

THE PRACTICE OF KNOWLEDGE EXCHANGE

This article will appear in shortened form in the Journal of Media Practice Autumn 2013, meanwhile this longer version will remain available until replaced by the peer-reviewed article. It covers the entire AHRC Knowledge Transfer Fellowship between September 2010 and End November 2012.

ABSTRACT (260 words)

Knowledge Exchange has been a buzz-phrase with the UK research councils for several years now. Initially this practice was called Knowledge Transfer until it was realised that that description was one-way only and that academia might in fact learn something from industry. After 25 years as a professional cinematographer in 2007 Terry Flaxton first won an AHRC Creative Research Fellowship that focused on high resolution imaging and how that might affect the production of art and then in 2010 Flaxton won an AHRC Knowledge Transfer Fellowship which completed at the end of November 2012.

Flaxton's first fellowship required a practitioner to turn their creative acts into research – with all the problems and opportunities that entailed - as many involved in practice as research understand. The second fellowship then asked for a distillation of knowledge gained from that research and production of 'research artefacts' (cinematic installations and artworks) and the dissemination and exchange of the new knowledge gained with the Creative Industries of the UK. But just how much of the research council's initiative was simply a 'buzz-phrase?' Just how much was effective research knowledge exchanged with communities - that themselves were *not* research oriented - and was there in fact a two-way exchange at all?

In this article Flaxton summarises his experience and the research area in general and discusses whether 'Practice as Research' is still an active and appropriate form that is 'fit for purpose' and whether or not the practice of Knowledge Exchange is itself an appropriate definition of what happens between academia and the commercial sector?

KEYWORDS

Knowledge Exchange, Digital Cinematography, Practice,

INTRODUCTION

Whilst with University of Bristol as a Senior Research Fellow, during the period September 2010 – November 2012, I won an AHRC Knowledge Transfer Fellowship (KTF) and successfully argued for the provision of a Red One Camera for the duration of the fellowship. This happened before the rise of Alexa and though certain drama Director's of Photography have now championed its use – notably Roger Deakins with his use of it on Skyfall - there is a 50/50 split between Alexa and the Epic (as can be seen with Ridley Scott's use of the Epic on Prometheus and Peter Jackson on the Hobbit). Regardless of brand loyalty, the point is that these are Digital Cinematography cameras (effectively delivering data rather than images) and they have a set of parameters that distinguishes them from Digital Video Cameras. In some ways it could be argued that they share more in common with 35mm film, than digital video – but I'll go into that later.

PRACTICE AS A DIRECTOR OF PHOTOGRAPHY

In trying to formulate a schedule of behaviour to deliver the knowledge I had gained during the three year UK Arts and Humanities Creative Research Fellowship that preceded my Knowledge Transfer Fellowship (2007 - 2010) I built upon my experience and 25 year grasp of Cinematography and its associated practices: no cinematographer can proceed in their task without an understanding of script writing, art direction, direction itself and a myriad other forms of practical behaviour that encompass real-world filmmaking knowledge. I also had a much longer involvement in the production of video art, plus a 10 year period of producing programmes for UK television, from documentaries to dramas, from satellite events to live studio work. My Creative Research Fellowship then focused on a long-held interest in the development of electronic imaging as I had entered the image-making world at the point that analogue video became available with the black and white half-inch tape-based Sony Portapak; through the arrival of colour video, then shooting one of the first video to film theatrical releases in 1987; I was around during the development of analogue HD systems (Philip's 1250 line MAC system) into the change from analogue to digital and DV, through the introduction of the Japanese 1080 line system where I had created early HD to film-out tests (1999), along the torturous path out of the compressed to uncompressed data era of Electronic Cinematography and finally into the arrival of the new form of 'Digital Cinematography', until one of the latest phases: the arrival of the Academy Colour Encoding System. ^{*1}

As my subject area of Knowledge Exchange was with the media industry, independent sector and educational institutions of the UK, I decided my schedule would encompass workshops, surgeries, the maintenance of online resources of interviews with people within the area of Digital Cinematography as well as gathering text based resources together, the creation of a symposium on the subject area and that at some time in the future I would begin a UK survey that would list access to Digital Cinematography equipment. Surgeries were un-evaluatable as a resource as fairly soon I made my telephone number and email address available and had many meetings throughout the two-year period to discuss specific projects and advise individuals and productions on pathways of production –these were so diverse they were beyond a standard set of questions that would

reveal a worthwhile conclusion. In one case I ended up shooting a project rather than just advising on it. In agreement with my two partners, the Watershed Media Center (Bristol) and South West Screen (now reformulated as Creative England) I also prepared a document titled: ‘Notes on Digital Workflows’^{*2}. In this document I tried to dispel the disinformation I had encountered both in HEI’s and in industry on the nature of Digital Cinematography.

RESEARCH ORIENTATION PRECEEDING THE KTF

To create a framework for the Knowledge Exchange that would occur in my fellowship I had once more to reflect on what I have been, am and will be. So, having been an artist and Cinematographer for 25 years, the aim of my previous fellowship was to investigate through practice and critical reflection what is happening to the audience gaze as it shifts from the analogue to the digital and on to higher resolutions.

In creating and staging my work I have noticed, reflected and written about a phenomenon that repeatedly occurs: as resolution increases so audience engagement deepens as the resolution of the work is increased – the measurement of this was the increased time people remain with the research artworks I had created to test the hypothesis. By the end of the fellowship I had created around 30 new works. This was never to be a ‘scientific’ test, more it was to allow me insight into people’s behaviour around new imaging media^{*3}.

Investigating this issue also provided a strategy of looking into the development of Digital Technologies and how the velocitization of innovation is affecting everything we know, but which has previously been framed through 600 years of text based behaviour and if David Hockney is right, accompanied during the same period with by a single lens viewpoint (through first the Camera Lucida, the telescope and finally photography, television and cinematography).

