# The Future of the Moving Image

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**Abstract**

Whilst at the Universities of Bristol and the West of England, in collaboration with BBC R&D, I have been responsible for the production of the first higher dynamic range, higher resolution and higher frame rate experiments to measure which combination of these developing parameters of image capture and display best engages the audience. What is essentially happening here is the mapping of the capabilities of imagining equipment to the sensory levels of the eye/brain pathway. But what do the expanding parameters of the digitally captured moving image mean to the viewer and how will this affect future patterns of production, consumption and understanding of moving images?

**Keywords:** Resolution, Frame Rate, Dynamic Range, Electronic Digital Cinematography.

We now have greater enhancements to our computational abilities that allow us to 'uplevel' the parameters we are testing and more importantly, this increase in itself speaks of what is to come. Our tests have revealed the creation of a sense of depth, without sensory tricks such as binolcular stereopsis, which is reliant on the eye tricking the brain to produce depth. However, trying to predict where technical and aesthetic developments will lead us does a disservice to the subject area. To more fully explore the importance of these developments, in this paper I attempt to explore the narrative that underlies Cognitive Neuroscience as a descriptor that may reveal the nature of that which looks, as being as important as that which is looked at.

Walter Benjamin said:

> "The camera introduces us to unconscious optics as does psychoanalysis to unconscious impulses" [1]

If this was thought to be true in the analogue age, in the digital age we might ask: What do new forms of capture and display reveal about our unconscious state? Moore's Law, when applied to the developing process of electronic or digital image capture, creates as profound a change as the invention of slow-motion in Benjamin's day. Increased capture quality and speed, handling and display of data, and the dissipation of bottlenecks in data flow, open new possibilities for how and why images are captured and displayed.

However, there is an underlying conviction in this research that something will be revealed about how these accelerations perturbate or excite the human perceptual system. Traditional forms of exhibition are already accommodating these developments with 4k projector systems, delivery of higher resolution television via terrestrial digital and higher resolution narrowcasting via the internet. Business as usual: but what might this all mean for image making and their consumption outside commercial circuits?

New interfaces are already being designed to control high-resolution, high-frequency images and new research is being undertaken to explore the relationship between humans and their works. What does this mean for the electronic arts community and on a wider level, human development?

## Argument

We've now entered an era of electronic capture in preference to photo-chemical capture. One of the paradoxes of Digital Cinematography is that in some senses it has greater similarities to photo-chemical film than digital video or televisual forms.

> "The historically determined optical pathway of digital cinematographic cameras is 35mm or above, and its images are reconstructed from a progressively based, lossless data flow, with one full frame of information at a time. It holds the image in a latent state until it is rendered (or 'developed'), but unlike film, its materialisation is non-destructive of its prior material state. However unlike film, its inception as an image capture mechanism is no longer its sole intent as a medium" [2].

The last point is perhaps the most important. For instance, with the use of two triangulated camera's photo-site grids, we can map 3D space in real Time. Recently we've seen the development of the Kinect but the singular vantage point is problematic in terms of accuracy. Some years ago (around 2008) I saw Studio Azzurro's two camera mapping system in action and was amazed at how little latency and how much accuracy there was in their system. Mapping space will allow us to create defined regions of space with greater and greater resolutions. This idea requires extremely fine tuning of the above triangulation, with high degrees of resolution, plus an auto correction of each partition in computer space to correlate with its position in actual space. However, it seems to me, the conception and manufacture of such a thing is within our grasp. If we can accurately map 3D space then we can create events in a location with gesticulation or voice and therefore trigger events. But not only this, that location could then be mapped over a distant and enabled space, so that events could be created there.

Furthering the above ideas with 'White Light Interferometric Scanning' we should be able to capture spatial images for 3D printing (White light interferometry is an extension of triangulation which can create extremely accurate measurements of X, Y and Z co-ordinates). Further, at a lab at ETH in Zurich in 2010 I was shown lenticular holographic images of a cup and then asked to reach out and 'touch' the cup which I did. The explanation of my sense of 'touching' was that a puff of compressed air had met my finger at the perimeter of the image. The research team had worked on the hypothesis that if a *sufficient* percentage of the brain was involved in one sense, then 10 % of engagement of another sense could convince the brain that the object was 'real' as two senses had confirmed its existence. Lastly, and using the camera more traditionally, we should be able to create images with enough resolution for very large displays. *If* large surfaces can be enabled to carry images then using a suitable material a building could be covered with an image. Building textures could be changed as clothes are changed.

