La Dispersion du Fils:
Into regions of incomprehensibility

Matthew McGinity
LFK(s)
Marseille, France / Berlin, Germany
mmcginity@lfks.net

La Dispersion du Fils **concerns the tragedy of Actaeon, the hunter transformed into a stag and chased down and devoured by his own hounds. The work can be taken as an algorithmic interpretation of the tale's central themes: metamorphosis and transcendence, pursuit of forbidden knowledge or unattainable goals, sacrifice and transgression, chance and control. Designed for display in a 360° omnistereoscopic multi-user virtual reality theatre, the work takes the form of a voyage through vast, living three-dimensional structures constructed entirely from audio-visual elements found in the film archives of Jean Michel Bruyère and the LFKs. The artwork is real-time, generative, aleatoric and chaotic; never repeating and never ending. Any single moment is guaranteed to never be witnessed again, and of all the possible states the system might assume, most will never be seen at all. This paper discussed both the immersive and emergent aspects of the work, from both technical and aesthetic viewpoints.**

Immersive art. Generative art. Aleatoric art. Panorama. Omnistereo. 3D. Metamorphosis.

1. THE AVIE CYCLORAMA

La Dispersion du Fils was created for display in the The Advanced Visualisation and Interaction Environment (AVIE), a 360° virtual reality theatre developed at the iCinema Centre for Interactive Cinema Research at the University of New South Wales (McGinity et al. 2007).

The AVIE is composed of a 10-metre diameter and 4-metre high cylindrical projection screen, with a narrow (80 cm) doorway providing entry. The screen is illuminated by ring of stereoscopic projectors.
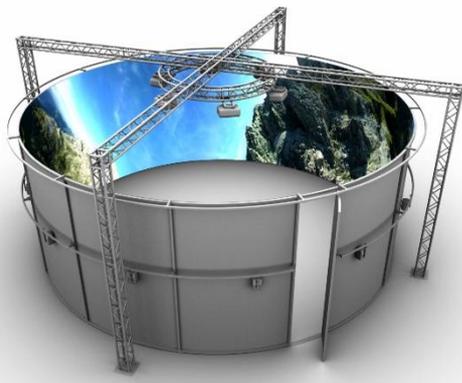

Figure 1: The AVIE system.

As a cylindrical display within which the audience view virtual or remote vista, the AVIE can be firmly placed within the long tradition of panoramic theatres, beginning with the 18th century panoramic paintings of Robert Barker and experiments in panoramic projection at the dawn of the 20th century (Barker 1796, Chase 1895, Grimoin-Sanson 1896, Baron 1897, Leguey & Bap 1902, Lumiere & Lumiere 1902). The AVIE possesses, however, four features that distinguish it from its ancestors: omnistereoscopic imagery, spatial audio, real-time image generation and interactivity.

1.1 Omnistereo

The AVIE was designed with a specific goal: to provide an immersive experience for up to 20 viewers in a single, shared social space. In the real world, a visual sense of 3D space – "spatial presence" – is won through active binocular perception of a field of light (Gibson 1979, Adelson & Bergen 1991, Zahorik & Jenison 1998). "Active" refers to our perpetual motion through our environment; we perceive the light field from shifting viewpoints and it *is* the resulting change and non-change induced by this motion (reafference), fused with the "extra-retinal" proprioceptive and efferent stimuli created by self-motion, that we perceive and experience as 3D structure (Wexler & Van Boxtel 2005).

Spatial presence in a virtual world is attained by providing this same active perceptual relationship with a virtual world. This can even be achieved using 2D images, by a) tracking the viewer's motion and rapidly generating the correct visual stimuli for each eye's point of view and b) removing all perceptual evidence of the image surface itself. Like this, a pair of images can serve as surrogates for direct perception of a light field. This is the technique used to great effect in head mounted VR displays (Sutherland 1968) and VR projections systems like the CAVE (Cruz-Neira et al. 1992).

Such head-tracked displays, however, are intrinsically single-user; they are restricted to the display of a single point of view at a time. Multiple viewers with head-mounted displays may share a virtual world, but our current inability to accurately depict the body, face and eyes of the users greatly inhibits natural communication, co-presence and sense of embodiment. Likewise, multi-user projection systems have been demonstrated (Fröhlich et al. 2005), but the technique does not extend beyond a handful of viewers at a time.