“It is perfectly clear that some artists used optics directly and others did not, although after 1500 almost all seem to have been influenced by the tonalities, shading and colours found in the optical projection”,^{*4}.

Hockney’s research has altered the history of the image so that we now know that our received notions of ‘perspective’ and ‘colour’ amongst other elements of visual composition are conditional on the use of a monocular lens. Hockney argues that prior to the use of the lens, visual imagination depicted a world with parameters derived from societal and religious demands. This employment to make images of the world came from patrons – employers with specific demands. Like all things art requires a market place to fund the survival of the artist; with the invention of new technologies through lens and mirror, greater degrees of verisimilitude of representing what lie before the artist were invented - which would be paid for by patrons. The artists that had this advantage would win commissions but keep the techniques secret. Hockney further argues, that with the invention of photography, artists were then freed to pursue other than a correct reproduction of the world, that artists could then revert to binocular stereopsis – the use of

two eyes rather than one.

He argues that a movement like cubism, for instance, could reflect the artists experience of the 3 dimensionality of the world – where 3Dimensions were also accompanied by a 4th, time, which enabled at first a multi-faceted rendition of the artists experience, followed by every kind of synesthetic metaphor, analogy, synonym and interpretation of colour, texture, space, time, form, to finally arrive at conceptual art as a means of deriving an experiential visual metonym for our ontological state. Simply put the artists two eyes were liberated because they connect directly with the brain in a crossover manner: the left eye is connected with the right brain and the right eye is connected with the left brain. With the advent of photography we no longer had to be dominated with a right eye, left brain highly ratiocinatory view of the world – which Professor Iain Gilchrist of All Souls Oxford argues is now the accepted dominant worldview of Western Civilisation^{*5}. So accompanying this monocular period almost exactly, the development of the ability to mechanically reproduce and disseminate printed text determined a highly ratiocinatory as opposed to right-brain left eye view – and text became the dominant form for scholastic or academic authentication and verification of ‘fact’ or ‘truth’.

True, you're reading this right now - but 'reading' has many forms and it's my conviction (and it powers my research), that the human gaze employs many strategies to examine the world and that the gaze itself is energetic. Chomsky speaks about language and thought and their co-dependent arising, but concomitant with these is the energy of the gaze which it seems to me after much reflection, is a bi-directional energy, which of course compounds, at least metaphorically, the co-dependence of thought and language. Today's screen and yesterday's cave wall were both mediators of two time periods: 'now' and 'before'. Digital Cinematography, partly because it is a way of enabling images to appear on the screen, is a mediator of both timezones. It seems to me to be a tool, if used as a metaphor, for whatever the human gaze is currently developing as a strategy to define our ontological state.

A DEVELOPMENT OF THE MONOCULAR GAZE

Digital Cinematography does not just capture images and it can actually desist in its two dimensional gaze – it can capture spatial information using a kind of ‘sonar’ to create a 25 frame per second rendition of the world. Resolution has to be a factor in this of course, and with High Definition, were one looking at a face, then the ‘relevant’ spatial information would immediately be apparent – but if one were viewing a landscape from 5 miles above, then the detail would not be sufficient if one wanted to chart the progress of a mole for instance, within a garden. A common shorthand for HD is 2k because HD is 1920 x 1080 lines, then 1920 is close to 2000: which can be written as ‘2k’. What would we need to see that mole in a 3 dimensional manner? We would require at least 128k (or even 256k) and a huge amount of computing power and storage (dependent on a large set of parameters).

Arguably, digital technologies are simply analog technologies enhanced by vastly increased computational powers, which simply decrease the time a ‘gesture of

requirement' is made and its computational answer is received. This loose definition should also take on the changes in the qualitative nature of the 'answer' as exerted by velocitization. This may be a clue to the nature of Digitality. Viewed this way, quantum computational techniques will also further enhance digital computation – with all the drawbacks *and* benefits of increased velocitization, but the changes that the qualitative nature of the information generated will be similar to the relationship between the conceptualisation of the real world and the quantum world. Put another way, given that quantum computation requires not only 'yes' or 'no' gates, but also 'maybe' gates and equally, 'not' gates, computational answers will be conditional upon interpretation. This computational state is very similar Nargajuna the Buddhist philosopher's argument (and I paraphrase): Neither this, nor that, nor both, and neither. Reaching back a short while, Lewis Carroll's *Alice in Wonderland* may be a very good description of the kind of perception of knowledge that will be required when negotiating the quantum computational landscape and the knowledge that it affords (after all, 'Lewis Carroll' is not a 'real' person).

So, in looking at what knowledge might have been gained in relating to the production of data that can be reassembled as an image, one has to be mindful that data itself, in its mathematical formulation, is simply one, potentially of many, definitions of 'data'.

Nature itself has already revealed ways of encoding data biologically and digital storage is simply a first step towards our understanding of how to store information. This metaphor itself is a way of understanding how the world, its image and we ourselves are within a complex transformative relationship as opposed to a fixed system of understanding – so *we* may have a relationship to the storage of information that changes the nature of that information. This latter is a model where both empirical and cognizant sensoria, are bound together as one. So, though I'm interested in both the technology and aesthetics of developing digitality - I am also concerned with the situation we find ourselves within, and how technology and art can reveal something of that state. In terms of knowledge exchange this would have to be the underlying meta-meaning of my fellowship and reveal itself specifically within a one-day practical workshop that delivered artistic, professional and engineering information. I decided that the teaching of the understanding of Digital Cinematography could be an intimation of the greater landscape that could be viewed if one realised there were an entire landscape to be seen.

TRANSCERENCE OR EXCHANGE?

