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There is no Dome?

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Abstract.
Fulldome is slowly emerging from its planetarium shaped incubator into a brave new world of digital projectors, real-time visualisation software, independent content producers and transdisciplinary collaborations. This paper takes a slow zoom through the evolution of Fulldome. It reflects on the technologies and institutions that have shaped the Fulldome orthodoxy and the recent emergence of a digital framework where all the different kinds of technologies, disciplines and media forms fit together. The Fulldome may no longer be full of stars, but the emptiness that lies beyond its domed surface offers new imaginings of a 'future in space'.

Keywords: Fulldome, Data, Model, Visualisation, Infundibulum.

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1 *"Any resemblance to any other world known or unknown is purely coincidental"* (*A Matter of Life and Death* 1946).

The Dome has always been a unique bubble in time and space - an oculus with its gaze fixed both on the distant past and near future. Whether it's 13.7 billion light years ago to the CMBR (Cosmic Microwave Background Radiation) or the modelling of imminent climate scenarios, the immersive qualities of the Fulldome environment appear to suspend the normal laws of physics, sweeping the viewer across molecular landscapes or skirting the edge of the observable Universe. This spatial-temporal bubble is a polysensory polypsical anomaly in the history of media technologies and associated art forms. Something a little like a scientific instrument but maybe more like an educational tool, possibly more like a cinema but probably more of a funfair ride.

The Fulldome is, of course, all of the above and it is this chameleon like quality that has created the identity crisis for the makers and making of content, for the institutions that build and look after them and the audiences that immerse themselves within them. For me the Dome is a transdisciplinary instrument for the manifestation of material, immaterial and imaginary worlds. For when it works the Dome simply disappears and the shadows that are normally cast upon flat surfaces form themselves through a more tangible experience somewhere beyond the perforated or plaster screen.

So, the following, in challenging the easy absorption of the Fulldome environment into the hegemony of Cinema, explores the recovery of the space and time of the Dome. By decoupling the dome from its superficial similarities this text attempts to understand the dome for what it 'is' and not what it 'looks like'. It explores the slow zoom to the micro/macro, the domification of digital content and the dome-shape of things to come.

2 Chrono-synclastic Infundibulum

> "These places are where all the different kinds of truths fit together as nicely as the parts in your Daddy's solar watch. We call these places chrono-synclastic infundibula."
> (Vonnegut, 1962, p.11-12)

The Dome is a place "where all the different kinds of truths fit together" (Vonnegut, 2006, p7). Its ability to break down disciplinary boundaries extends beyond its popularity as a vehicle for large data visualisations. There is something sensuous and calming about the space of the dome. Even without multi-speaker amplification, the acoustics of this natural whispering gallery creates both a dense dead silence and a complex multidirectional pool of sound. Even without a projected image it is hard to focus on the dome, your eyes see through and beyond the surface. These affordances create an environment that is extremely conducive for relaxation and meditation. The addition of a fisheye projector, surround or ambisonic sound system and a backend digital media server makes the contemporary dome a powerful experience.

The relationship of the projector to the dome is critical. The omni-focal fisheye lens unfurls the projected image across the inner dome surface providing a projected image that fills the viewers vision. This complete image is not the simple surround of the panorama, but the near complete immersion of the viewer, subject to the truncation of the particular dome. And here in lies the first institutional issue. It is not just the electronics and the screen that are the problem; the dome is a 'building'. The dome is useless without the fisheye projector and the projector is useless without the dome. Whilst the emergence of very credible inflatable domes, small high-resolution projectors and powerful desktop/laptop computers makes portability a plausible option, the larger 40 seater+ dome will always require a building to support it. And with a building comes Estates, space-charges and the usual trappings that institutionalise the Fulldome architectures.

This institutionalisation of the Fulldome has preserved a certain modus operandi which was established early in its analogue evolution, dominated by

the likes of Zeiss (http://www.zeiss.com/) and Spitz (http://spitzinc.com/domes/), right through to the emergence of the digital systems in the early eighties, championed by the likes of Evans & Sutherland (http://www.es.com/) and R.S. Cosmos (http://www.rsacosmos.com/) et al. The sheer size of the projectors and the domes onto which they projected required a level of servicing that significantly influenced the development of content and the nature of the audience. Dominated by the public understanding of science agenda and the 50's and 60's desire to conquer the heavens, the development of the Fulldome was driven by forces beyond the average art & design institution or creative practitioner.