A cylindrical stereo panorama is capable of providing an active perceptual relationship with a virtual world for multiple viewers at once. It does so by sacrificing some degrees of freedom with which we explore our visual environment and with them, a certain degree of spatial presence. However, unlike traditional 2D images, not *all* degrees of freedom are lost – the viewer can still actively explore their visual environment by turning their heads and eyes, and exercising vergence. Furthermore, the combination of stereoscopy and border-less image results in the disappearance of all evidence of the image surface.

When omnistereoscopic imagery is displayed in the AVIE, the walls of the cinema quite tangibly disappear. A vista opens up, extending in all directions and the sensation of space stretching out beyond the cylinder is both physical and concrete. It is not so much that the screen becomes a window, for this would suggest the presence of a window frame, but rather that the screen, and the whole AVIE apparatus with it, disappear. Of the real world, all that remains is two floating black circles – the floor and the ceiling.

Stereo panorama are created by assuming a) a fixed central viewpoint, b) a direction of view that is everywhere radially outwards from this viewpoint and c) a horizontal binocular separation, yielding a multi-perspective image sometimes referred to as *omnistereo* (Peleg et al. 2001). The result is an encircling stereoscopic image that provides an effectively perceptually correct image for all viewing directions.

While, strictly speaking, this method only yields undistorted imagery for viewers located at the centre of the cylinder, for the stationary observer distortions introduced by viewing them off-centre are largely imperceptible. To the moving observer, however, this discrepancy becomes indeed evident. The lack of motion parallax produces an illusion of apparent motion between foreground and background, creating a form of visual paradox where objects are perceived to both be stationary and moving at the same time.

In contrast to head-tracked systems like a head-mounted display or CAVE, the AVIE is ineffective at presenting virtual objects near at hand. However, for rendering scenes that extend beyond the bounds of the cylinder, the omnistereo projection is highly effective.

1.2 Surround sound and interactivity

A circle of 12 loudspeakers provides a spatial sound display, using amplitude panning to position sounds anywhere around the circumference of the cylinder (Pulkki 1997).

The AVIE system can display images and sound that are pre-recorded or pre-rendered, or content that is generated in real-time. The latter permits interactivity, in which viewers are able to control or influence the virtual events unfolding around them. A visual tracking system is used to track the positions and movements of the viewers within the cylinder.

2. *LA DISPERSION DU FILS*

2.1 LFKs

Directed by Jean Michel Bruyère, the LFKs are an interdisciplinary artist collective whose creations include elements of film and photography, text and poetry, theatre and performance, sculpture and site-specific installation, painting and graphic design, music and sound, and algorithmic and immersive cinema. The works are highly political and socially engaged and often produced in cooperation with members of the public: residents of a housing project in Le Havre, street kids of Dakar, young adults from the banlieue of Marseille.

Beginning in 1994, Bruyère and the LFKs adopted the tragedy of Actaeon as a form of manifesto; the misfortune of Actaeon would be taken as the founding act of an *art cynique* (so named in reference to the hounds of Actaeon), and in the subsequent decade, the LFKs developed and exhibited twenty unique exhibitions, installations and performances concerning the fate of Actaeon and his dogs (Bruyère 2003).

With many of these projects involving the production of film, by the end of this époque the LFKs had amassed a vast library of filmic material. A significant number of the films were created in Senegal with the young students of the *Man-Keneen-Ki* orphanage/clinic/art-school founded by Bruyère in Dakar. From the films of the LFKs, Delphine Varas selected, edited and semantically sorted over 500 unique clips to create a database comprising over 18 hours of footage. To this, Thierry Arredondo added library of sonic textures, recording for each of the movie clips a unique soundtrack, using his voice alone as instrument.

Figure 2: L'Insulte Faite Au Paysage (LFKs, 2005).

Drawing from the iCinema AVIE project *TVisionarium* (N. Brown et al. 2008), in which the possibility of using 2D moving images in immersive 3D space had been demonstrated with great effect, *La Dispersion du Fils* would take the form of a virtual world in which all 3D forms and surfaces are entirely constructed from mosaics of 2D moving images.

2.2 Transfiguration of the hunter

La Dispersion du Fils concerns the tragedy of Actaeon, the hunter transformed into a stag for having dared lay eyes on the naked Diana, and chased down and devoured by his own hounds. Among the countless interpretations of the myth, none are so pertinent or potent as that offered by Giordano Bruno, for whom the myth expressed the philosophical quest for knowledge, truth and beauty.

