPK Keynote Performance at Conference on Tangible, Embedded and Embodied Interactions (TEI 2018), KTH Stockholm. https://tei.acm.org/2018/program-overview/

MAY
OPK preliminary documentation shot at Northumbria.
https://vimeo.com/228634638

AUGUST
GAMS 3.0 system moved to Northern Dance.

OCTOBER
Intensive Industrial Innovation Programme North East (European Regional Development Fund), Named PhD supervisor to Craig Green, 2019-22 - *The Emergent Theatre: Developing emergent narratives by bringing together virtual reality, augmenting reality, artificial intelligence and the performance arts.*
Partner, Northern Dance.

OPK Performed at Northern Dance, Newcastle, invited performance.

OCTOBER-NOVEMBER
OPK FINAL documentation shot at Northern Dance.
https://vimeo.com/showcase/5176262

JANUARY
OPK documentation of Solomon Lennox's performance shot at Northern Dance.
https://vimeo.com/385116415

FEBRUARY
Final pre-release version 1.5.9 of FlashTrack mapping software complete after extensive beta-testing and UX design by Gibson.

JANUARY-DECEMBER
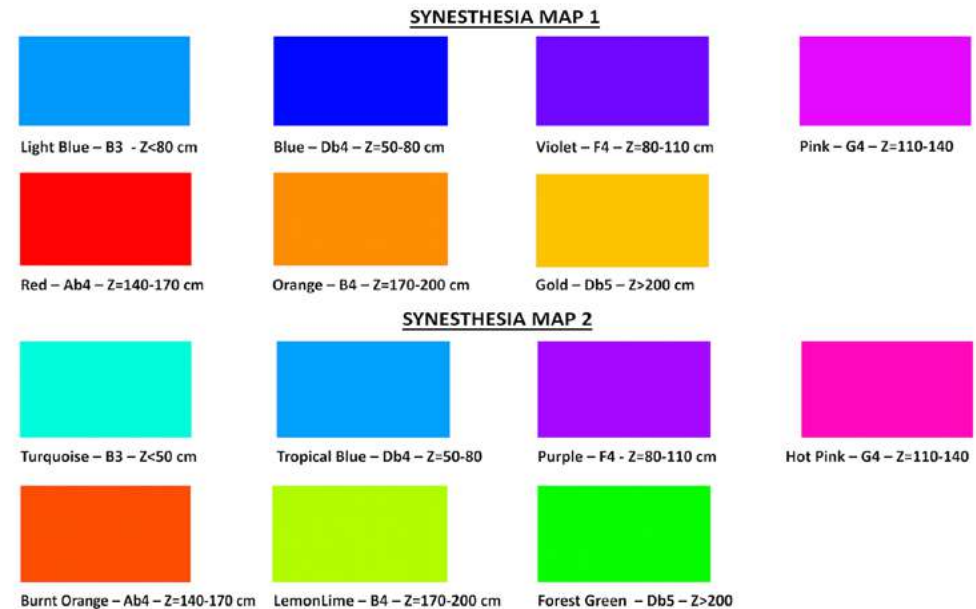*Ephemera* in further development with Northern Dance

RESEARCH CHALLENGE

The research challenge of OPK resolves around "the body as experience, instrument and interface." (Gibson 2018). Using motion-tracking as an interface the research creates a unique total media artwork, as controlled by the movements of one performer in real-time. The key objective is to create a body-based performance interface and template that can be entirely controlled by one expert performer through his/her movements in 3D space.