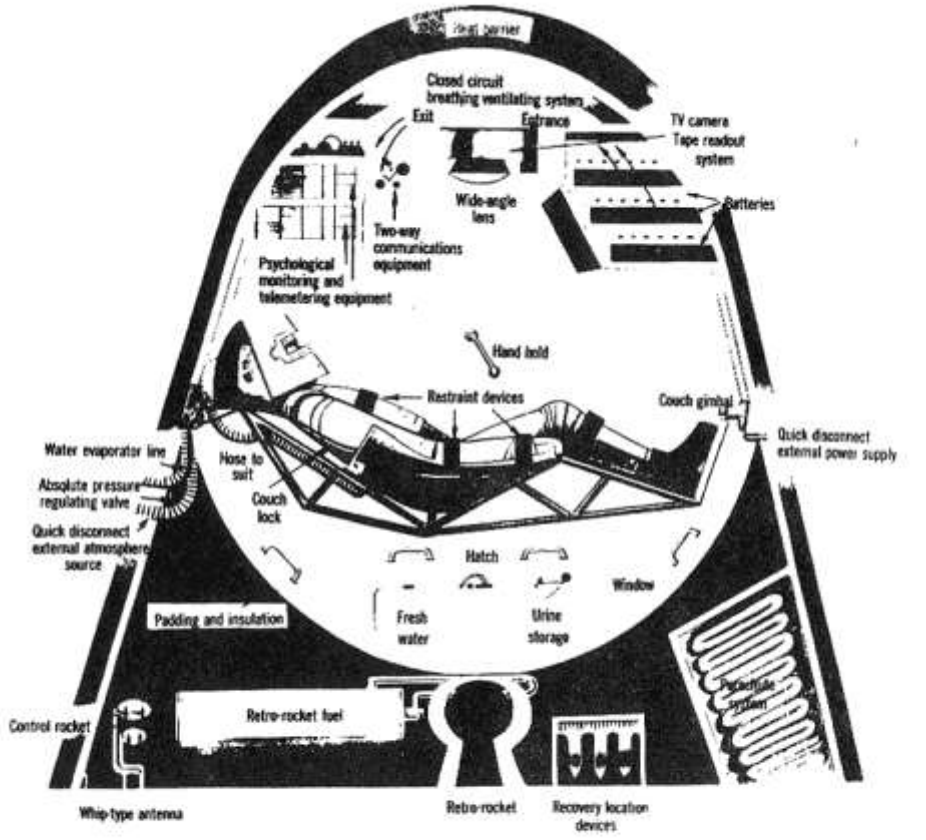
The alternative history of the Fulldome environment has been mapped elsewhere, most notably by David McConville (2007), and it is easy to see the ruptures in art and media history that have aspired to and desired the affordances of the Fulldome environment. The potential and ambition of early Twentieth Century technologies to break free of the edges of rectangular frame and its dimensional shift to the white cube can be felt in the writings of Moholy-Nagy (1946), "-seeing, feeling and thinking in relationship and not as a series of isolated phenomena. It instantaneously integrates and transmutes single elements into a coherent whole". This coherence is only now becoming a practical reality through the Fulldome technologies described below. The forces and actors that have been dormant or unformed are slowly emerging through a loose affiliation of technologies and practices.

3 *I Wish I Was A Space Man, The Fastest Guy Alive*. (Gray 1963)

The language of Fulldome has been dominated by space visualisations. From the tiny pinpricks of light cast by the praying mantis like Zeiss projectors to the faster than light zooms of skyscan (http://www.skyskan.com/) and Uniview (http://www.scalingtheuniverse.com/), Fulldomes have been about looking up. Domes are no longer full of stars but it would be a mistake to forget their significance in driving the evolution of the Fulldome. In his postfix to the "The Future in Space", Eisenhower (1958) frames the global clarion call to break free from the confines of the planet to "take Man where no human has ever gone before." The pamphlet also identifies the nature of these brave explorers; the 'Ideal Spaceman' must be "Normal to an Abnormal Degree." And further specifies a fundamental requirement that defines this 'normality' - they "must want to come back"! To the average not normal enough member of the public, the closest you could get to space and the future was through the Fulldome.