In writing this, in terms of digital cinematography, I am aware that knowledge about Digital Cinematography, which is *apparently* now in the common domain but was in the past, the very recent past, truly esoteric knowledge. But unless people are using this new equipment 'in anger', that is on projects where you simply have to get it right or you get sacked – then there are still huge amounts of disinformation to be found flowing and consumed with a Bacchanalian pleasure in many sectors of engagement with this equipment. A certain aspect of that knowledge is held within the higher-end productions as typified by feature films like 'The Hobbit', but that level is unobtainable by the limited

productions of either television, or educational work. Television requires a robust pathway that technicians know will eventually deliver a highly compressed signal for transmission and there's a certain amount that can be got away with that is not possible at the cinema level. However, industry does not stop and critically reflect on its behaviour so it is important that academia speaks to this lack – but I believe industry should be involved in the articulation of that state because it experiences what theoreticians guess at and if a proper exchange were to take place, then the gain would be both for academia and industry alike. This then would truly be 'exchange'.

CRITERIA FOR DEFINING DIGITAL CINEMATOGRAPHY

Until recently many manufacturers used chips of around half to two thirds of an inch size. This Charge Couple Device (CCD) size was similar to the optical pathway of early television plumbicon tubes that corresponded to the same optical pathway of 16mm film. This characteristically generates a large depth of field. Each camera used three chips to derive the three colours from which a colour image could be reconstructed. When Red introduced the Red One, it began with a single 35mm sized single CMOS (Complimentary Metal-Oxide-Semiconductor) that used a Bayer filter to extract colour information. Bryce Bayer invented this system for Eastman Kodak in 1976 – primarily to extract information from scanned film images. 35mm has an area four times the area of 16mm film – as early industrial processes took the 35mm film strip and split it down the middle (the first 17.5mm camera appeared in 1899 and split once more for 9mm, 8.5 or 8mm film).

With the above in mind here is what I consider to be the governing and defining principles for Digital or Data Cinematography:

- a) the optical pathway is 35mm or above (derived from technical and industrial limitations possible at the time of origination for manufacturing photo-chemical negative).
- b) DC generates a progressively based non-compressed data/image flow relating to a specific time-base as opposed to an interlaced image flow characteristic of video (one full frame of information at a time rather than a field-based workflow)
- c) like one of its predecessors, film, DC holds the image in a latent state until an act of development (or rendering) is applied - *but unlike film* - is non-destructive of its prior material state
- d) DC's capture mechanism though generating a nondestructive, *non-compressed* data pathway from which an image can be reconstructed, is not its sole intent as a medium or method of capture (but is distinguished from digital video, the sole intent of which is to generate images in a compressed manner from less than 35mm optical pathways)

These latter three qualities are also base characteristics of many developing digital technologies – for instance real-time mapping of environments requires a capture of infra-

red imaging sources (cameras used as sonar devices) running at or above 25 fps. Using this criteria, digital cinematography is about more than just capturing images - it's a portal onto the digital landscape so far unexplored due to its apparent function as an image capture medium.

CREATING A KNOWLEDGE SYSTEM

When I became a Knowledge Transfer fellow on September 1st 2010, I decided I would take my time and try to understand what needed to happen. Knowledge Transfer was a new UK Research Council Strategy and initially I had to come to terms with certain propositions from the Arts and Humanities Research Council – one of which stated that no new research was to be done. I'm an inveterate maker, I can't help but turn ideas into moving image projects and I wasn't going to begin abstaining at the start of my KT Fellowship. Previously I had had to teach myself to make art with one part of my self and then critically reflect upon it with another part – an intellectual version of Gollum. In three years of practice as research I feel I had successfully begun to cognize the nature of this form – even though for a while after, I deliberated on the issues that separated the two. By 'cognize' I mean the state where what you 'do', is what you've previously understood.

Within academia the belief that complex language can better reveal specific meaning, because it is *efficient* as it utilises short cuts through the employment of meta-language, is broadly held. 'To be precise' is the intent and that precision should reveal meaning. But Knowledge Exchange requires a departure from this lingua franca and the landscape that one enters when heading out of a university has many features – one thinks one knows that landscape and it seems so familiar, but only when the journey begins do you realise that you need a Stalker to guide you, as everything is not as it seems. Academic language is shunned for the use of common language. People seem to not want the level of detail of articulation that academics enjoy. But the idea that the outside world is simpler is an idea that soon becomes disrupted, as people outside academia are as complex as those inside, and there's a low tolerance for descriptions that do not 'cut to the chase'. Outside, complexity comes in expression, in gesture, in pauses, in other languages than word-based language.

The idea of research suggests that one has an absence of knowledge that can be gained if a dominant and recognised scientific methodology is utilized. This methodology posits an initial hypothesis that may be examined experimentally, then checked. This didn't quite fit with the production of art as the artist looks inwards to find their knowledge, to internally reveal it, yet the gaining of scientific knowledge posits that knowledge comes from without. It's the old conundrum of a priori and a posteriori. 'Do I discover knowledge from without or reveal already held knowledge within?' This second proposition is not so daft as it seems. The construction of our physical selves has developed over time, our sensorium is constructed from the very same stuff that we use to apprehend and interact with in the world.

When the arguments around a priori and a posteriori, were first constructed we had to have

faith in some things we now ‘know’. What we know is that, in an empirical way, we are not apart from the world – we are of it. There are no gods separate from us -not that the ancients especially believed this, but as in ‘The Screwtape Letters: Letters from a Senior to a Junior Devil’, we can easily be encouraged within any narrative system to externalise what is within us and create separation by conceptualising it as outside of us ^{*6}. The common sense, the mind is a product of a set of interactions. Whether or not there is something beyond it and us – is a possibility, but cannot be expressed in any standard form – faith has had to move one step back from the equation - what we can assert is: that we are here now and we are an interconnected part of now.

