CONNECTEDCULTURE

Project Report

Centre for Telecommunications Research
Department of Informatics
King's College London

Cinema Arts Network

Ericsson

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21stCENTURYRENAISSANCE

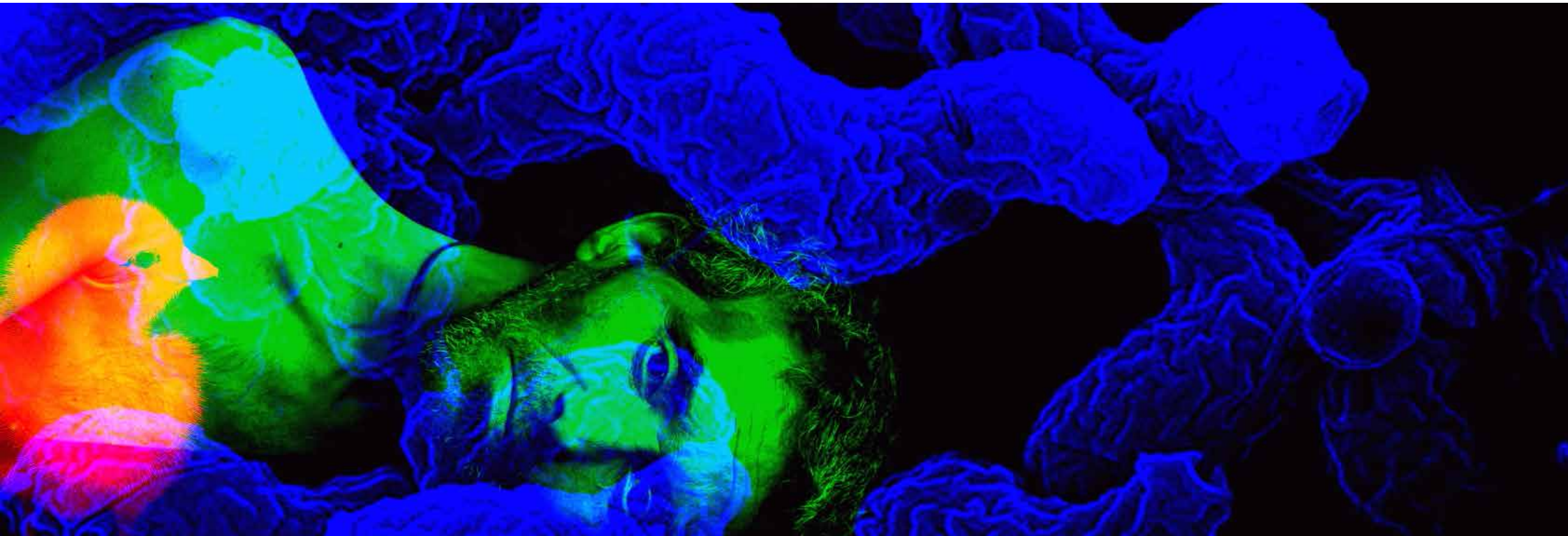
Six centuries ago a group of Italian inventors discovered how to portray 3D objects on 2D surfaces. Perspective had been known for centuries, but it took a multidisciplinary team to make it a successful communications medium. Not a team of artists, scientists and engineers, but a team of artist-scientist-engineers. Brunu Brunelleschi, Leon Battiste Alberti and Leonardo da Vinci were archetypes of the Renaissance: people who cultivated multiple intelligences to solve thorny problems.

Renaissance painting gave birth to technical drawing, photography, cinema, television and most electro-optical media. For 600 years flat panel displays dominated global telecommunications, but they are giving way to VR and other immersive media. Can 21st century specialists invent new paradigms that have the powerful elegance of Renaissance engineering?

At King's College London, we think the future lies in a combination of science, technology and aesthetics. For one year our Connected Culture project recruited interdisciplinary thinkers and doers to lay the foundations for 21st century communications. With support from 9 institutional partners, over 50 participants created 6 events that probed the expressive potential of 5G networks, spatial soundscapes and 3D video.