Whilst cinema projected the future as a space populated with aliens and tales of invasion, the Fulldome immersed audiences in awe-inspiring visions of so faraway so close. Whilst the space race found a new propaganda tool, the audience embraced a scientific mythology that is now being slowly reversed through the use of the same Fulldome environment. The desire to escape may well have been fuelled by the Fulldome, by bringing the faraway closer Fulldome may have reinforced the concept that hopping to the next planet, once we had trashed this one, might be feasible. In the Twenty First Century the Fulldome space oculus is slowly being turned to look back at Earth. We now "must want to come back" because we know there is nowhere

else to go. It is hard to shake the complacency of centuries of viewing the world through an Albertian window that places us at the centre of the Universe. In a peculiar inversion of the Fulldome, the sketch of a mission to Mars depicts the ideal supernormal spaceman staring up at a fisheye lens set in the Fulldome ceiling of the space capsule - hurtling into space looking at ourselves.



SKETCH shows how a passenger would look inside a spaceship. Comfort devices would be built into container for maximum reliability for both man and machine. Man, wearing spacesuit, reclines on couch for protection against gravity forces.

Figure 1: Supernormal Spaceman.

This fascination with looking at our reflections in the technologies we build is embedded in our collective worldview. Inspired by the Ray and Charles Eames film entitled Powers of Ten (1968), Uniview, SCISS's powerful Fulldome visualisation tool of the known Universe, presents a contemporary model of the Universe based on the latest astronomical observation drawn from a range of sources, including real time WMS data[i]. Uniview allows a 'pilot' to navigate an audience through the Universe, visiting planets, constellations and numerous animated scientific data visualisations within a digital environment that in many ways resembles a 'game engine'. This game engine feeds of a database of cosmological information sourced from international space organisations rendering it in high resolution on the fly. However, Uniview's lineage goes back further than Powers of Ten which drew

inspiration from Kees Boeke's (1957) *Cosmic View: The Universe in 40 Jumps*. The opening sequence of Powell and Pressburger's (1946) 'A Matter of Life and Death' predates the slow zoom of Powers of Ten by some twenty years. Whilst this slow zoom to a 'real English fog' (interestingly to about the same distance from earth as the boot-up view of Uniview) shifts to the radio wavelengths of a young David Niven's conversation, the comparison between Powers of Ten, Uniview and a Matter of Life and Death is pertinent if only to reinforce our preoccupation with placing ourselves at the centre of the Universe.

Uniview departs from this pre-Galilean model through its ability to tell different stories and present a variety of models to challenge worldviews. It is not a film that plays from beginning to end, there is no middle, the viewer is free to fly or jump to any position in any data set. Although Uniview is constructed from data collected by instruments only a stones throw from our planet (the furthest having only just reached the edge of our solar system) this dynamic and astronomical 3D model operates as a reader for a wide variety of information. Representations, trajectories, scenarios and probabilities can be played out enabling subtle shifts of perspective. Not only can we see our own reflections but we can also see them in relation to circumstances normally out side of our frame of reference.

