Institution: University of York
Unit of Assessment: 35A, Music, Drama, Dance and Performing Arts
Title of case study: The Morning Line

1. Summary of the impact (indicative maximum 100 words)

The University of York's research in surround sound production, conducted over twenty years, has in recent years been implemented and further developed in *The Morning Line*, a huge, transportable sculpture by Matthew Ritchie, produced by Thyssen-Bornemisza Art Contemporary (T-B A21). T-B A21 have to date commissioned thirty professional composers and sound artists of international standing to create new works of sound art for the structure, all realised with software systems developed at York. The installation has been exhibited in large public outdoor spaces in European cities between 2008 and 2012. *The Morning Line* (*TML*) integrates into contemporary artistic practice the long-term, York-based research uniting sound reproduction technologies and human spatial perception. The research has, in this way, generated new forms of creative practice, transforming the work of a large number of sound artists and, through repeated, open, long-term public exhibition, contributed to public experience and understanding of sound art and audio perception.

2. Underpinning research (indicative maximum 500 words)

The research underpinning *The Morning Line* combines conceptual and theoretical approaches with practice-led developments and implementation.

Much spatial audio research focuses on sound reproduction technologies, such as Wavefield Synthesis, which seek to recreate the acoustic transmission of spatial sound under controlled conditions. The work described here differs in that it is concerned with spatial sound reproduction **and** music content generation, both informed by human spatial perception.

Ambisonics is a spatial audio encoding method developed by Michael Gerzon, based on spherical harmonic modelling of three-dimensional soundfields. This allows computer-generated sound to be heard uniformly in 3D spaces. Early analogue electronic experiments with 3D Ambisonic sound reproduction conducted by the BBC led to significant and influential research from the early 1990s at York by Dave Malham (Senior Technician, Experimental Officer) and Richard Orton (Senior Lecturer, retired 1996), with Tony Myatt (Lecturer, Senior Lecturer until 2012) joining the work in 1992. This research produced large-area Ambisonic loudspeaker arrays, moving Ambisonics from a domestic technology to one suitable for public presentations.

One of the factors affecting the progress of spatial composition was that the sound reproduction system could not make allowances for different sized spaces. Many spatial sound practitioners rely on the assumption that if the ear is stimulated in a manner similar to that of a natural acoustic soundfield, spatial audio perception will automatically result.

To examine this problem, Lennox (PhD 1995–2005), Vaughan (Associate Researcher, 1996–2002) and Myatt conducted research into contemporary theories of spatial perception, published in a series of articles (from 1999). This theoretical work integrated findings from psychology with small-scale musical experiments to validate aspects of the theory. Early research found that much spatial audio reproduction and spatial music was impoverished to a point where it could not appeal adequately to human spatial perception; surround systems predicated on a 'sweet spot' generally present the listener with less sonic information when they move. The primary findings suggested that better understanding would occur through the potential for listeners to move and actively explore a soundfield. Contemporary models suggest that perceptual understanding is equally informed by knowledge and predictions about a space as by auditory stimulus at the ears. Methods were derived from York's Real-Time Interactive Multiple Media (RIMM) project, led by Myatt, with European Framework 5 funding 1999–2000 and partners including IRCAM (Institut de Recherche et Coordination Acoustique/Musique), Paris, who supplied and modified jMax and Spatialisateur applications, and SIM-PK (Staatliches Institut für Musickforschung – Preußicher Kulturbesitz), Berlin, who hosted and facilitated the construction for the main performance. These were then combined with perceptual research findings to develop composition and production techniques, first tested and demonstrated in public by Myatt's composition *untitled 3* at the Staatliche Hochschule für Gestaltung, Karlsruhe in 2007, staged to coincide with the 'Next Generation' conference on Music in Space at ZKM, 2007.

From 2008 this research continued as part of the T-B A21 project, *The Morning Line*. Myatt led the team (all at York), working with Malham, Peter Worth (PhD and Project Researcher, 2007–12) and Oliver Larkin (Research Support Programmer from 2009). The *TML* audio system consists of software authoring tools and the *TML* Audio Engine, audio signal processing software that controls how sound is reproduced on specific loudspeaker configurations. New audio representation formats were developed based upon the creation of Spatial Audio Objects (SAOs). These objects combine sound material and information about spatial behaviour. Up to 100 simultaneous SAOs can be sequentially and/or simultaneously reproduced by a computer. Software tools to create and playback SAOs were developed by the research team, along with software protocols for algorithmic and live control of sound materials. This facilitated a flexible, multi-area spatialization platform; a sound system with multiple zones and surround cells that can be employed for a variety of artistic approaches and physically explored by listeners.