Our results demonstrate how arts and technology can interact more fruitfully, and they also show how the university can use its naturally broad resource base to stimulate the broader ecosystem. For individuals we demonstrate the value of cross-training in solving problems that pay no heed to disciplinary boundaries.

The massive challenges of this century require a holistic approach - compartmentalised thinking has brought unforeseen and unwelcome results. We may do well to start a 21st century Renaissance that combines the rigour of science with sensitivity to both the human condition and the beauty of the natural world that surrounds it.



WORKSHOP1**STORY**

To start the project, networking professionals worked with dramatists to develop *Fundamental*, a series of short plays intended for black box theatres.

Fundamental casts a modern light on relationships. Taking inspiration from recent science, its creators craft stories that resonate with the uncanny universe of quantum physics.

Connected Culture required simple artistic concepts to test complex engineering propositions. The team extracted dramatic gestures from theories of uncertainty and entanglement. These took form in the story of a woman reaching to herself across space and time.

WORKSHOP2**ANALOG**

We invented the ‘analog’ workshop to perform dry runs without building expensive systems. Prototypes were developed with cardboard, tape and coloured string that could be quickly tested and reconfigured.

Producers from Battersea Art Centre coached the project team in ‘scratch’, an agile approach that encourages flat teams and co-creation in a non-linear working environment.

By end of day, the team had a working technical configuration that saved considerable expense when it came to actually building the telecommunications that bring networked theatres to life.

WORKSHOP3**SOUND**

During this workshop, we explored how to acoustically bind three separate spaces. Today's media sets a high bar for theatre technology. Somehow you must create a performance that surpasses the home experience.

The team adopted the Soundscapes spatialised audio system invented at King's College London. With lightweight software and speaker arrays, they were able to crisply place an actor's voice at a specific spot on stage.

Placement of sounds turned out to be a critical factor in psychological immersion. With Soundscapes remote voices sounded immediate and spontaneous - they recaptured the excitement of live theatre.

WORKSHOP4**VISION+BUSINESS**

At RADA we experimented with a rehearsal of *A Little Night Music* directed by Edward Kemp, who is also executive director of RADA.

Our networking and audio processing technologies were applied to two issues. The first was logistical. The performance took place in the Jerwood Vanbrugh Theatre on RADA campus. On stage were actors and a piano played by musical director Michael Haslam. But instrumentalists from the Royal Academy of Music and an additional pianist were in a remote studio.

We modified RADA's gigabit Ethernet to operate with 5G methodologies. Both spaces were served with studio microphone arrays and two-way video accessed by monitors that were hung over the pianos. The Soundscape system was set up in the Vanbrugh mainstage, and the remote studio had 2x2 stereo.

Soundscape spatialisation literally added a new dimension to networked performance. Because their output was placed in a specfic place, musicians playing in the remote studio felt present, and the workshop had fluid moments when the directors, performers and audience operated in a single physical-virtual space.