> And so we see Actæon, pursued by his own dogs, persecuted by his own thoughts, running and forging a new path. His strength is renewed to proceed divinely and with lighter steps... into denser thickets, into deserts, into the region of incomprehensibility.
>
> Bruno (1585) in Ordine (1996)

Of sacrifice in the pursuit of truth, no one can speak with greater authority than Bruno, whose reading of the myth proved terribly prescient.

> Here his many big dogs put him to death; here ends his life in the eyes of the mad and sensual

world of blindness and illusion, and he begins to live on the plane of the intellect; he lives the life of gods, feeds on ambrosia and becomes drunk on nectar.

> ibid.

At the heart of *La Dispersion du Fils* lie the themes central to the myth of Actaeon: metamorphosis and transcendence, the endless pursuit of impossible goals, chance and control, and persistence under change.

2.3 The Helix

The central element of the work is the *Helix*, an endless, undulating and sinuous tunnel existing in a state of eternal motion and flux.

Figure 3: The Helix

2.3.1. The path of the Helix

The Helix traces a meandering path through space, at times straight or gently curved, at others spiralling, kinked and knotted. This motion is modelled on a form of *random walk* (Pearson 1905), an iterative, stochastic process similar to the haphazard motion of a body suspended in a fluid. Known as *pedesis* or Brownian motion (R. Brown 1828)*,* its underlying atomic nature was precisely divined by Lucretius:

> For thou wilt mark here many a speck, impelled
> By viewless blows, to change its little course,
> And beaten backwards to return again,
> Hither and thither in all directions round.
>> Lucretius (60BC in Leonard 1921)

Here, it is employed to model the path of the Helix (and therefore the viewer) through space, and in doing so follow the "aimless steps" with which Actaeon wandered "the Mazes of the pathlesse Wood" on the slopes of Gargaphie (Ovid & Sandys 1632, Ovid & Kline 2000).

More precisely, the Helix follows a path that is best described by a *Lévy flight* – a class of random walk in which chaotic and meandering paths are punctuated by long, relatively true and unwavering trajectories. Such flights have been shown to well

describe the movements of the foraging animal, or an animal on the prowl in search of new quarry, having been observed in the movements of deer, bees, amoeba and albatross (Viswanathan et al. 1999), spider monkeys (Ramos-Fernandez et al. 2004), great white sharks (Sims et al. 2012) and even humans (Rhee et al. 2011, Scafetta 2011). The proposition that amoeba seek their prey in much the same manner as the great white shark is a wonderful image. In following a Lévy flight, the movements of the Helix echo that of the hunting dog – the hounds of Actaeon – as they endlessly search for their master, having unwittingly devoured him.

Figure 4: The random walk of the Helix

2.3.2. Growth and decay

The essential experience of *La Dispersion Du Fils* is a journey along and within the Helix. As the viewer advances along the Helix, its tail cracks, frays and crumbles into loose elements, which are then dispersed into the void. Meanwhile, at the head, the exact opposite occurs, as a cascade of fragments arrive from afar, drifting in to attach themselves to the leading edge of the Helix's skin. Like this, the Helix undergoes a continual process of accretion and dispersion such that, like a motionless train that travels by attaching new wagons to one end while removing wagons from the other, it can duly be described as being at once both stationary and in motion.

This opposition permits the Helix to play two very different roles in the unfolding events. As a stationary object, the Helix serves as a fixed path along which the viewer journeys. But when seen to be in motion, it becomes a vessel or host or, when seen from outside, a fellow traveller.
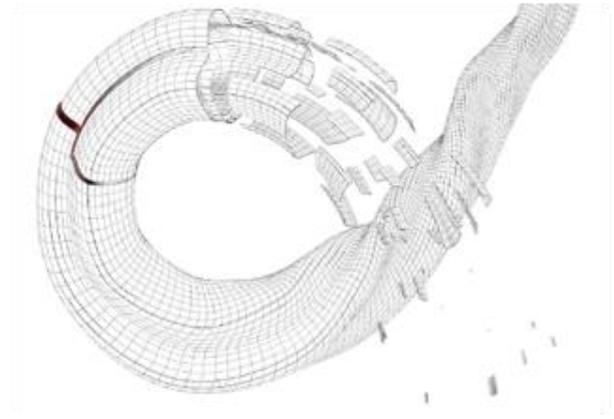