A STRATEGY FOR PRACTICE AS RESEARCH

So having healed my own internal rift in my Creative Research Fellowship – not just healed but turned the scar tissue into productive understanding and behaviour, I then:

- i) Conceptualised ways in which my research question could lead to the creation of ‘artefacts’ (my research artworks)
- ii) Then exhibited them at many locations where they were regarded amongst other things, as ‘art’^{*7}
- iii) I then critically reflected and wrote about the process taking into account audience response in peer-reviewed articles
- iv) Then presented the outcome of the work in conferences.

This group of 4 actions comprise the strategy of the creation of a Practice as Research Portfolio as a robust academic methodology approximate in weight to anything the sciences have devised – we in the Arts simply have to stand our ground recognizing that there are as many holes in scientific methodology as in artistic methodology.

At the same time my prior research is now taken up and being developed into new research strategies with the BBC and Faculty of Engineering at University of Bristol. The Engineering and Physical Sciences Research Council is interested in the new area of Higher Dynamic Range, Higher Frame Rate and Higher resolutions, which when calibrated together can perform deeper engagement ^{*8}.

After 3 years of research, which was after all the base knowledge for KT fellowship itself, it was difficult to split what I knew on ratiocinatory level from internal knowledge; somehow the behaviour of ‘practice as research’ besides discovering empirical things about the world, also revealed glimpses of the nature of the ontology of the sensorium.

THE LOOK FROM CAPTURE TO DISPLAY: A SYMPOSIUM

At the beginning of my Knowledge Transfer Fellowship I proposed to my colleague Dr Richard Misek, the co-organisation of ‘The Look from Capture to Display’ a symposium which would take place in early 2011 at the Watershed In Bristol ^{*9}. My intent was to lay out my understanding of data pathways to production through its dissection into 4 segments and plenary. Each of the four sessions comprised a presentation by an academic

to open up wider questions, a presentation by a film industry professional, and then a dialogue between the two. The intention was to introduce the practice of each to the other and of both to the general public, facilitating an open conversation about the aesthetic issues, pressures, technologies, and production roles involved in contemporary film production. We felt that, importantly, we should discover and reveal a language common to both.

We also set up an evaluation of this event and concluded that we were going in the right direction. Those results will be encoded in the design of an international forthcoming conference on the nature of moving image training^{*10}. Regarding the worth of an event such as this, it made clearer to all of those involved that this kind of symposium/conference allowed a greater degree of internalization of the knowledge than standard conference form. I believe that multiple events which split the audience do not allow for knowledge building and feel that one of the fundamental mistakes that conferences make is to deny the voice of those attending by limiting audience dialogue times. It could be argued that conferences of two days should use at least half a day of presentations for pump priming on day two concerned with dialogue and resolutions to action.

INSIGHTS DERIVED FROM STAGING THE SYMPOSIUM

I realised from staging the symposium that I needed to know more about the sector and whether early adopters had taken up the challenge of Digital Cinematography so I created an online survey to try to find out roughly how many digital cinematography units were present in UK HEI's – this was only to be a snapshot. There are currently over 370 Universities and Institutions of Higher Education in the United Kingdom and Eire (depending on how you count and who you include). In an unpublished consultation document that I was writing to interest a group of universities in setting up a Digital Cinematography Research Unit (DCRU, Mid 2011), I wrote the following concerning the level of equipment in England:

Delivering access to research, skills and equipment to HEI's in the subject area of Digital Cinematography is problematic for various reasons but at a basic level a single Digital Cinematography kit is expensive at around £50,000 (\$80,000) each unit and £70,000 (\$110,000) if you introduce post-production into the equation. There are currently 10 camera units in education; there will be 13 by the end of the year. University of Bristol has two of these units - the current 10 units are situated: 4 in media departments, 3 in film schools, 2 in engineering departments, 1 with an KE Fellow (myself, Bristol). By the end of the year 3 other DC kits will arrive in 3 more film schools and after this year's NAB, because newer equipment is cheaper, penetration into HEI's will increase - this increase needs to be accompanied by knowledge and skills as these newer kinds of equipment utilise data production rather than image production. There is an argument that British moving image training needs a radical overhaul.

My agenda for the creation of a Research Unit was twofold, that acting together, we could be in accord with Research Council goals of amortizing costs for equipment between universities and secondly we could jump start the unification of teaching practice around moving image training. Duncan Petrie, Professor of Film and Television at York University and Professor Rod Stoneman, Director of the Huston School of Film & Digital Media at the National University of Ireland allowed me to see part of their argument from their forthcoming book, *Cultivating Film-Makers*^{*11} in which they discuss some of the reasons why moving image training in the UK is constructed as it is. I wrote the following with what I had seen of their argument in mind:

The education and training of film and television-makers in the UK is arguably in a state of crisis. The sector comprises a rag-bag assortment of different kinds of provision: from long standing single-discipline institutions such as the National Film and Television School and the London Film School specialising in postgraduate industry-related training, to University departments offering a wide variety of theoretically and practically oriented programmes in film, television and media studies at bachelors, masters and even doctoral level, to an array of Further Educational colleges specialising in various kinds of technical skills-training. In 2003 Skillset, the sector skills council for the creative industries, and the UK Film Council published a national training strategy that claimed many existing media courses were of poor quality and irrelevant to the needs of industry. However, this strategy entailed its own limitations and flaws. The view of education it espoused was overtly instrumentalist, equating the formation of future practitioners with industry-relevant ‘skills-training’. Moreover, it ignored more than a half-century of the development and impact of film schools, not just in the UK but also around the world.