The key aims of OPK are:

1. To develop an interaction strategy for expert users, rather than the general public. The goal is to have a physically demanding performance that is richly interactive for the performer and comprehensible as genuinely live for the audience.
2. To create and theorise a formal system for matching of audio, visuals and movement, enabling complex interaction with a media-rich environment through body movement. The project uses a simulation of synesthesia as a method for linking the mediums of image, sound and body movement.
3. To create an interactive system that requires physical activity from the user, therefore discouraging passive, inactive interaction with digital systems. See my REF2014 ICS for more background:

http://impact.ref.ac.uk/CaseStudies/CaseStudy.aspx?Id=35176

SYNESTHESIA MAP 1

Light Blue – B3 - Z<80 cm	Blue – Db4 – Z=50-80 cm	Violet – F4 – Z=80-110 cm	Pink – G4 – Z=110-140
Red – Ab4 – Z=140-170 cm	Orange – B4 – Z=170-200 cm	Gold – Db5 – Z>200 cm	

SYNESTHESIA MAP 2

Turquoise – B3 – Z<50 cm	Tropical Blue – Db4 – Z=50-80	Purple – F4 - Z=80-110 cm	Hot Pink – G4 – Z=110-140
Burnt Orange – Ab4 – Z=140-170 cm	LemonLime – B4 – Z=170-200 cm	Forest Green – Db5 – Z>200	

Above: Synesthesia map for two specific (related) melodies in OPK. The videos and light colours are matched to specific notes at specific spatial coordinates.

Below:

OPK documentation peformance.

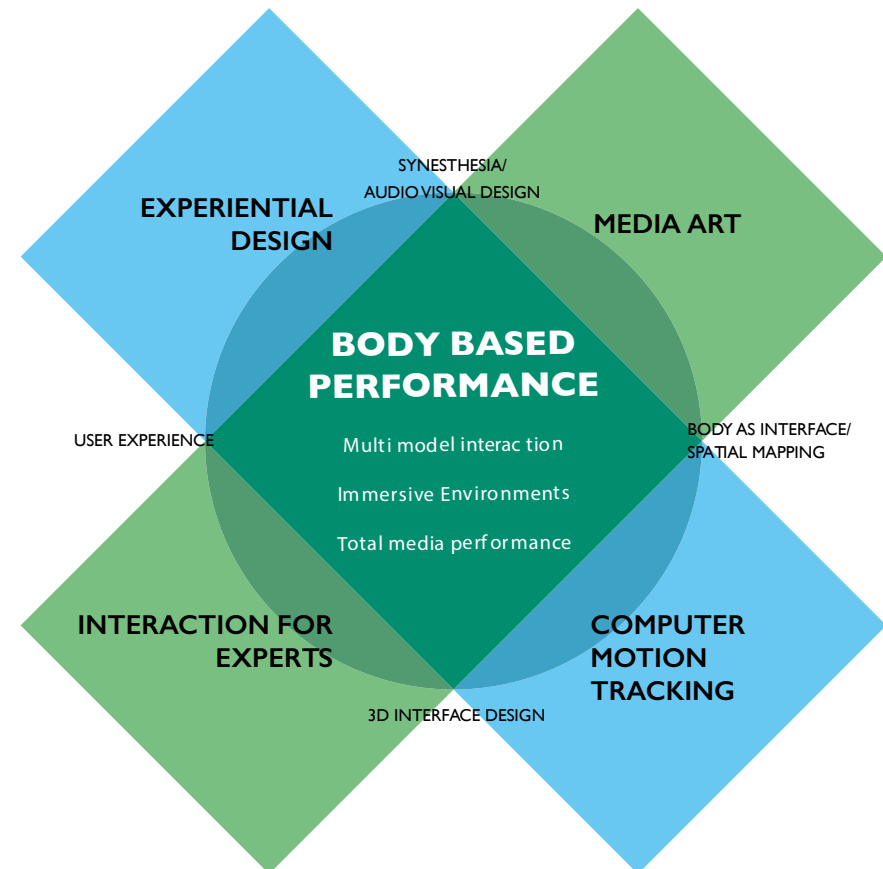*Video credit: Camera by Liam Hardy.*

Editing by Steve Gibson.

CONTEXT

This research expands on my 25-year project of working with motion-based systems for the control of mixed media elements in real-time. The work is situated within Media Arts practice, but makes use of ideas and precepts from Experiential Design, and Computing. It can be precisely described as a body-based, multi-modal immersive environment and interface for an expert performer. Its primary communities are in Media Arts practice and Body-Based Performance.