Figure 5: Accretion and dispersion at the ends of the Helix

To experience *La Dispersion Du Fils* is to travel through, and with, the Helix. To achieve this motion, the AVIE is modelled as a moving platform, with mass, stability and velocity. The AVIE is bound to follow the Helix, but the character of its motion is constantly varying. Sometimes rapid, other times slow. Sometimes tumbling, or pitching and tilting, or at other times its orientation fixed in the direction of travel. The large part of the viewer journey takes place within the Helix, but forays into the outside world occurs sporadically. Occasionally the AVIE will drift a great distance off into the void, and a distant perspective of the Helix is won.

Figure 6: The AVIE travels along and with the Helix

In this respect, the work can be considered an experiment in *vection* (the illusion of self-motion arising from visual stimuli) and perceptual rest-frames (elements in our environment that we perceive as at rest) (Prothero 1998). The system is continuously manipulating perceptual parameters known to influence these phenomena (Riecke & Schulte-Pelkum 2013), including the speed, size, frequency and rhythm of motion stimuli, translational vs. rotational motions, foreground background relationships, and transitioning from within the Helix where the entire field-of-view is engulfed in optic flow, to without, where a variety of potential rest-frames compete for purchase.
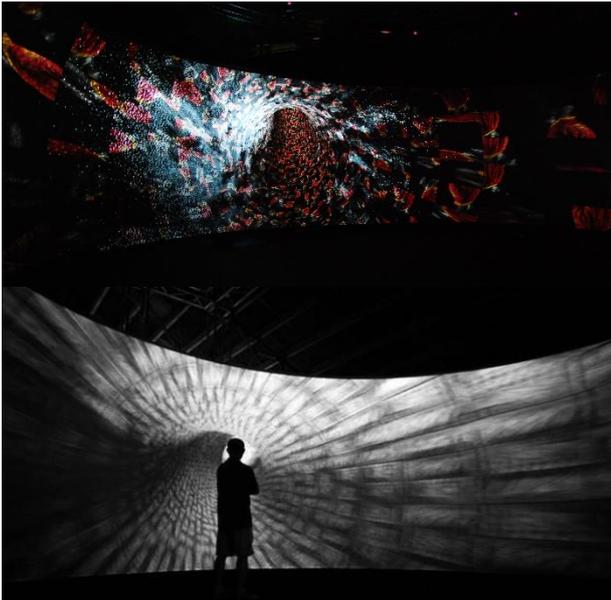
Figure 7: Views from within the Helix

2.3.3. Perception of life and attribution of mind

The skin of the Helix is perturbed on a micro-level with surface variations captured from a deer's antler. On a macro-level, a fractal noise field is used, which, when put in motion, yields rhythmic behaviours evocative of throbbing, twitching, pulsing or breathing. Travelling bulges and lumps appear like peristalsis. Movement appears anatomical, and one can almost see muscles and tendons at work. The perception of this motion as organic is immediate and direct and can be resisted no more than one can resist seeing the colour red (Troje & Basbaum 2008).

Figure 8: The surface of a deer's antler is used to perturb the surface of the virtual world

Once an entity is perceived as being animate, attribution of volition, intentionality, mood and mind follow soon after. As the seminal experiments of Heider and Simmel (1944) demonstrated with their simple animated blocks, the perception of motion as intelligent, intentional or emotional can be elicited with the barest of stimuli. Despite its alien form, the invitation to anthropomorphise (or at least zoomorphise) the Helix, and perceive in its movements the expression of sentience and will, is difficult to resist. By animating the parameters of motion over time, the Helix's behaviour ranges from tranquil to frenzied, from idle listlessness to hell-bent desire. In doing this, the Helix is given a personality. It appears to be in possession of different moods, or rather, to be possessed by different moods. The Helix, through motion, is transformed from abstract structure to the belly of an animal.

Figure 9: View from exterior

It is important to note that all of these perceived organic behaviours and outward signs of a mind or personality, are *entirely emergent*. They are not designed, and no explicit model of mood or anatomical feature exists in the code. The parameters are simply randomised, and these phenomena exist entirely in the eyes of the observer.

2.4 Spatiotemporal montage

The Helix is constructed entirely from moving images. As the viewer travels the length of the Helix, sections of the Helix are continually recycled from the tail to the head. During this stage of renewal, new images are selected from the database and mapped to the skin of the Helix.