This also required the addition thought, that the Arts also requires a different attitude to training than the idea of ‘craft-training’, to take account of the peculiarities of ‘Glitch Art’ and what crafts people see as low craft-focused image production which deals in the peripheries and inconsistencies of the media used. I have used this position often to generate my own work, even though I thoroughly embrace the concept of craft-training: I always wanted to understand the medium I was creating art within, thinking that, had I been born in the 1500’s for instance, I would need to know how to mix my own paints and pigments, so I’d better know how to make moving images in whatever technology made itself available. I would also argue that the sector was also then profoundly ignorant of the tsunami-like development of digital and pervasive media and their impact on media training: that the speed-blindness, or velocitization of technological impact (including the lazy quoting of Moore’s law as a self-fulfilling prophecy of continuous inability to deal with the flow of technology) may be a governing factor of the crises we are in. In my consultation document I built upon Petrie’s and Stoneman’s insight to bolster the rationale for the research unit and also for a forthcoming conference:

A newly formulated Digital Cinematography Research Unit can relieve the pressure

which produces the dichotomy between the needs of both the academic and the creative, where the current situation in film schools in Britain and elsewhere is predicated on a conceptual division between skills training and academic education, which in turn relates to a broader division between intellectual and creative endeavor within the educational process. Particular problems would be examined through papers, conferences and symposia. A major conference in collaboration with other HEI's will be organised to examine the teaching landscape of British moving image. One of the main subjects to be examined (with reference to Petrie and Stoneman once more) is the role of categorisation and exclusion in relation to 'instrumentalised notions of skills and aptitudes - even at the level of primary and secondary education nearly everyone is taught that they can't draw / paint / make art, that they are not 'creative'. A primary intent of any colloquia, symposia or conferences should also examine the implications of purely 'academic' modes of thinking and writing in relation to forms of cultural expression and practice and how these can function to restrict and even undermine certain kinds of experience and expression. Importantly, different models of pedagogy in tertiary education should be considered, notably the development of practice-based research within film and media departments',^{*12}.

THE PRACTICE OF EXCHANGE OF KNOWLEDGE

Early on I had decided I would commit myself to a series of workshops that would practically engage those attending whilst at the same time revealing the mysteries of complex ideas like Modular Transform Function, the Nyquist-Shannon Sampling Theorem, Bayer Patterns Filters, Fourier Discrete Cosine Transforms and the development of Wavelet theory (explanations of which can be found in the Notes on Digital Pathways which you can download – note 2). I decided I would have faith that whoever came, came because they wanted to learn the mysteries revealed and that they would come with bright and open minds. Having taken people through that level of Engineering I would then proceed through Eisenstein's theories around Horizontal Montage to Goddard's Vertical Montage, deconstruction, semiotics, structuralism and of course the Death of the Author.

In all of the workshops I was assisted by a young film-maker – as we drove to each of the workshops the conversation was filled with questions around what the facts were and what my intent was. By the end of the workshops the film-maker, Josh Randall, said that by doing the same workshop so many times he'd taken on the ideas at a very deep level. The workshop consisted of the actual construction of the camera from out of the carry-case (built from the ground up) and with every additional piece of equipment being added, the lens, the matte box, the battery, the hard drives, the electronic viewfinder etc, this then afforded a means to introduce each new subject: Light into glass, optics, optical pathways, sensors, different kinds of sensor, Bayer pattern filters to generate the idea of colour, colour space, photosites, conversion of light to voltage, voltage to data, recording data, compression, display technologies, audiences, perception, mirror neuron function, immersion, film theory, signs and symbols, mis-en-scene and so on.

In physical terms we went through capturing and processing the data and finally post

producing, one-light grading and editing. The idea being that we would reveal the simplicity of the pathway. Everyone then saw Digital Cinematography from concept to displaying the images they captured on a screen. People are very bright if you speak to them in the right way. The idea that slow thinkers means lack of inherent intelligence is wrong, it just takes longer with further use of metaphor to get complex ideas across. Equally, direct fact can be relayed in a way that exposes meta-levels of meaning. Often the workshops were attended by people who knew quite a lot in one area, including professionals, plus there were undergraduate, graduate and doctoral students – there were hardly any people attending with little knowledge about the subject.

EVALUATING THE UN-EVALUABLE

In total there were 19 workshops, with an average of six people attending each – I had conducted other events previously with many more people, but to ensure depth of knowledge and deeper spread, I decided to limit attendance to a small number so that people would glimpse the possibilities of the medium and then virally spread the information if I managed to motivate them. I also decided I would try to evaluate what level of learning that would be achieved, so I set about constructing an evaluation process comprised of a pre-workshop and post-workshop questionnaire where I could have people self-evaluate their knowledge beforehand – and similarly self-evaluate their knowledge after the workshop.

The entry requirement for the workshop process became:

- i) Take the pre-workshop questionnaire
- ii) Read the pathways to production pdf I made available before the workshop
- iii) Take the workshop
- iv) Re-read the pathways to digital production pdf
- v) Take the post workshop evaluation questionnaire

This is similar in some ways to the old tv adage of ‘Tell them what they’re going to see, show them it, tell them what they’ve just seen’. Given that there is always a failure rate when trying to get people to fulfill the contract you’ve negotiated with them i.e. ‘coming to the workshop means that you undertake and agree to accomplish and complete ALL the above 5 points’ – there are some who see this as an infringement on their rights, there are others who are plain lazy and there are also students who don’t realise that learning is a two-way process and so consequently one is looking for the return of the final questionnaire to compute on a percentage basis what level of learning has been achieved.