As noted the context for OPK lies in Media Arts practice, including physical performance. The project builds on the research of Atau Tanaka on sensor-based instruments (Tanaka, 2011) as well as more general ideas of interactivity in media and interactive arts (Edmonds, 2011). In addition, the project relies on both my personal experience of teaching Experiential Design for ten years, as well as the work of Evangelos Lympouridis and others on the design of body-based experiences and Computer-based Motion-tracking performances (Lympouridis, 2012).

The project makes use of motion-tracking to allow the user to control audio, video and lights in 3D through body movements. I have been lead beta-tester (one of two worldwide) and UX designer for the Gesture and Media System (GAMS) motion-tracking system for the past 15 years. In this capacity I have held a number of major grants (e.g. Canadian Foundation for Innovation New Opportunities Grant, 2003-2008, total value over $500k). I have also worked with the developers of the GAMS system (initially APR Inc. and now Moment Research) intimately over this period.

EXPERIENTIAL DESIGN

SYNESTHESIA/ AUDIO VISUAL DESIGN

MEDIA ART

BODY BASED PERFORMANCE

USER EXPERIENCE

Multi model interaction

Immersive Environments

Total media performance

BODY AS INTERFACE/ SPATIAL MAPPING

INTERACTION FOR EXPERTS

COMPUTER MOTION TRACKING

3D INTERFACE DESIGN

Previous to this census period I have produced a number of works that have been exhibited internationally including Virtual DJ (2002-07) and Virtual VJ (2011-15).

These projects have both fed directly into this current project and form a long arc of working to define a genre of body-based performance and to provide both an interface for that genre as well as some general formal precepts for its realisation.

Right: Vitual DJ at Digital Art Weeks, Zurich (2006).
Photo credit: Simon Schubiger.
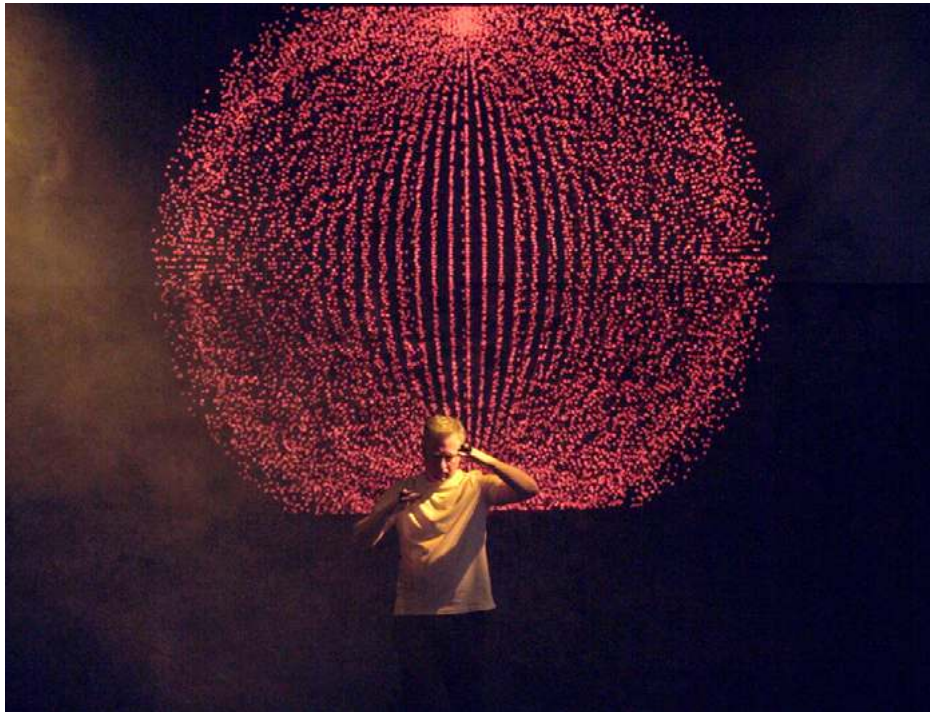
Left: OPK live performance at Northern Dance, Oct 2019.
Photo credit: Liam Hardy, Northern Dance.