The selection process works by forming 'probability-waves' dictating the density, number and diversity of films, orientation, size, temporal coherency of speed and phase, colour and theme. Numbers of these film-waves are superposed along the length of the Helix, such that all points on the surface of the Helix lie under two or more superposing waves. As the viewer advances and new skin elements accrete at the head of the Helix, these overlapping probability waves are 'collapsed' to assign a specific film, size, orientation, speed, phase and duration to the newly grown skin. A 'box-filling' algorithm is used to arrange films of differing sizes in a mosaic around the Helix).

In this manner, films are applied to the surface of the Helix. The result is a form of perpetually evolving tapestry of images, at times highly ordered, at others chaotic, but always in smooth transition as one wave of films gives way to another. The relative temporal synchronicity or asynchronicity of the films creates spatiotemporal rhythms, pulsations and rippling patterns across the surface of the Helix. These motions complement the already animated skin of the Helix, creating rich

visual fields of motion texture. When seen from a moving viewpoint, the effect is a form of spatiotemporal montage, as the spatial relationships between the images are transformed into temporal ones as the viewer travels along the surfaces.

Figure 10: Mapping movies to the Helix – emergent audiovisual patterns.

Each film possesses a specific sonic texture, which is also attached to the skin of the Helix. As the viewer advances along the Helix, they travel through a 3D field of sounds: a spatial-temporal composition of sound texture. The sounds are synchronised with the movies, so just as the temporal (a)synchronicities of the images creates visual patterns, here these temporal relationships form cadences and syncopations, murmurs, throbs and echoes. As the Helix bulges, ripples, curls and distends, the sounds move with it, firmly attached to the inner surface of the skin.

The result is a form of algorithmic composition created and experienced by ego-motion. When heard through the spatial sound system of the AVIE, the sound field has a tangible structure, and the sounds can be heard from afar and receding into the distance, giving the viewer an impression of their velocity. When the Helix curls in on itself, its structure can be heard through the walls of the Helix, as the future and past of the traveller's path pass within ear shot of the present.

In constructing 3D structures from 2D images, the difference between perception of images and perception of space is thrown into stark relief. The 3D structures are perceived as *immediately present*, as ready at hand, occupying space and possessing mass, momentum and substance. Here, the spatial sound helps enormously to solidify their materiality and physicality. They are very much the *here* and *now*. In contrast, the scenes depicted *within* the images are experienced as remote and removed; as mediations or representations of distant or long-passed events. They have lost their immediacy.

2.5 Dispersion of the Helix

The fragmentation of Helix is not limited to the head and tail. From time to time, the Helix may enter states of high fragmentation, in which the entire skin, or portions of it, cracks a little, or splinters or shreds, to reveal a world beyond the Helix. From time to time, the viewers are delivered by the Helix to one of a number of 'landscapes' representing different thematic elements of the myth: the hounds of Actaeon scouring the slopes of Gargaphie, Diana as the goddess of change and infinite mutability, the terrible muteness of Actaeon's transfiguration, the heliacal rising of Sirius the dog star.
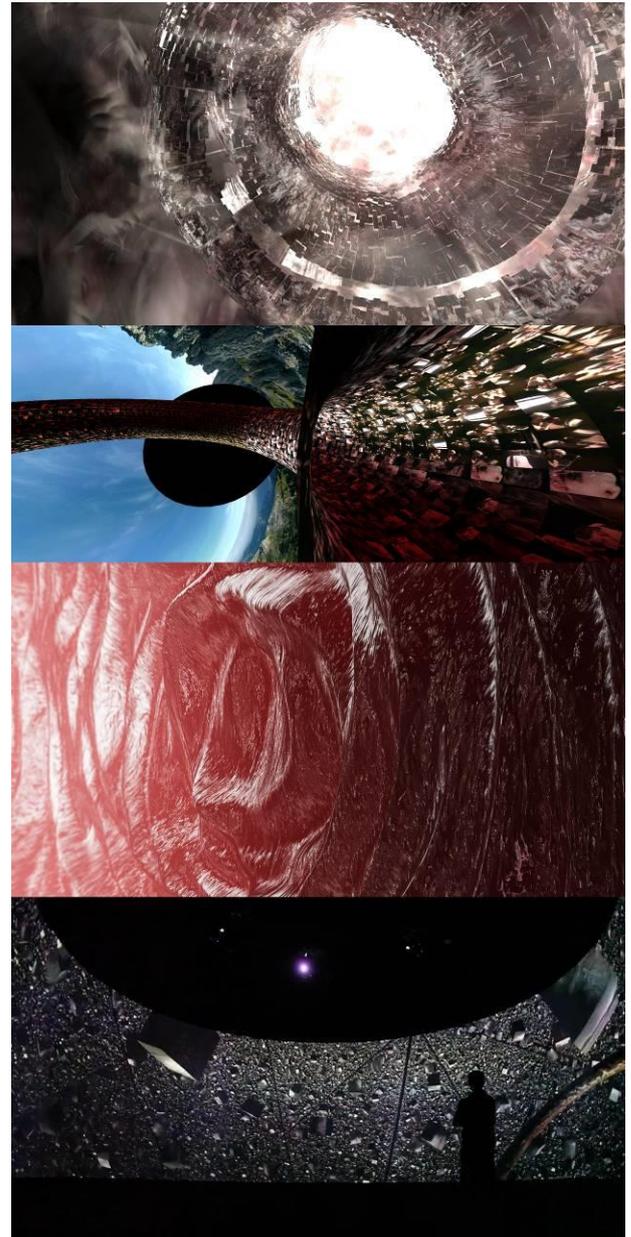