I constructed a set of questions that had a ten point answer i.e. ‘do you know how to expose film?’ where 0 is knowing nothing and 10 is understanding everything. Of course, that’s different from ‘do you really *understand* how to expose film to produce exact results’ and equally different from ‘do you know what happens photo-chemically when you understand what exposing film to light?’ But given the minefield of associations, intents, misunderstandings and all the rest that can occur with a simple question, I chose questions

that allowed there to be a difference between ‘before’ and ‘after’ a workshop that was purporting to convey knowledge about a subject. At this point, to better understand what follows, you can go to the URL referred to in the notes to take the evaluation yourself: ^{*13}

A lot of my training is based on the idea that the understanding of digital cinematography can be enhanced by understanding film principles. Not the least because the manufacturers of digital cinematographic equipment have tried to follow a through-line about light, the means of capture of its values, rendition of what has been captured and treatments that enable a flow of images that accrues to what we are ‘used to’. And yes the charge of remediation is always present – but, in the end, light is the medium we are dealing with and this has to excite a change in a medium whose values can then be captured, so that we can then render meaning and significance from that act.

As an example of this it helps to know that in a film camera, to enable both the exposure of film frame and also to enable this film frame to be moved on by the sewing-machine style technology, a ‘shutter’ revolved, that half of it was black to shut out light and half was clear to allow light through for exposure of the frame. Each revolution of the shutter took a 25th of a second if the shutter was set at exactly half the spinning wheel – and so one half of 360 degrees is 180 degrees. Therefore this had a shutter angle of 180 degrees at one fiftieth of a second. Thus time and angle have a correspondence. The sensor does not have an angle – but it does switch on for a certain amount of time. With 25fps this is a fiftieth of a second and with 24fps a forty-eighth of a second. DP’s experiment and so they can work out that if you lessen or decrease the shutter angle you can increase sharpness of image and get an effect of similar to the one in Saving Private Ryan or increase the shutter angle to increase motion blur.

WAS KNOWLEDGE TRANSFERRED?

During the 19 workshops, 102 people from industry and universities took part and I compute from 18 questions that overall knowledge of cinematography across all classes of attendees held before the workshop was 30%, which rose to 67% after the workshop. I also asked a general question of people who had taken the workshop to estimate their own knowledge prior to the workshop (which computed to 41%) and then what they thought they knew after the workshop (which was 69%). That’s a 28% increase which is different from the more extensive calculation of 37% which I had made from the 18 questions – and that I believe relates to the following:

In examining the ‘data’ generated from a questionnaire about knowledge held, there were obvious inconsistencies. For instance, with regard the simple question: ‘Do you know how to expose film?’ I had said in the evaluation that the student should give a value between zero and ten to answer the question. In the questionnaire before the workshop the students might answer 10 before and in the questionnaire afterwards, they might answer 7. So what’s going on here? One simple answer is that they realised what they didn’t know by being exposed to more knowledge than they thought existed.

Another is the following: the premise of this questionnaire is that 0 equals absence of knowledge and 10 equals a complete grasp. I believe the student answers to the best of their ability and the best of their knowledge. But I know from my own experience that after 30 years of shooting that I would answer 7 or 8 in answer to the question ‘Do you know how to expose film?’ I exposed my first piece of film in 1971, shot video from 1976 on, then in 1992, I took on a major film shoot only knowing the theory. The project was to shoot a 100 person concert with a well known singer in a massive recording studio with three cameras - and this was her 50th year in the business – so no pressure then. Since then I’ve shot a lot of film, both Super 16mm and 35mm. With that context, I would say that my answer to the above question in 1992 was about 5 - 6. It all came off perfectly by the way, because I stuck to the theory. I might now answer 7 – 8.

So that conditional answer takes in all of that experience and is an expression of knowing about the complexities that an experienced person is aware of (and also the presence of Murphy’s law that if anything can go wrong, it will go wrong). But aside from that, one can never know the complete answer. I also believe that if Roger Deakins were to fill in this questionnaire he might write down 9. We would believe him but wonder why he didn’t write 10. But Deakins is no fool, he knows that the master of the form can only know *nearly everything* about the form but not all. One must always keep ‘1’ behind in the storehouse for the unexpected.

The student of course expresses their newly found humility without shame but still with naivety and then puts down 7 after the workshop – still a ridiculously high number – they should in fact put 2 or 3 because ‘0’ is knowing nothing, ‘1’ is ‘well I did it a few times and was amazed that the theory worked’, ‘2’ is ‘I feel a little bit better as nothing has gone wrong yet’, ‘3’ is ‘something went wrong and something unexpected happened’ and so on. There are many other conclusions one can draw from this system and I shall do further work on the figures to extrapolate meaning – but the response of the students at the time and the comments that followed told me what had happened in terms of delivery of both technical and contextual information.

The base line though, is that my overall calculation of the increase of knowledge using all answers came out at 30% knowledge held before with a 37 knowledge gained, which totals 67%. The single question evaluation taken after the workshop where I asked people to evaluate what they thought they knew before and then what they thought they knew after, came out at 69%. That’s within a plus or minus 2% error margin when compared to the more extensively computed result of 67%. But of course whilst looking like a highly successful control for the figures, this really means very little. At the actual events the expressions of realization were my confirmation of what was being learned and eventually I received testimonies from various people that speak of far more than a numerical increase.

Comments from Filmmakers:

A day crash-course, learning the RED ONE inside out, start to finish. A truly immersive technological torrent of theoretical and practical information - Strongly recommended to anyone with an interest in a future in digital cinematography. Ben Hoy-Slot, filmmaker

The beast which is RED came tamed in a day, thanks to Terry and his assistant, Josh. Lee Evans, filmmaker

The workshop was well run and organised; there was a balanced mix of technical instruction with room for creative freedom. Since showing off the work we created at the session my fellow course-mates who attended and I are the envy of our colleagues. We are very grateful for the opportunity to get hands on with the Red camera. Nick Pearson, film-maker

Speaking as a director, Terry's workshop has plugged so many gaps in my knowledge that it's gently removed the fear of the technical aspects of digital cinematography getting in the way of creativity. Joan Beveridge, film maker

Digital cinematography is the frontier, and you know what - it's an exciting one! (Undergraduate, University of the West of England)

APPRAISAL

So to sum up and evaluate the process, here are some thoughts on Knowledge Transfer behaviour:

THE WORTH OF SURGERIES

These have short term worth on one level, because they are about imparting information with regard a specific request or problem – however, one would expect the knowledge to disseminate virally from individual contacts as knowledge spreads.