Right: Set Up and audience for Virtual VJ at Jade Valley, near Xi'an, China (2011).
Photo credit: Zheng Wang.

METHODS & PROCESSES

OPK makes use of the Gesture and Media System as well as the associated FlashTrack 3D spatial mapping software. This software is used to map media events (lights, sound, video) in space and to define relationships between body movements and the control of audio-visual parameters. Two small infrared trackers are used to define the points of control. This system is the ideal tool for the simple programming of audio-visuals for movement-based control.

The project uses two Martin Mac250+ robotic lights that follow the performer and change colour in response to the position of the user. These changes are matched to musical changes as well as coloured video images. The project uses Ableton Live for the sound element. This software is ideal as it allows for non-linear arrangements of sound files in real-time and is not reliant on a pre-defined audio timeline. Similarly the live visuals software Modul8 was used due to its ability to randomly access a large bank of video images that are not reliant on a pre-defined visual timeline.

The innovation of this research is in the audio and video software packages being matched simultaneously with synchronised robotic lights, all controlled by the movements of a single user, creating an original interface. The piece was developed by using synesthesia maps to create the links between audio, video, lights and movement. The musical materials were then composed as independent sound objects that could be triggered in various parts of a room. These were then matched to image and light colours based on the synesthesia maps. https://vimeo.com/228634638

Below: Infrared trackers used by the GAMS tracking system.
Photo credit: Liam Hardy, Northern Dance.

In addition to my own live performances of OPK in front of audiences, I have also trialled the piece with one expert performer: Physical theatre and martial arts movement performer Solomon Lennox, a theatre reseacher with extensive experience in physical theatre and technological performance, and therefore was an ideal expert performer.

Solomon shadowed my performance of one section of OPK, and following that improvised his own performance, which produced a noticeably different result than my performance. Solomon states:

"OPK demonstrates rich synthesis between the live embodied modalities of the performer and the mediated technological states/scenes. The interplay, afforded through the use of GAMS, between the embodied and the mediated, facilitates a unique immersive performance experience…. serving as a novel methodology for performers…."

Solomon's performance illustrates that the interface created in OPK is adaptable for other expert performers, but has enough interactive richness to allow for a complex re-interpretation.

Below: Screenshot from FlashTrack of one room used in OPK. The interactive space is represented by the Blue-Green bounding area. There are three events currently visible in different areas of the room: when the performer is in the brown rectangle the kick drum is played, when he is in the orange rectangle, delay can be added to the drums using tracker speed, when he is in the grey area the kick drum is turned off. The Tracking map applies to Tracker 2 (multiple maps assigned to different trackers can be loaded simultaneously).
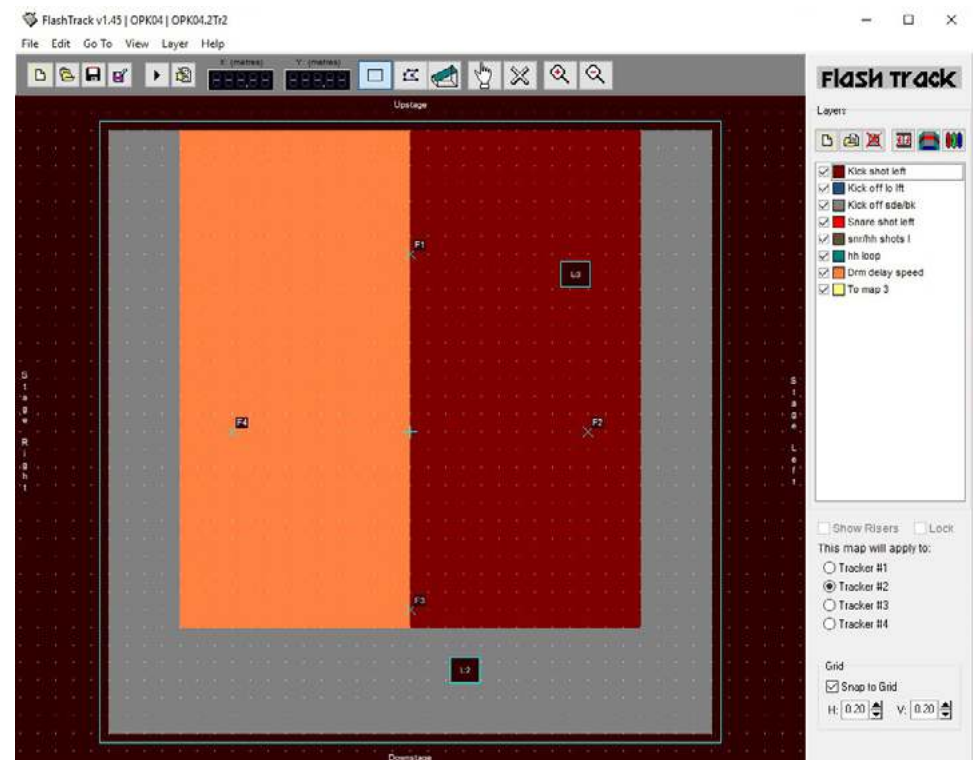
Audio-Video-Light map - OPK 03