Figure 11: example 'landscapes' – Canicula Gargaphie, VøSPAZÀR, Forest

2.6 Interactivity

The initial version of the work exhibited in 2008 supported interactivity, by using a visual tracking system to map the movements of the viewers to the movements of the AVIE and/or the virtual world. Various interaction strategies were examined, from mapping group properties (for example the collective speed, centre of mass, density and uniformity) of the audience to such things as the speed and trajectory of the AVIE or the Helix, to giving individuals a means of 'taking control' of various aspects of the system.

However, after much experimentation and testing, all interactivity was abandoned, having been found to have an overwhelming destructive effect on the immersive and aesthetic qualities of the work. The reasons for this are numerous, but two are worth listing here. Firstly, being a multi-user experience, it proved difficult to find strategies that give rise, for all viewers, to the direct *perception of causality* between their actions and events (Michotte 1963). Without the perception of causality, a sense of agency becomes elusive, and this was seen to produce either a sense of frustration or confusion, or a period of 'puzzle-solving', in which the viewer devotes their energies to trying to uncover the causal connections between their actions and the world. Secondly, inviting the viewer to consciously and intentionally interact with the virtual world demands of the viewer some *role* in the unfolding narrative. With *La Dispersion Du Fils*, however, there is no role for the audience; the audience within the universe of *La Dispersion Du Fils* exist entirely as observers. Demanding an audience exercise their powers of causality without providing explicit roles or goals was observed to have a single outcome – the viewers made a *game* of it. To grant a sense of agency in a virtual world is to beg the question of one's role in that world, and this must be answered in a meaningful way.

2.7 Metamorphosis

The artwork is computed in real-time, using iterative algorithms with chaotic behaviours. Furthermore, the many parameters determining the movements, appearance and evolution of the system are themselves in continual motion, also following chaotic trajectories. The result is a world of permanent metamorphosis. The parameter space has a sufficiently high dimensionality to guarantee that no particular state will ever be visited twice, and that the same path through this space will ever be taken twice. The work never ends nor repeats. Any given moment is guaranteed to *never be witnessed again*, and of all the possible states the system might assume, most will never be seen at all.

The journey of the viewer now occurs on multiple planes. On the physical plane, they are free to move within the theatre. One the perceptual plane, they are winding through the Helix. Yet, on the narrative plane, they are weaving a path through the filmic database of the LFKs. And, finally, in parameter space, they are traveling through the space of all possible forms.

At first attempt, one might hope to construct a system where, for all possible paths through parameter space, the resulting visible world is always 'well-behaved'. But can such a system permit genuine discovery of novel forms? The position taken here is that risk is a *necessary element* in any artistic endeavour. To discover the islands in parameter space that give rise to true wonder, we must be prepared to sail the seas of incoherence. Like Bruno, we must be prepared to travel "into denser thickets, into deserts, into the regions of incomprehensibility."

For a much lengthier discussion of the topics addressed here, and others, see McGinity (2014).

3. ACKNOWLEDGMENTS

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