WORKSHOP5NETWORK

Photographs by Richard Eaton

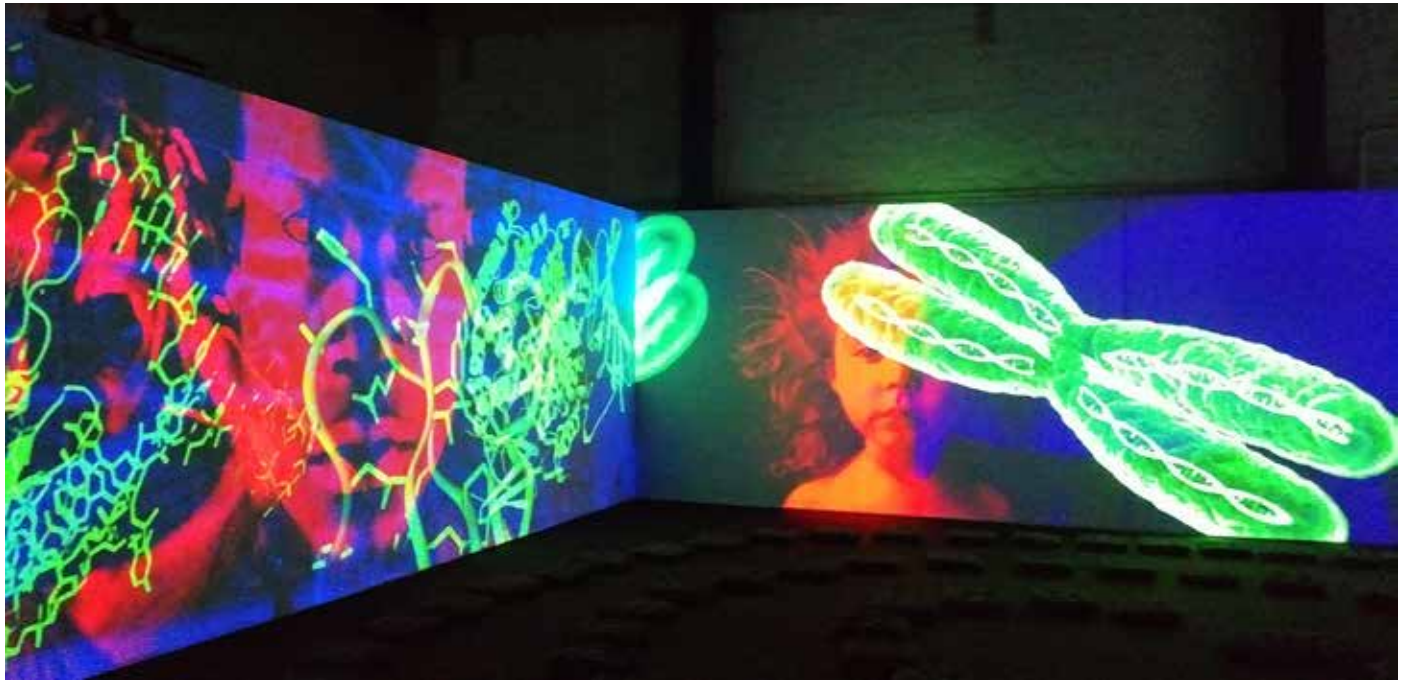
At Sadler's Wells we partnered with Guerilla Science and international Hip Hop Festival Breakin' Convention to present a 'transatlantic cypher' based on *Epiphany*, a multimedia artwork developed by Ali Hossaini. A cypher is a freestyle vocal performance using rhyme and rhythm.

In an engineering first, we used a mobile network to connect Sadler's Wells with Plush Studios in New York City. A choir in New York, classically trained but singing blues, joined UK Beatbox Champions to perform themes from *Epiphany*.

For audio we implemented 2x2x2 stereo. Multiple monitors carried video from New York to the audience at Sadler's Wells, and the event was webcast by Guerilla Science on Facebook Live.

Sound from New York was crisp with a broad frequency range, and well-executed pans in the mix created a feeling of presence, particularly within audience seating in front of stage. Video was delayed 5 – 7 seconds, but audience members who were surveyed claimed not to notice. By contrast, delays in audio were painfully obvious.

WORKSHOP6IMMERSION



The installation of *Ouroboros* at Click Festival was the final workshop. Held in Helsingør next to Hamlet's castle every May, Click is Denmark's premiere event for art and science. *Ouroboros* is a video cycle by Ali Hossaini that presents the history of the universe as an immersive 3D installation.

Video was projected on three 10m x 3m walls that formed a square with the fourth side open to the festival. Soundscape was implemented by ten speakers placed outside the installation. The carpeted interior contained 150 cushions for floor seating. Visitors were offered 3D glasses at the entrance.

Ouroboros audio is an original ambient composition by Keir Vine. It draws on global music traditions and, thanks to Soundscape, offers a structured auditory space that fully complements the video.

During its course, the audio describes a circle, a square and then a triangle. A particular musical form expresses each figure. For instance, the circle places visitors inside a Tibetan singing bowl.

A visually impaired child enjoyed a full run of audio before describing its spatial structure with accuracy.

CONCLUSIONS

Immersion - not networking - is the creative and business driver for new generations of live performance.

Networks are critical enablers for contemporary production, but artists and audiences are motivated by direct experience.