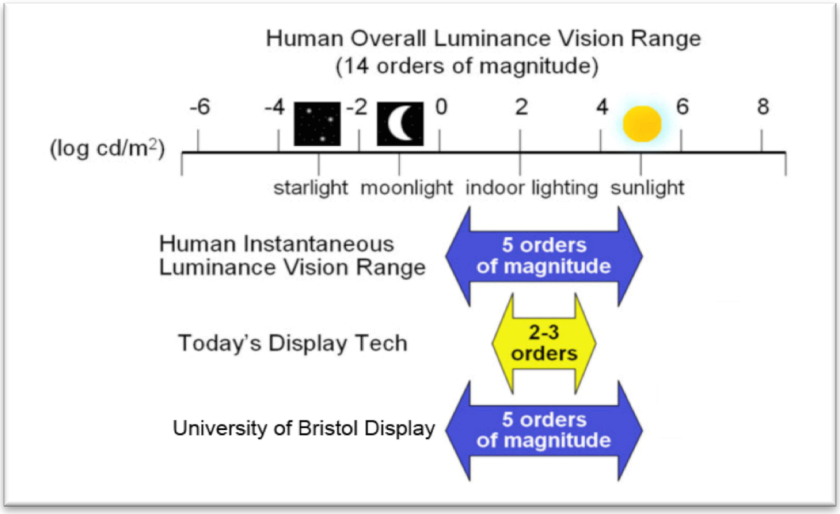
## Current Research

At University of the West of England, the center for Data Imaging Research in Electronic Cinematography and Transmedia (DIRECT) will be examining these developments. In collaboration with University of Bristol, my current research strategy now centers on our physiological specificity. I've been working with Professor Dave Bull of Faculty of Engineering and Professor Iain Gilchrist of Department of Experimental Psychology in partnership with Marc Price, a Senior BBC R&D Engineer to examine the immersive qualities of a combination of higher frame rate, higher resolution and higher dynamic range images. In November 2012 we completed the first test shoot for this level of motion image production (50 frames per second and 200 fps), the results of which will be published in a BBC White Paper, September 2013 [3].

If you look at this diagram (Figure 1), it shows that the human eye/brain pathway uses 5 of a 14 order of magnitude scale, sliding this instantaneous facility up and down the scale to deal with starlight at one end and desert sun at the other.

All contemporary displays currently show between 2 – 3 orders of this scale, however we now have a prototype which displays 5 orders. Coincident with this, the BBC in turn have created a 200 frame per second projection system.

**Figure 1: Human Overall Luminance Range. © Flaxton**




By combining variants of frame rate, resolution and dynamic range, we should be able to effectively produce 'the perfect picture'. By calibrating these different parameters to produce a combination that best resonates with our eye/brain pathway, the proposition is that if we can manipulate *all* the factors of the construction of the digital image then conscious immersion may follow.

So far we have built the immersion lab and experiments have matured a post-production pathway to the point that higher dynamic range moving images can be displayed on an HDR display, but we need to refine the process so that true colour rendition also accompanies the so far discoloured images.

## Developing the argument with the help of cognitive neuroscience

At this point in time, questions of 'what next on the horizon' do the subject an injustice. That we are interested in expanded parameters of the moving image simply as a product of 'scientific' curiosity is misplaced. Cognitive neuroscience provides us with an idea of the nature of the paradigm change we are undergoing to accompany the invention of the digital. The narrative that develops places the emphasis on what is looking rather than what is being looked at and by whom, and so comes to rest on the nature of the sensorium that is gazing at the moving image - and not the technical construction of the moving image itself.

Within this narrative, cognitive neuroscientists argue that mammals and possibly all animate creatures have within their minds a precise internal map of their immediate environment; that each creature can only maneuver within their world by first imaginatively representing their intentions in that world as a rehearsal for action. I would now like to concentrate on the work of Emeritus Professor Merlin Donald, Queen's University, Ontario, due to his having written the 'go-to' book on the subject in 1991, *Origins of the Modern Mind* [4]. Further quotes I make will be from later editions and papers.