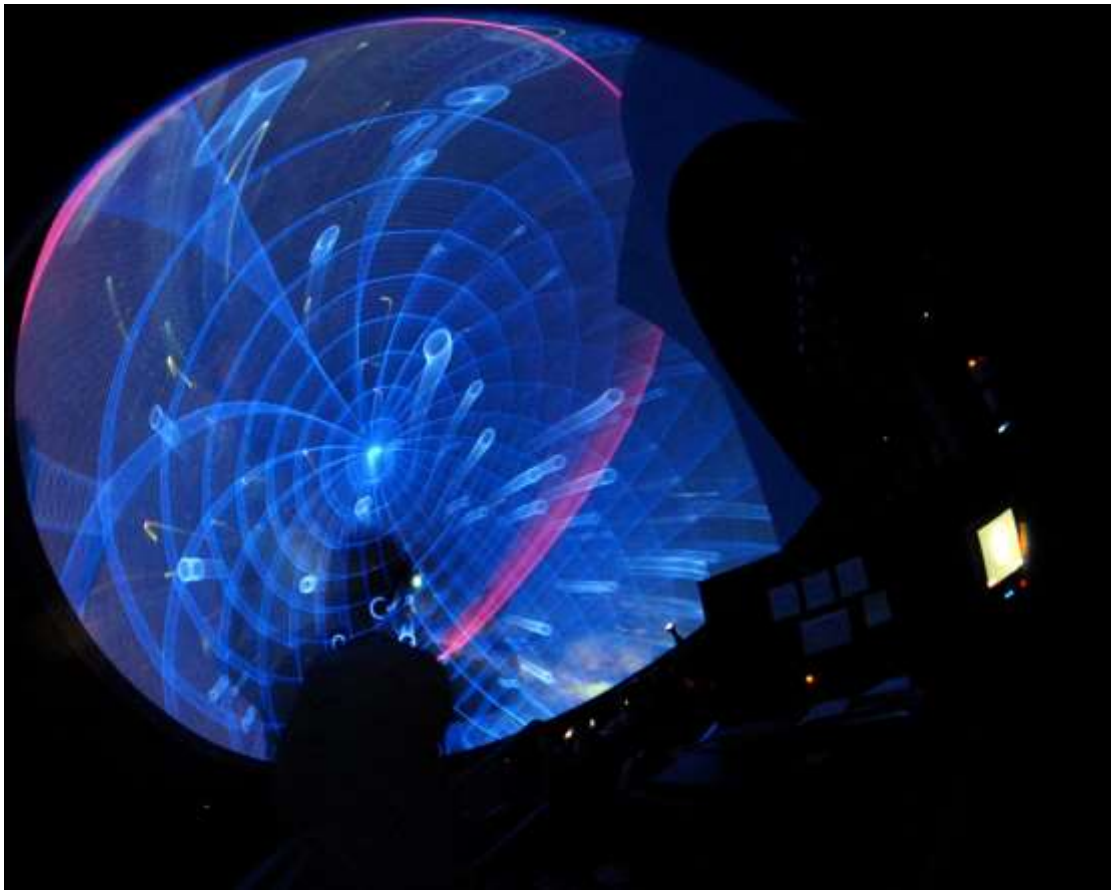


Figure 2: Uniview.

4 *A Real Model.*

I once had the pleasure of supervising a postgraduate architecture student (Epps 1997) who was threatened with failure by a member of the architecture staff for not presenting a 'real model' for assessment. Apparently a model built from balsa wood and card was somehow 'real', whereas the digital model being presented was not. The history of model making is littered with ambition, conquest and desire, whether it's the architectural model of a CEO's headquarters, a master plan for a city's future or a general's model of a battlefield. Uniview's model of the known Universe transcends these petty concerns by effectively presenting a reader for different forms of data. The Fulldome environment transforms the viewer's relationship with the model, no longer the top-down-arms-length-bird's-eye view but dynamic vantage point that immerses the viewer at the heart of the model. Framed in this instance within a cosmological context this approach is key to the future of Fulldome productions. Being able to draw on data and construct immersive models through similar engines releases the Fulldome from its cinematic stranglehold and provides a robust instrument for nurturing transdisciplinary debate. The example of a workshop that brought together postgraduate students from Advanced Architectural Design, AHO Oslo School of Architecture and Design, Norway, with members of A.V.A.T.A.R, Bartlett School of Architecture, University College London and staff and students from i-DAT, illustrates the significance of the Fulldome environment. Here, designers, architects and coders processed the realtime data from a building into dynamic visualisations within i-DAT's 9m Fulldome (http://www.i-dat.org/toolbox/). The intention was to encourage the development of methodologies for building design based on the modelling of behaviour, data and interaction. The success of the workshop was clearly manifest through a transformation in the participant's appreciation of the building as a temporal system, and not a physical mass of glass and steel. R. Buckminster Fuller's 1962 plans for the dome predict this potential.

> "The consequences of various world plans could be computed and projected, using the accumulated history-long inventory of economic, demographic, and sociological data. All the world would be dynamically viewable and picturable and radioable to all the world, so that common consideration in a most educated manner of all world problems by all world people would become a practical event".
> (Fuller, 1962)