3. References to the research (indicative maximum of six references)

The items below are selected from a large body of relevant published research (theoretical and practice-led). All articles were peer-reviewed. *Computer Music Journal* and *Organised Sound* are leading journals in the field. Item 1 has been influential in the field of spatial audio, and has the most citations of any CMJ article that year (Scopus).
Item 1 was submitted to RAE2001 and items 2–4 to RAE2008. In RAE2001 the overall assessment for Music at York was 5A, and in RAE2008 91% of the submitted research was ranked 2* or above. Items 5 and 6 evidence the ongoing research developments, underpinning impact and feeding from the live experiencing of this work. Publications without DOIs are available on request.

1. Malham, D.G. and Myatt, A. '3-D Sound Spatialization using Ambisonic Techniques.' *Computer Music Journal*, 19/4 (Winter 1995), pp. 58–70. DOI: 10.2307/3680991
2. Lennox, P., Vaughan, J. and Myatt, A. '3-D Audio as an Information- Environment.' *Proceedings of the Audio Engineering Society 19th International Conference on Surround Sound*. New York: AES, 2001, pp. 295–306. (Also in *Proceedings of Seventh International Conference on Auditory Display*, Helsinki University of Technology, Finland, 2001.)
3. Myatt, A. 'Strategies for interaction in construction 3.' *Organised Sound* 7/2 (2002), pp. 157–169. DOI: 10.1017/S1355771802002078
4. Myatt, A. 2007. *untitled 3*, live performance for computer and nested sound systems (41 channels) (30 mins), premiere HFG, Karlsruhe, June 2007.
5. Myatt, A. 2011. 'Multispatial Sound', in *The Morning Line*. Zyman, D. & Ebersberger, E. (eds.). Vienna, T-BA Contemporary, Verlag für moderne Kunst Nürnberg. ISBN 978-3-86984-242-4.
6. Lennox, P. and Myatt, A. 'Perceptual cartoonification in multi-spatial sound systems.' Proceedings of the 17th International Conference on Auditory Display, Budapest, 2011.

The research was supported by the following grants:
1997 Myatt, A.: HEFCE Joint Research Equipment Initiative, in collaboration with Silicon Graphics Inc (SGI). Total award £996,000 (HEFCE £336,000; SGI £660,000).
1999/2000 Myatt: European Commission IST project under the 5th Framework: IST-1999-21022 RIMM. Real-time Interactive Multiple Media performance. €128,128. Period 2000–1 (extended. 2002)
2007–10 Myatt: Arts and Humanities Research Council. New Aesthetics in Computer Music (Contemporary practice in digital, post-digital music and electronica). AH/E002056/1. Total £285,903 (Research activity £195,903, Research Ph.D. funding £90,000).
2008–11 *The Morning Line* Project Seville, Thyssen-Bornemizsa Art Contemporary, Vienna, Austria: £16,673 (May–Jan. 2008); £4,000 (2009–10); £8077 (2010); £11582 (2011).

4. Details of the impact (indicative maximum 750 words)

The contract to realise *The Morning Line* sound system was awarded to York by Thyssen-Bornemisza Art Contemporary in 2008, following competitive tender. Francesca von Habsburg's T-B A21 is an immensely significant force in the commissioning of contemporary art, with a particular commitment to long-term, major, international, interdisciplinary projects that can be experienced by large numbers and will 'provoke and broaden the way viewers perceive and experience art' (T-B A21 website). Perceptual research underpinned the York bid and informed subsequent knowledge

transfer in the areas of research outlined above: this was the reason for York's success. The defining attributes of the bid specification were: that the music should be spatially explorable by listeners; that the audio presentation should support this robustly; that the compositions should allow many spatial audio elements with independent spatial controls. It should allow commissioned composers and artists to create new spatial music with appropriate software tools to make and reproduce their own spatial audio works. York researchers worked with New York architects Aranda/Lasch and Arup Advanced Geometry Unit to develop loudspeaker arrays for the *TML* structure.

To date, T-BA 21 has invested almost €2M in the construction, installation and commissioning for this project. The *TML* sculpture is 20m long and 10m high, weighs 20 tons, and the sound system has 47 channels and 53 waterproof speakers. The structure is modular, capable of being radically reconfigured for alternative performance venues and adaptable to a changing programme of contemporary music.

TML has been exhibited as an outdoor sculpture in public spaces in: Seville, for a year (2009, including as part of Seville Biennial of Contemporary Art); Istanbul, for six months (as part of the European Capital of Culture 2010); Schwarzenbergplatz, Vienna, for six months (2011, shown in the images above). It has also been exhibited at the *T-B A21 SoundSpace* at the ZKM (Zentrum für Kunst und Medientechnologie), Karlsruhe, which from 2013 will house *TML* when it is not travelling. Each outdoor exhibition was launched with a three to five day music festival, and in Vienna T-B A21 hosted. *The Morning Line Symposium*, a gathering of contemporary arts practitioners alongside scientists, architects and engineers, using the project as the basis from which to examine relationships between sound, architecture, contemporary art and science. Given the locations of *TML* exhibitions, outdoors, in central locations within major European tourist cities, in addition to the open access and duration of the exhibitions, it is estimated that *TML* and *SoundSpace* installations have been seen by between 1 and 2 million people.