Note trigger from Live	Distance from Tonality	Synth 1 Video-Light Colour	Synth 2 Video-Light Colour
D4 (74)	Closest	White (0)	Red (84)
Eb4 (75)	4th Closest	Blue (36)	Forest Green (60)
F4 (77)	Furthest	Red (84)	Turquoise (36)
G4 (79)	**None**	**Tan (14)**	**Hot Pink (96)**
Bb4 (82)	3rd closest	Orange (120)	Purple (144)
B4 (83)	3rd closest	Burnt Orange (120)	Violet (180)
C5 (84)	2nd closest	Yellow (24)	Burnt Orange (120)
D5 (86)	Closest	White (0)	Red (84)
Eb5 (87)	4th Closest	Blue (36)	Forest Green (60)
E5 (88)	4th Closest	Navy Blue (106)	Lemon Lime (60)
F5 (89)	Furthest	Red (84)	Turquoise (36)
G5 (91)	**None**	**Tan (14)**	**Hot Pink (96)**

Above: Synesthesia map for one melody in OPK03.

Top left: One Modul8 bank of coloured videos used in OPK03, and matched to the notes above using the map above.

Below left: bleton Live audio set for OPK03. The instrument in channel 1 plays the melody shown in the map above.

Right: Solomon Lennox performing at Northern Dance, Jan 2020.
Photo credit: Liam Hardy, Northern Dance.

DISSEMINATION

OPK was completed in Spring 2018 and performed at the ACM's Tangible, Embedded and Embodied Interactions (TEI) 20018 conference in Stockholm in March, 2018. The performance was held on the opening night in the large "Nymble" hall of KTH and was attended by approximately 200 participants.

As an accompaniment to this keynote performance, I presented a refereed Arts Track Paper on OPK for TEI2018: "Opto-Phono-Kinesia (OPK): Designing Motion-Based Interaction for Expert Performers" https://dl.acm.org/doi/10.1145/3173225.3173295

The paper provides a broader research context for interactive work that is intended for expert rather than general users. It discusses the historical and contemporary use of synesthetic models as a method for unifying sound and image. It presents an in-depth analysis of, and argument for the use of these (and other) models as a way of providing meaning for both audiences and performers of body-based, technologically-enabled performance work. It also advocates for the inclusion of the possibility of error as imperative for humanizing digital audio-visual performance. Using specific examples from OPK, the paper unpacks how this tension can deliver a much more physical, engaging and expressive performance model than currently offered by dominant modes such as laptop performance. Simultaneously it argues for the value of using three mediums (sound, image, movement) in tandem as a means of assisting performer and audience comprehension of a complex media performance.