THE WORTH OF SYMPOSIA

This was a very beneficial event for all involved. I conducted an online appraisal where people again filled in an evaluation form and the results came in at around 70% approval for the event with various constructive comments to improve it so that the next would be a better experience. The event also had real impact of those taking part. Academics spoke about a new way forward where we exchange real-world knowledge with our industry counterparts and people from industry spoke about their own practice being enriched and that they would think again before their next set of acts.

THE WORTH OF WORKSHOPS AND THEIR EVALUATIONS

Workshops do much the same as surgeries in terms of viral distribution of knowledge. On a deep level a workshop can change a life, as one did for me some 30 years ago.

Evaluations and questionnaires can always be improved upon, but in the end they produce a simplified picture of growth of understanding. In that sense all of my workshops generally increased the knowledge of those that attended by roughly one third, however, I am aware as a teacher that I reached beyond a measurable set of co-ordinates to reveal the landscape that I can see and that those that attended will also speak of this new landscape. Was knowledge exchanged in a two-way process? I can say with certainty that as the workshops progressed I fine-tuned my concepts around the transference of information and this was based upon direct feedback from the continual evaluation process. Did I really learn anything from the process? I learnt that disinformation is a continuous problem around complex and new subject areas.

THE WORTH OF ONLINE RESOURCES

I have been publishing outcomes online from 2007 onwards – not only within traditional forms of academic dissemination of knowledge, but also through maintaining online resources. Though recognizing these important forms of dissemination, there is a real problem around the publication of a monograph that costs £75 and up and few copies are printed for use in reference libraries. I have maintained a blog – and yes, arguably this is to a limited academic standard – but it allows a freer flow of thought and information and also allows one to create the ideas that later appear in peer-reviewed form.^{*14}

Besides the recording of symposia a key online initiative that I have maintained as a KE resource (that I began during my AHRC Creative Research Fellowship) is the ‘Verbatim History of Digital Cinematography’^{*15} where I’ve interviewed people I believe that have something to say with regard the development of the subject area. I feel that we now need to build up teaching resources that can also be used by future researchers. Early film has little or no verbatim reports from the beginning and with this resource I wanted to address this balance one hundred years on (in a similar mirror period of development) this time of Electronic Cinematography rather than Photo-chemical Cinematography.

As to the worth of the above, I can only take note of the use of a page on Academia.edu which offers a means of tracking how many hits you’re receiving and what the nature of those hits are and what actions they manifest in^{*16}. At the time of writing on looking on my academia page I see that I have 11 notifications which tells me when I view the stats: 3 people from India, two people from the United States, and one person each from Belgium, the UK, South Africa, Italy, Turkey and Canada have viewed the page in the last 2 days. So with regard online resources from the KT Fellowship – I can see the counter clocking up numbers and the fact that these numbers are by inference international, heartens me to believe that online resources have a much wider reach than traditional academic forms of dissemination.

CONCLUSION

In terms of evaluating and reflecting upon the whole gesture of a KT Fellowship I need to step sideways: A few weeks ago, as I began to try to come to grips with some deeper issues before beginning this article, I noticed the December issue of America

Cinematographer, still unopened from a week before^{*17}. So in a gesture of Geoff Dyer-like displacement from the task at hand, I opened it up and glanced through. This was replete with advertisements for Red, Alexa, and all the Sony variants, F5, F55 and F65. Ironically it is now Sony who are trying to catch up now as it was Sony with their CineAlta Brand that first took on Kodak and the photo-chemical dominance of the motion imaging market 25 or more years ago. Looking deeper into the ASC magazine, Skyfall is given 15 pages (which shot this huge franchise not on 35mm but on the 2K Alexa even though it had to be up-rezzed to show in iMAX cinemas). Of course Pirates of the Caribbean 3 and the Social Network championed the Red One, as Prometheus and the Hobbit Trilogy championed the Epic – as years before Star Wars pushed the Sony 900 into the frame (later followed by Avatar).

But further on in the American Cinematographer Magazine, almost as an act of ‘balance’, Seamus McGarvey BSC is described using Kodaks’s Vision 3 stock to shoot Anna Karenina. But that choice may be about a deep need to reference David Lean’s Zhivago, to confer the aura of the original gesture though it’s medium of capture, that the deep human psychic expression exemplified by Russian Romanticism should use film stock and not the clinical new medium - as more of a marketing principle than a formal necessity. The only real way that the question of the appropriateness of film or digital can be dealt with is if a Digital camera were placed side-by-side with the Panflex Millennium on a shoot such as this, or Lincoln, (in the same magazine) or even Cloud Atlas all of which have been shot on 35mm. The ASC and BSC side-by-side tests of digital cinematography cameras only pointed a gesture of small understanding towards the new medium - but Roger Deakins grand statement is the one that is eye catching, as the acknowledged Master of the Medium speaks to the world about what he can do and more to the point, is prepared to do with this new medium.

A VELOCITIZED CONCLUSION

The camera introduces us to unconscious optics as does psychoanalysis to unconscious impulses^{*18}

Though he is referring to a photo-chemically based image capture medium, Walter Benjamin’s statement, when combined with David Hockneys research on the adoption of the single lens to aid in reproducing reality, is wide enough to include:

- i) the use of the monocular lens of the Camera Lucida from 1200 onwards - which was to determine forms of representation including the idea that perspective as represented through a single lens as ‘real up until the arrival of photo-mechanical capture
- ii) through the entire photo-mechanical and photo-chemical epoch which is revealing itself as essentially a romantic period (are not most film theorists nostalgic for romance and atmosphere?) and here I include the advent of analogue video
- iii) through to and past our present epoch which includes the digital and the data-

pervasive-computational-clinical present.