From the margins to immersion

For thirty years networked performance has lingered at the margins of theatre. Part of the reason lies in infrastructure: it is no secret that high bandwidth, low latency connectivity is essential to live collaboration. 5G promises to overcome past difficulties with superfast wireless service.

Although a full 5G environment does not exist, we applied 5G methodologies to simulate its performance. We also simplified our creative impulses. Earlier efforts to carry a narrative resulted in complex failures that revealed no clear path to success. Instead we focused on gestures – singular expressive concepts – that could be used to test engineering propositions.

Other obstacles to earlier efforts related to working methods. Traditionally trained artists and scientists have different approaches to creativity – something we decided to overcome. To maintain an experimental posture, each event was treated as a workshop. Each workshop isolated a problematic element of networked performance. Each element required an artistically engineered solution. By exploring single topics in depth with ample cross-disciplinary support, we were able to discern conceptual, aesthetic and technological issues with networked performance while suggesting pathways to impact.

Researchers who are cross-trained in art, science & humanities will power future progress.

Our conclusion about immersion is curious when we consider high drama on networks: from the first telephone romance, now lost to history, to the pulsing cacaphony of social media. Drama is no stranger to distance, but, for the stage, it occurs despite, not because, of it. This counters our premise that better networks would support new generations of 'networked' stagecraft. Our investigation of audio clued us to what is at stake psychologically, and thus artistically, when performers interact at a distance.

In previous networked performances that we observed, audio was carried on mono or stereo channels placed near video panels. Our approach required us to consider audio in isolation from video. As we conducted our first tests with *Fundamental*, a series of plays inspired by physics, a major problem yawned. Conventional audio created a sense of dull disembodiment that undermined the drama. Fortunately we had the opportunity to incorporate Soundscape into later workshops.

Soundscape is a software application for creating spatialised audio in two parameters: placement of individual sounds at a precise location, and reproduction of particular sound environments. Unlike competing systems it does not generate a physical sound field model. Instead it uses signal processing to create psychoacoustic images. Because these 'sound images' reproduce the psychological, not physical, characteristics of audio waves, they require minimal processing, and they allow real

Audio is as important as video in the creation of virtual spaces.

time manipulation with inexpensive equipment.

A Soundscape set up consists of five+ speakers arrayed in a circle that defines a stage. For *Fundamental* three stages were set, each with an actor at a different life phase: present, past and future. The dramatic gesture was introspection. (Or self as other.) Superficially it seems we could have have used a single speaker to represent remote personae. In practice, this felt like a person on a loudspeaker.

We found that only spatialisation created a transparent feeling of presence. Psychological immersion requires a sense of space to contour the audio source, and Soundscape structured the audio field – and restructured the acoustic space – to create natural sensations.

Auditory perception is attuned to qualities such as the shape of a room, its volume and the texture of walls. These liminal traits inform the experience of presence, and more fundamentally, the sense of reality that pervades a sound reproduction. At the beginning of the workshop, we assumed that control over direction and auditory volume was sufficient for telepresence. Our experiments revealed additional parameters that proved vital to the sense of drama. Creating a virtual space, or merging remote spaces into a unified experiential field, requires precise control over perceptions of resonance, reflection and spatial volume.

Workshops at RADA (Royal Academy of Dramatic

CONCLUSIONSCONT

Art), Sadler's Wells and Click, a national festival of art and science in Denmark, underscored the centrality of immersion as a creative and technological driver. They also clarified the tight coupling between networks and edge processing applications for audio and video.

An engineering first

The networked performance at Sadler's Wells / London and Plush Studios / New York was the first ever to happen over a mobile network. Dr Alain Renaud of MintLab, Prof Alex Carôt of Anhalt University and Drs Maria Lema Rosas and Fragiskos Sardis of King's College London developed workflow that enabled musicians to collaborate in real time across the Atlantic.

Innovative methodology

Connected Culture laid the foundation for substantial changes in how the arts and technology interact; and also how King's College London interacts and creates impact in the wider creative and commercial ecosystem.