The impact of the research is technological, artistic and cultural. The work is extremely significant for developers of audio technology (in academia and commercially); for example, Myatt and Larkin were interviewed about the project for the website of cycling74, the company behind the most widely used graphical programming software for audio, visual media, and physical computing (Max, MSP, Jitter, Gen).

The work has established a new form of artistic practice for academic and artistic communities, situated within the broader, growing field of spatialized sound and offering artists particular tools for exploring relationships between sounds in different areas (rather than moving the sound around one area that surrounds the listener). Since 2008 T-B A21 have commissioned thirty composers/sound artists from 17 countries to produce new works for the *TML* structure using these methods and technologies. These include figures as diverse as: Russian-English composer and inventor of the VCS3 synthesizer, Peter Zinovieff; influential German guitar-and-laptop artist Christian Fennesz; veteran Japanese experimental sound pioneer, Yasunao Tone; leading recorder of wildlife and natural phenomena, Chris Watson; installation artist Florian Hecker; experimental US rock guitarist and artist Lee Ranaldo (Sonic Youth); and Norwegian environmental sound artist, curator and producer Jana Winderen: this range is indicative of the broad application across musical practices and genres. Many of those commissioned have

acknowledged considerable changes to their practices as a direct result of involvement in the project. Zinovieff describes the experience as life-transforming (email to Larkin, 06/05/13): he had removed himself from such work for around 35 years, due to the gap between his aspirations and available technologies, but the developments for TML turned this around: 'Everything I do now in my busy composing life derives from The Morning Line and ever present spatial possibilities in the presentation of new electronic pieces.' In addition to the installed works, the curators programmed live events (often as part of the linked festivals), with real-time performances from some of these composers plus invited live electronic artists and DJs. All *TML* artists were supported by Myatt and Larkin through on-site visits to *TML* and in workshops at MIAM (the Centre for Advanced Studies in Music, University of Istanbul), at the Akademie der Bildenden Künste, Vienna, and via video conferencing. This support was related to spatial audio perception, its impact on compositional methods and implementation techniques. Many composers travelled to York studios for consultation and production support. The final stage collaboration took place in-situ on *TML*, to mix, adjust and test the works prior to exhibition.

This application of the York research has provided new opportunities for public performance and new sonic experiences. While specific impacts upon the large number of visitors cannot be proven, the experiential nature of the work, with the technological developments rooted in understanding of spatial audio perception, encourages active individual exploration. In this respect the numerous amateur youtube videos posted online act as indicators of engagement. The increasingly common experiencing of surround sound in cinema formats serves as a comparator for audiences; walking around *TML*, exploring perspectival relationships between areas of sound, is a different aural experience, sophisticated and subjectively determined.

5. Sources to corroborate the impact (indicative maximum of 10 references)

Corroboration of impact in terms of spatial audio and creative practice:
1. The Morning Line. Zyman, D. & Ebersberger, E. (eds.). Vienna, T-BA Contemporary, Verlag für moderne Kunst Nürnberg. Revised from *TML Istanbul*, (2010) and *TML Seville* (2008).
2. *The Morning Line* pavilion website (corroboration of design, implementation, scale, events) http://www.tba21.org/pavilions/103?category=pavilions
3. *TML* seminar (Vienna, 2011: includes videos of sessions, all uploaded to vimeo): http://www.tba21.org/program/seminars/111?category=seminars
4. AES tutorial article: Malham, D. G., Myatt, A., Larkin, O., Worth, P., Paradis, M., *The Morning Line*, 128th Audio Engineering Society Convention**,** May 2010, online Paper Number**:** 8073.
5a. http://cycling74.com/2011/06/22/the-morning-line-part-1/
5b. http://cycling74.com/2011/06/22/the-morning-line-part-2-surround-concepts/
6. Tony Myatt radio interview with Susanna Niedermayr, *Zeit-Ton*, OE1, ORF, Austria, broadcast (8 June 2011). http://oe1.orf.at/programm/276494

Corroboration of impact on commissioned composers/ sound art practices:
7. Statements from independent composers/sound artists.
8. Peter Zinovieff, 'Nuzuh,' Cambridge Literary Review 3 (2010) http://www.cambridgeliteraryreview.org/wp-content/uploads/ZinovieffCLR3.pdf
9. Sound archive site: http://www.tba21.org/pavilions/49/subarticle/29

Sources to corroborate public impact:
TML festivals (includes artist line-ups, images of audiences, footage of events):
   10a. TML Seville (2009): http://www.tba21.org/pavilions/49/page_2?category=pavilions
   10b. TML festival Istanbul (2010): http://www.tba21.org/pavilions/49/subarticle/40
   10c.TML festival Vienna (2011): http://www.tba21.org/pavilions/49/subarticle/46
   10d. TML festival for Spatial Sound, Vienna (2012): http://www.tba21.org/program/archive/180?category=archive