Donald argues that being in the world is an aspect of mind and that human communication developed through three scaffolded phases, built one upon another. He further argues that:

> "Because evolution is conservative, the modern mind retains all previous stages within its complex structure" [5].

Donald argues that the *mimetic*, the first stage of development, came when, say, an ape saw a group of other apes in the distance and came down from her perch in the tree canopy to tell her fellow apes what she'd experienced in her world picture:

> "The Mimetic Domain comprises gesturing, pantomime, dance, visual analogy, and ritual, which evolved early and formed an archaic layer of culture; based mostly on action-metaphor. Mimesis allowed for the spread of tool-making technology and fire-tending, through imitation and ritual." [6]

In telling her tale, she and her watchers physically developed a sympathetic mirror-neuron system so that we primates can empathise with each other's experience. Then, as recently as 150,000 years ago, homids developed larynxes suitable to accurately render and replicate sounds which become more specific than pantomime in conveying details of the world. In uttering controlled sounds, she has changed the physical construction of her own brain and skull. This is Donald's second stage. He argues:

> "Mythic culture is based upon spoken language, and especially on the natural social product of language: Storytelling. Mythic Culture, retains a subsidiary mimetic dimension, manifested in ritual costume and gesture, which is then epitomized in various forms of art". [7]

Here, we can easily see the nascent seeds of theatre, cinema and television – and all their digital grandchildren.

The third stage, the Theoretic, began 10,000 years ago when the hunter/gatherer settled down to farm. The mythic period had become so sophisticated that descriptions of the world were taken up by specialised members of the tribe, such as Shamans, who were the beginnings of the bureaucracy of a priestly class.

There were also accompanying physiological developments as the brain developed to deal with audio culture, which needed more memory storage. Neuroscientists postulate the existence of Engrams – sites within the brain where long-term retention of different kinds of memory are stored.

Though these physiological developments had begun at the beginning of the Mythic period, it was now refined and echoed by one more physical and material development in the real world, Exograms. Certain neuroscientists suggest that an Exogram is a site outside of oneself where memory can be stored and which then stimulates memory recall: Stonehenge for instance, or a book, or an artwork. Next the third stage arrived:

> "It started very slowly with the emergence of sophisticated writing technologies and scientific instruments, and then, after a long gestation period, became dominant in Western Society after the enlightenment" [8].

Theoretic Culture is symbol based, logical, bureaucratic, and heavily dependent on external memory devices, such as writing, codices, mathematical notations, books - and computers. As theoretic culture develops, internal memory is becoming less important as we externalise our inner selves and remake the world in our own image. Donald continues by saying that theoretic culture and language is still a minority culture that is:

> "disproportionately influential because of its place in the *distributed* cognitive systems that determine such things as our collective representation of the past and our tribal and class identities" [9].

Extrapolating from the idea of a scaffolded evolution, it is now possible to postulate that we are on the edge of a paradigm change and that such change comes when the fundamentally conservative tendencies of evolution can be seen, *metacognitively* speaking, as inhibiting the progress of the species.

Because we have digested the lessons of the theoretic through the Victorian cataloguing and indexing period, we can now understand that innovation is important as it rewires brain pathways, a process which then leads us to experience a sense of comfortableness with very high speeds of change.

*Velocitisation*, my term for the fourth stage of change, is a means by which we reach back into the picture that mammals have created in their heads *and change it*. In this stage we are manifesting outwardly the most important Exogram of all: *Data*. This development has raced through species' consciousness through virally communicated mimes (ideas distributed through mimetic behavior), exemplified recently in the Harlem shake. This itself is a kinetic moving-image cognitive neural exchange which has been transmitted through YouTube™ , itself a cognitive distributive exchange network.