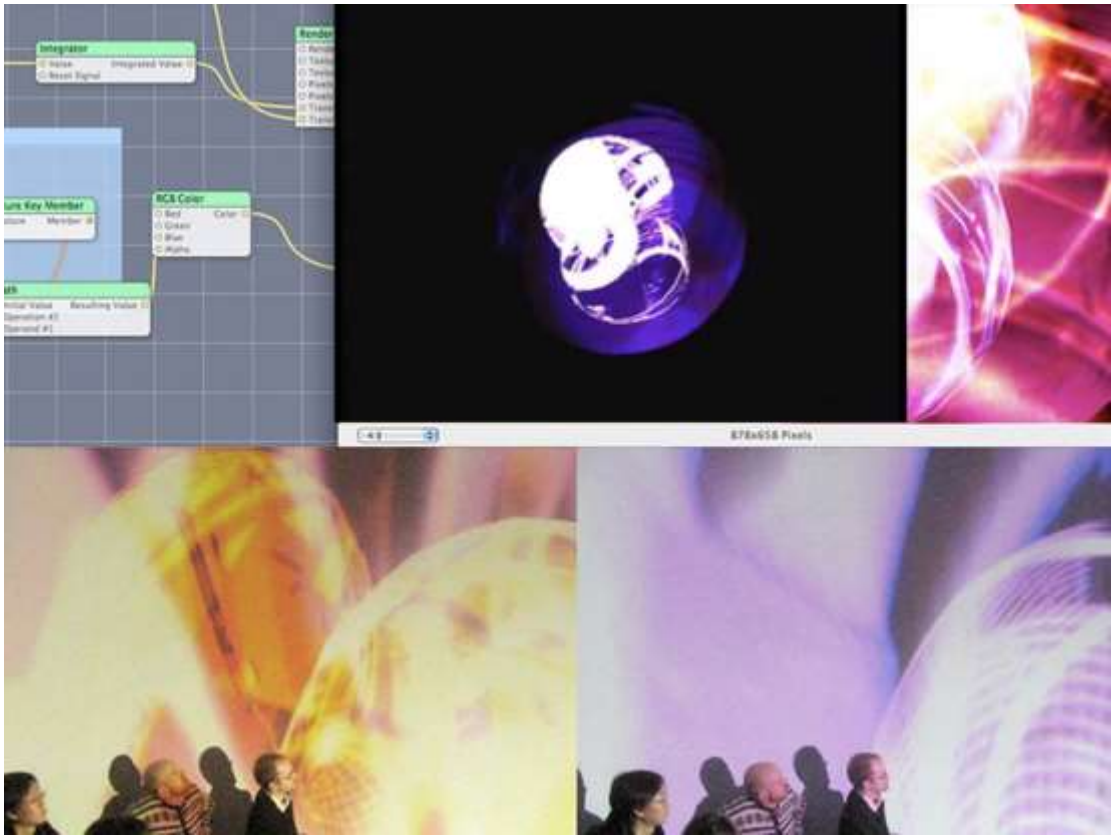


Figure 3: Fulldome workshop.

The digital imaging technologies of Atomic Force Microscope (AFM), Scanning Electron Microscope, X-ray computed tomography and the Radio telescope open up new dimensions. More dimensions are unveiled, more realities are modelled and more truths envisioned, but locked in their walled disciplines these new visions of reality are lost to the broader culture. There are more things in heaven and earth than currently understood in our media philosophy. The imaging and modelling technologies presented below are similar in principal to Uniview and are unlocking the potential of the Fulldome to provide a new perspective on the world.