First it created a viable platform for innovation where the most important stakeholders, i.e. large corporates, SMEs/start-ups, stakeholders and universities, can co-create without major financial or regulatory pressure. This is important as interaction between major players (e.g., Ericsson and the National Theatre) often occurs only at the procurement stage where it is too late to articulate needs and deliver well-fitted solutions. An innovative but neutral 'sandpit' environment is paramount in ensuring the best innovation return on every pound.

This, in turn, underpins another fundamental shift from an ecosystem which judges incurred cost rather than total value. As an example, theaters mainly see connectivity as a cost item and not as an enabler for artistic progress. The joint working methodology has helped organically nurture in-house innovation and thus shift perception from cost to value. For example, RADA now understands how 5G ultra low-latency networking technology could underpin a new business model where theatres create a virtual consortium.

Working methodology for engineers at King's College London changed substantially. Notably, the iterative design methodology used in the project has made engineering innovation cycles more effective and efficient.

Finally the tight co-creation process has enabled King's College London to streamline impact and create a porous engagement model with the wider stakeholder ecosystem. Frequent field trips motivated staff as innovative engineering concepts moved quickly from theory to practice. It has created new skills that are urgently needed by both the arts and engineering communities.

In summary, the arts has triggered innovation in science and engineering, and science and engineering have shifted perception from cost to value. Scaling this working methodology to more verticals at a national level presents an important opportunity for the UK in coming years.

Accelerated development

Soundscape was invented by Prof Zoran Cvetkovic and his team, Drs Enzo De Sena and Huseyin Hacihabiboglu in the Department of Informatics. The team confirmed that participation in Connected Culture accelerated Soundscape development. In 6 months the software climbed from a Technology Readiness Level of 4 to 7. (On a scale of 10.)

The following areas benefited:

Usability: A new user interface was developed for artists that includes automation, intuitive controls for placing sound sources and other functionality.

Deployment: Testing versions to advanced prototype in different environments proved the auditory perspective is robust and offered a framework for future development.

Optimisation: Deployment of the software in real world environments enabled developers to test for bottlenecks and implement more efficient use of computational resources. The need for high fidelity sound during the artistic performances forced developers to achieve a step-change reduction of audible artefacts.

Commercialisation: Interaction with artists informed the next steps in the development of the UI for commercial applications. Integration with JackTrip, Soundjack, Adobe Audition and other applications led to specification for development of plug-ins and interface with other software in creative workflow.

PARTICIPANTS

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Royal Academy of Dramatic Arts
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Michael Haslam - Music Director
Faoileann Cunningham - actor
Katie Buchholz - actor
Christopher White - actor
Liam Jefford - actor
Eleanor de Rohan - actor
Ralph Davis - actor
Aimee Lou Wood - actor
Lettice Thomas - actor
Alfie Webster - actor
Catherine Dryden - actor

Royal Academy of Music
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Camilla Marchant - flute
Stephen Payne - horn
Ellen Roberts - double bass

Room One
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Laurance Chater - filmmaker

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Aline David - movement director
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Aaron Dootson - lighting designer
Max Taylor - audio technician

Independent actors | London
Gemma Brockiss
Janine Harouni
Tom Bailey
Nigel Barrett
Gemma Brockis
Claire Cordier
Susie Trayling
Yolanda Mercy
Claire Cordier
Lulu Raczka
Yolanda Mercy
Laura Wyatt-Keefe

Videographer
James Williams

Beatboxers | London
Grace Savage
MC Zani

Independent performers | New York
Kate Eberstadt - choir director & singer
Donju Min - singer
Jon Perkins - singer
Christopher Ramirez - singer
Marisa Onanian - singer
Emily Suzuki - singer

Plush Studios | New York
Alex Derhohannesian - studio director
Danny Irizarry - audio engineer
Rob Fielack - audio engineer

FUNDERS

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SUPPORTING INSTITUTIONS

Breakin' Convention
Centre for Telecommunications Research at King's College London
Ericsson
Guerilla Science
National Theatre
Plush Studios
Royal Academy of Dramatic Arts
Room One
Sadler's Wells
Vodafone

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