> It's unexplored and offers up the potential for new expressive possibilities.

Maxine Fell, Lead Dancer, Northern Dance

Above: Performance, TEI2018.
Photo credit: Jan-Erik Saarinen.

OPK has also been extensively documented and has been disseminated on Vimeo as listed below. An invited performance was held in Oct. 2019 at Northern Dance in Newcastle. A further studio performance at Northern Dance by Solomon Lennox was also documented and disseminated on Vimeo.

Main documentation:
https://vimeo.com/228634638

Captioned Video explaining all interactions:
https://vimeo.com/372366196

Extract from TEI performance:
https://vimeo.com/262398826

Solomon Lennox's Performance at Northern Dance:
https://vimeo.com/385116415

Creative FUSE documentation:
https://vimeo.com/album/5176262/video/283689603

OPK Vimeo Showcase:
https://vimeo.com/showcase/5176262

Above: OPK documentation peformance. *Video Still: Camera by Liam Hardy.*

As a trained dancer I have my own set of instructions, rules and methods which are firmly embedded into my dance brain and muscle memory. After exploring the GAMS technology, I found that adaptions were needed to work with the systems and my relied set of dance rules had to be broken. I can control the environment and also respond to it, often I feel that I'm a physical manifestation of the sensors. It's unchartered territory with a new set of stimuli, it's unexplored and offers up the potential for new expressive possibilities.

Maxine Fell, Lead Dancer, Northern Dance

"OPK has helped Northern Dance identify opportunities in the deepening of audience and performer experience. It has helped us to think in terms of an 'extension beyond the body', communicating performance sensations and narrative in a richer, more encompassing manner. These tools can allow us to more effectively punctuate and navigate a performance, supporting meaningful narrative development, as well as giving the audience a more immersive experience.

Liam Hardy, Head Technician, Designer and Videographer, Northern Dance

Testing the GAMS 3.0 system with OPK was a great way to put a spotlight on the system's strengths and weaknesses. Real world testing is the best testing and a relatively complex project like OPK was quite helpful in moving the GAMS system along in its development cycle. Fixing these issues not only helped OPK but the GAMS system as well and was just what GAMS needed in terms a proper real-world test.

Conroy Badger, Lead Programmer, Moment Research Corporation

"Northern Dance has entered into this engagement with complete openness to the creative possibilities as a way to find where the interaction between technology and artistic intention can most convincingly add to the emotive experience. The early results show immense potential for both the physical and digital forms to interact seamlessly in the work of professional dancers and choreographers, even those new to working with technology in this way."

David Leonard, Director of Northern Dance and CEO of PaperDove

"Within the arts track Opto-Phono-Kinesia(OPK): Designing Motion-Based Interaction for Expert Performers, performance by Steve Gibson from Northumbria University was very impressive, being a mix of sound and images controlled by body movements…."

Simran Chopra, "Tangible, Embedded and Embodied Interaction Conference 2018," NorSC Lab website,
https://nor.sc/2018/04/09/tangible-embedded-and-embodied-interaction-conference-2018/

These tools can allow us to more effectively punctuate and navigate a performance, supporting meaningful narrative development, as well as giving the audience a more immersive experience.

Liam Hardy, Head Technician, Designer and Videographer, Northern Dance

Below: Solomon Lennox performing
at Northern Dance, Jan 2020.
Video credit: Camera by Liam Hardy.
Editing by Steve Gibson.

https://vimeo.com/428177419

REFERENCES

Edmonds, E. (2010). "The art of interaction," Digital Creativity, 21:4, 257-264, DOI: 10.1080/14626268.2010.556347

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Lympouridis, E. (2012). Design Strategies for Whole Body Interactive Performance Systems (University of Edinburgh, 2012).
https://era.ed.ac.uk/handle/1842/10434

Tanaka, A. (2011). "Sensor-Based Musical Instruments and Interactive Music," in The Oxford Handbook of Computer Music, Dean, R.T., Editor (Oxford University Press, 2011), pp. 233-257.
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