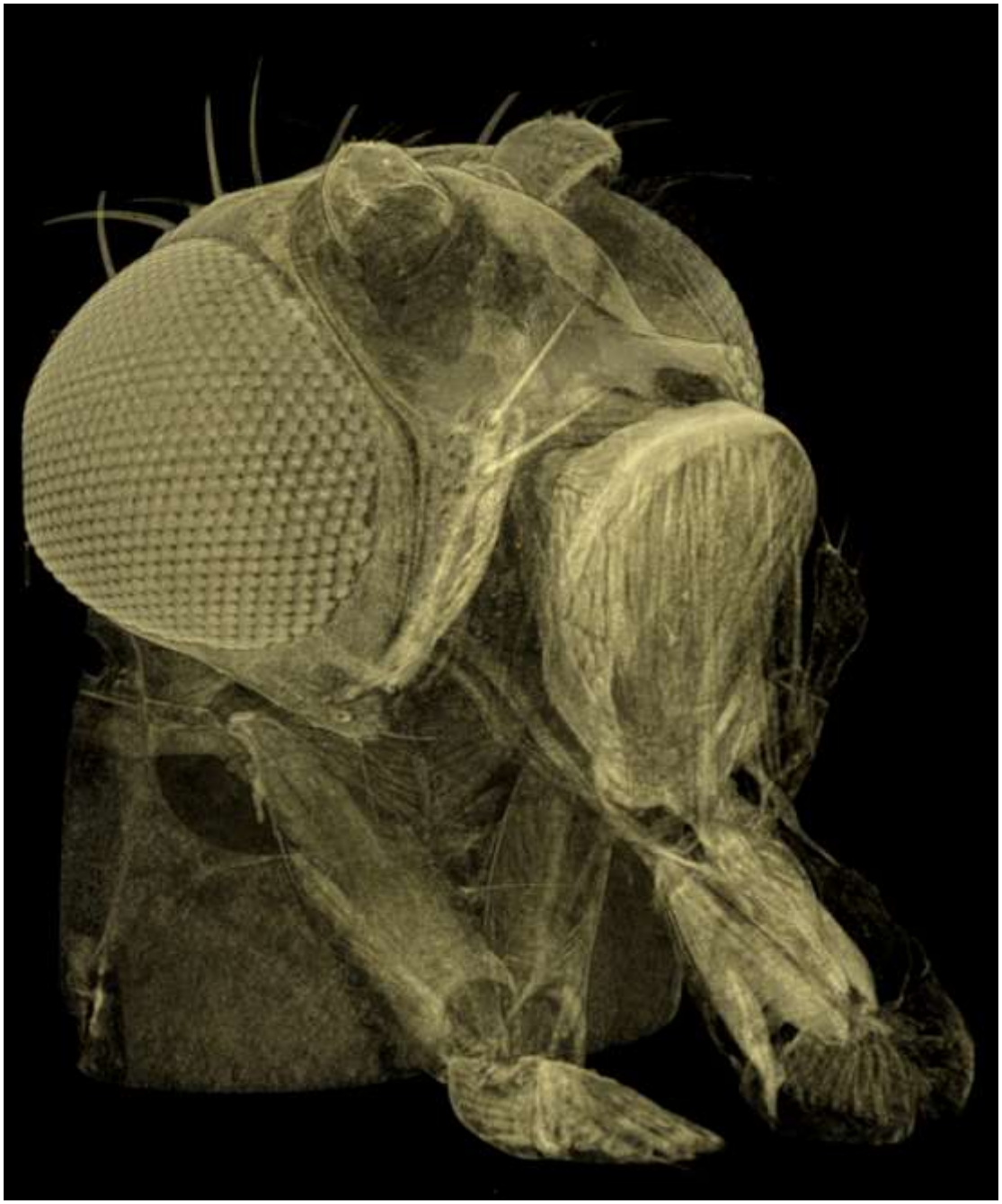


Figure 4: Fly thru.

At the heart of this transformation of perspective is the ubiquity of data and its ability to flow between formats, readers and aggregators. For instance, the ubiquity of XML based formats is being established within many disciplines, this is already true of GML, and KML - but can be seen in disciplines as diverse as Neuro-science (NeuroML), Chemistry (CML) and initiatives by Usman Haque (https://pachube.com/) to establish an Urban XML along with Operating-Systems (http://www.op-sy.com/) which utilise standard XML and RSS formatting. Not necessarily transcoding (Manovich 2001) but reading and parsing the same data into different engines enables a shift in disciplinary understanding. For instance, importing of data generated by an Atomic Force Microscope into Blender Game Engine (http://www.blender.org/) transforms the classic blurry orange rendered image into an immersive molecular

landscape that can be traversed by the viewer, providing a shift in scale that is startling. The power of the dome is to place the viewer inside the thing they normally only perceive from some great distance, such as the constellations through the lens of a telescope or the molecules at the tip of an AFM stylus.