In this mimetic communication, one person expresses difference, and then at an appropriate point all express a response *differently*: In doing this we mimetically express what velocitisation means to us, together, as a common understanding. Velocitisation can be understood through Donald's reflections on the digital period:

> "In other words, the best exographic systems reduce the load on the brain by simplifying some operations, and designing the interface technology so as to focus the mind on a task relevant issue. The juxtaposition of mind and exogram quite literally changes the nature of the task facing the brain. By achieving this kind of redesign, mathematical operations that might have required genius level skills can be rendered accessible to a multitude of less-talented people. While it is still the human observer who makes decisions and judgments with regard to thought and action, it seems that the exographic revolution – the exporting of the human memory record from brains to exographic media – is almost complete". [10]

Here Donald echoes arguments that the professionalization of software programs delivers professionalization to the user of those programs – thus velocitising their behaviour. In this process, which has in turn been both celebrated and lamented, one thing is clear at least in terms of the cognitive neuroscientific narrative: this grand human project, to become at one with reality by utilising our prior sense of otherness, takes hold of the problem of existentialism and reconnects us with our environment in a surprising way. As Donald writes:

> "This process has undoubtedly accelerated the long-standing symbiosis of the brain with the external symbolic world it has created, and put pressure on the young to assimilate more and more technologies. There is no longer any doubt that this symbiosis of brain with communications technology has a massive impact on cortical epigenesis and, with the rise of mass literacy, that this effect is present in a very large percentage of the human population. The driver of this increasingly rapid rate of change, human culture, can be regarded as a gigantic search engine that seeks out and selects the kinds of brains and minds it needs at a given historical moment" [11].

In this statement Donald for the first time goes beyond the boundaries of the terms of the scientific project: there are echoes of both Darwinist and Gnostic sentiments in the above statement. The Darwinist can be seen in the use of the concept of natural selection, yet this is balanced by the belief that reality can be changed through faith – that mountains can and will be moved by the interior spirit of human sentience. As he writes:

> "Whether viewed in terms of the functional Architecture of the brain, or the larger cognitive capacities of the human species, the trend toward externalizing memory and restructuring the larger social-cognitive system has generated a radical change in the intellectual powers collectively at the disposal of humankind" [12].

The original proposition that all sentient creatures create a version of reality in their own mind is now being changed by the externalisation of our world picture. Our exograms are themselves developing to merge with our internal constructs, as the more we reflect on them, the more we physically re-create them and thus in this democratized, creative and innovatory behavior we go beyond the need for theoretic intervention. The position of the artist or shaman is now available to all:

> "Surveyed as a whole the domains of art ultimately reflect the entire structure of the human cognitive-cultural system" [13].

Donald furnishes us with our most profound rebuttal to the governmental (theoretic) argument that the scientist or engineer is understandable in his or her benefit to the community because they build bridges across ravines for us to get to the other side. In the light of that idea, what do we as artists contribute? Within the cognitive neuroscientific narrative we can confidently answer: the reason we want to cross the ravine at all, is because our basic internal motivation is that of being curious about the world – *Wonder is our response as it is our internal developmental state that powers our desire to cross the ravine*.

## Conclusion

The point of examining at length the cognitive-neuroscientific worldview, in this case through the work of Merlin Donald, is that should our theoretic minds grasp at instrumentalised notions of cognitive-neuroscientific methodology to solve the evaluative needs of subject areas, we may simply replicate previous blindspots of theoretic behaviour. The use of what the cognitive neuroscientist might identify as a third stage cognitive construct - which itself contains a commitment to materialistic progress - will not necessarily deliver a fourth stage solution which deals with a combined engrammatic and exographic reality, where the boundaries of the material and the virtual are blurred.

Of course if as researchers we already subscribe to the idea of the substantiality of the world, a world without porous boundaries, then it will remain to others to debate the idea, because in the end unspoken and undeclared interests do not chime in academic, scholarly and theoretic disciplines.

I have been careful in my own work on the expanding parameters of the moving image, to recognize that often simply accumulating details of a process only allows *circumstantial* evidence to be produced which lead to implied truths. That measurable results imply correlations is no real evidence at all. It was for that reason that I called the first HDR movie we made: 'The Human Condition' as a grand and therefore ironic overstatement of the value of our experiment.

It would be prudent for every audience member, every creator and cinematographer, every theoretician, to now recognise the *concept* of the flowing together of both Exographic and Engramatic forms of cognitive neural behavior, because it is a useful metaphor to work with in developing new theoretical positions with regard what moving images actually do for us as a species. Whether viewed in terms of the functional architecture of the brain, or the larger cognitive capacities of the human species, the trend toward externalizing memory and restructuring the larger social-cognitive system in any form of sense-related behavior will continue at a pace. If correct, the notion of externalization and development will generate radical changes in the intellectual powers collectively at our disposal, which in turn will help renovate and renew the human condition. It would also be prudent to thoroughly question that concept too.

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