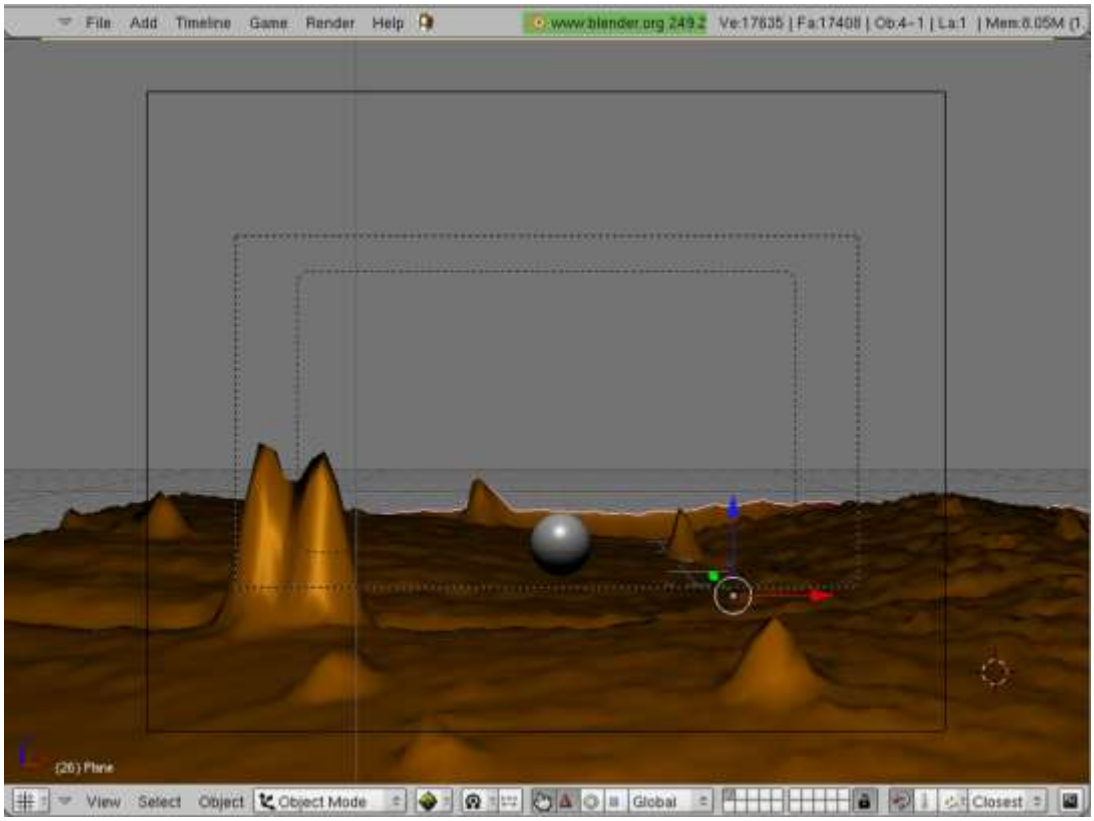


Figure 5: Molecular Landscape.

5 ***The Structure of Fulldome Revolutions.***

There are many variables in Fulldome construction, ranging from:

- the physical build of the dome, such as plaster, more contemporary perforated segmented screens to inflatable negative and positive pressure screens;
- the tilt of the dome and relation to the seating, with more traditional planetariums being horizontal with a view into the Fulldome night sky, to more forward looking flight simulator style systems;
- the field of view of projected content and the level of truncation or shortening of the dome behind the viewer's head;
- the height of the 'springline' or the bottom edge of the domes bowl, placing the viewer within the dome or slightly lower so the viewer looks up into the dome.

These basic considerations are coupled with the scale of the dome and the need for projectors to provide an appropriate resolution. Fulldome projection systems have been ingeniously devised to range from a single fisheye to multi-projector extremely high-resolution edge blended systems. The larger the dome the more complex the backend system needed to feed the projectors.

This need for resolution and multi-projector systems has complimented the institutionalisation for the fuldome. As computing technologies rise to meet the challenge the dominance of long established companies. There are now four Fulldome festivals in the world; the Fulldome Festival in Jena, Germany (http://www.fulldome-festival.de/), Domefest in Albuquerque, New Mexico (http://www.domefest.org/), the Immersive Film Festival in Espinho, Portugal (http://iff.multimeios.pt/), and the new kid on the block, FULLDOMEUK (http://www.fulldome.org.uk/), which is slightly more nomadic having launched in Plymouth in 2010 and at Birmingham Thinktank in 2011. What is particularly interesting about these events is that there is a clear trajectory in the evolution of content. With the advent of powerful single and multi-projector digital systems for new builds or planetarium conversions, the focus is shifting from the stars to a multitude of content. Along with the shift in the technologies of projection, production and playback there is a steady increase in the amount of 'independent' productions. Although still dominated by the 'science' productions for large planetariums, the cracks are forming in the production and licensing models. This particular paradigm shift is also opening up a new transdisciplinary dialogue between creative practitioners with the skills to handle the production tools and the plethora of disciplines eager to immerse new audience in their data.

The key enabling tools for this paradigm shift include Paul Bourke's Warp mesh patch for Quartz Composer, the Elumenati's Omnity plugin for Unity 3D and dome mode in Blender Game Engine. The use of game engines for real time data visualisation is a significant step forward for the field. Video oriented tools produced by the Navegar Foundation, such as the Full Dome composition plugin for After Effects and DomeView are bringing dome production to the standard desktop and laptop. In addition Fulldome research initiatives are growing through the activities of organisations such as Society for Arts and Technology [SAT], Montreal based PANODÔME and PANOSCOPE 360° (http://www.sat.qc.ca/index.php?lang=en) initiatives and Sydney based iCinema Centre for Interactive Cinema Research (http://www.icinema.unsw.edu.au/). As well as the increased speed in graphics card rendering and Solid State Drives (SSD), new hardware solutions are creeping in from the VJ/video mapping community. For instance, the Addict Server (http://www.immersive.eu/) demonstrated at the Birmingham Thinktank (http://www.thinktank.ac/) FULLDOEMUK festival in March 2011 had, within the space of a few hours, hooked up the six spare VGA cables to deliver real-time high-resolution multi-projection for a fraction of the price of the installed Digistar (http://www.es.com/products/Digistar.html) system. And then we have the Fulldome itself, as high-resolution projectors get more powerful and portable the inflatable portable dome becomes a significant mover in the dissemination of Fulldome content.

6 *'The thing's hollow - it goes on forever - and - oh my God - it's full of stars!'* (Clarke 1968)

The slow zoom of the planetarium is syncretic with the slow fade of its cultural importance. The final phase in the transformation of the Fulldome follows the institutional liberation through mobility, technological

democratisation and the reconfiguring of its media forms. Our need for a future in space is slowly being inversed as we realise the increasing importance of dealing with the here and now. This “mote of dust, suspended in a sunbeam” (Sagan 1994) is being viewed from a new perspective. The Fulldome is becoming increasingly important in illuminating this shift of perspective. The refocusing from space to Earth is unlocking a new dialogue between disciplines as the data tools for generating ‘real’ models of the world require new levels of information literacy and new media forms. Through the unique qualities of the Fulldome these forms increasingly embrace Oliver Grau’s aspiration where,

> “The goal is a symbiosis of human being and computer image, where contact is effected via a polysensory interface that ultimately is not perceived by the human user and fades from consciousness.” (Grau 2003)

As a place where all the different kinds of truths fit together and impossible spaces and times converge, it is not the dome that bends, there is no dome.

Notes:
A Whispering Gallery is n acoustic architecture, such as the dome in St Paul’s Cathedral in London or Grand Central Terminal in New York City, usually a dome or vaulted ceiling. In such a space a whisper can be clearly heard across the far side of the room.

Star Projectors originally developed by the Carl Zeiss Company in 1924 consisting of spherical clusters of lenses to construct complex star patterns. Located in the centre of the theatre these mechanical giant robots have all but been replaced by digital systems.
XML: Extensible Markup Language, is a scripting language that is both machine-readable and human-readable. It uses open standards define and format documents and data. XML is used widely across the World Wide Web and is supported by numerous application programming interfaces (APIs) to format data and transfer it from one software environment to another.

Picture Credits

1. *Supernormal Spaceman*. *The Future in Space*. Produced by the United States Information Service circa 1958.
2. *Uniview.* I-DAT Immersive Vision Theatre showing Univeiw. http://www.scalingtheuniverse.com/
3. *Fulldome workshop.* http://www.i-dat.org/ahobartletti-dat/
4. *Fly thru*. Drosophila (Fruit Fly). i-DAT/Immersive Vision Theatre. Musaab Garghouti (i-DAT), Pate Carss (i-DAT), Peter Smithers (School of Biomedical and Biological Sciences, & Dr. Brian Metscher (Dept. of Theoretical Biology, University of Vienna). Volumetric rendering composed of 600 slices at 6 µm Software : DICOM data to OSG, Drishti & 3d Studio Max.
5. *Molecular Landscape.* http://www.i-dat.org/scale-electric-19-20072010/

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Vonnegut, K., *The Sirens of Titan*. Victor Gollancz, 1962, pp11-12.

Links

Inflatable Domes http://www.elumenati.com/products/domes/ and http://www.go-dome.com/
Uniview video: http://www.scalingtheuniverse.com/videos.php#AMNH
WMS data: http://www.opengeospatial.org/standards/wms
Re-Imagining the Big Picture. Worldviews Network Overview: http://www.worldviews.net/about.html
Paul Bourke's

Warp mesh patch for Quartz Composer:
http://paulbourke.net/miscellaneous/domemirror/warppatch/
Elumenati's Omnity plugin for Unity 3D:
http://www.elumenati.com/products/software/omnity/
Navegar Foundation Full Dome composition plugin for After Effects:
http://software.multimeios.pt/fulldome/