So it would seem from my own Freudian slip above, that the use of a word like ‘clinical’ comes easily as a description of this new medium - but that may simply be a remedial gesture, of which currently, there are many. From many news reports it would seem that Peter Jackson’s trial of a new display rate of 48fps on the Hobbit is in trouble. The media is telling us that apparently we don’t like 48 frames per second (but then this production is being screened at 2k and if one were following through and multiplying from 24 fps at 2k, one would then project at 48fps at 4k) – there are even assertions that consciousness occurs at 40 frames per second in the popular press*¹⁹. Looking at the cinematography of the Hobbit, what has been achieved by Andrew Lesnie using an Epic, with less fanfare than Roger Deakins use of the Alexa on Skyfall, is that Lesnie achieves as much of a painterly image in a Digital Cinematographic medium as he did on Lord of the Rings on 35mm*²⁰.

Jackson maintains – as does James Cameron with the forthcoming ‘Avatar 2’ – that we will get used to high frame rates: 10 – 15 minutes is currently recommended for adjustment *²¹. Before them, Douglas Trumbull championed Showscan, a 65mm film system running at 60 frames per second. But pushing that amount of expensive film stock through a camera proved ridiculously expensive - And here’s much of the rub around digital cinematography: The dreams of film can be realised at proportionately little extra cost in this new form. Jackson and Cameron, in terms of late-capitalist production of not only entertainment, but ‘film practice’ itself, have their fingers on the pulse of the popular mind in a way that all the nay-sayers of change put together, cannot really challenge.

KNOWLEDGE EXCHANGE AND FURTHER RESEARCH

My current research, and site of Knowledge Exchange, is a collaboration with Faculty of Engineering at University of Bristol and BBC Research and Development. This is about Higher Frame Rates (HFR), Higher Resolution (HR) and Higher Dynamic Range Capture and Display (HDRC or HDRD) – it is about the combination of all three – or rather the *calibration* of all three to create the most immersive form of that combination.

If you look at this diagram (Fig1) it shows that the human eye/brain pathway uses 5 out 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 only currently exhibit between 2 – 3 orders of this scale, but one of a new series of prototypes, held at University of Bristol, displays across 5 orders of magnitude and BBC R&D in turn have created a 200 frame per second projector where we intend to display images upon higher than seen before. By combining variants of frame rate, resolution and dynamic range, we should be able to effectively produce a deeply immersive picture by then calibrating these functions to produce a combination that best resonates with our eye/brain pathway - and therefore conscious awareness.

The proposition we are constructing is that if we can manipulate *all* the factors of the construction of the image, then conscious immersion may follow, providing people have gotten used to what it is they are seeing (including the perceptual issues around signal compression). At the end of November 2012 we managed to capture the first version of these kind of images and in January 2013 we will be constructing an immersion lab at University of Bristol to examine audience response to this new form. We hope shortly, to be joined by some prominent industry names in this enquiry and no doubt, those interested in the future of cinema – and whatever it might turn into – will be interested in this work. It is our intent to maintain the visibility of the research so that it has a relationship to the classroom, as we feel that the velocitization of the relationship between research and knowledge exchange is so fast, that research is now ‘knowledge’. However – we are aware that critical reflection and corroboration of evidence, as much as the discursive theoretical tradition, is as important as ever it was.

NOTES AND REFERENCES

If it becomes tedious to type URL's into browsers you can get access to all links and URL's mentioned in the text by going to <http://www.visualfields.co.uk> and click DIRECT, then click the relevant link.

*¹ Academy Colour Encoding System - Either type this URL into your browser <http://www.oscars.org/science-technology/council/projects/aces.html> or go to <http://www.visualfields.co.uk> click DIRECT, then click 'Academy Colour Encoding System'.

*² Notes on Digital Workflows, Flaxton 2011. Either type this URL into your browser <http://www.visualfields.co.uk/DIGITALWORKFLOWS.pdf> or go to <http://www.visualfields.co.uk> and click DIRECT, then click 'Notes on Digital Workflows'

*³ For anyone who is curious about what my prior research and creative concerns are with regard high definition imaging, please see an article I wrote for the Journal of Media Practice Volume 10 Numbers 2 and 3 entitled Time and Resolution: Experiments in High Definition Image Making (2009). In this article I describe an assessment of my AHRC Creative Research Fellowship: 'High Definition Imaging: An Investigation into the Actual, the Virtual and the Hyper Real'. This fellowship took place at University of Bristol between 2007 - 2010. This can be found at academia by clicking though to 'papers': <http://bristol.academia.edu/TerryFlaxton> Or type in this URL in your browser <http://highdefinition-nomercy.blogspot.co.uk/2009/02/high-definition-imaging-work-so-far.html> Alternatively go to <http://www.visualfields.co.uk> and click DIRECT, then click 'Time and Resolution'.

*⁴ Secret Knowledge, Rediscovering the lost techniques of the old masters', David Hockney, page 17, Thames and Hudson, 2001

*⁵ The Master and His Emissary, Professor Iain McGilchrist, Yale University Press (2010)

*⁶ 'The Screwtape Letters: Letters from a Senior to a Junior Devil', C.S.Lewis, Harper, 2008 (first published 1942)

*⁷ In fact one of my pieces, 'In Re Ansel Adams' has been accepted into the Harris Museum in Preston's permanent collection and an installation, 'In Other People's Skins' has been seen as far afield as China, America, Italy, Norway, Sweden and the UK by over 300,000 people. Access this URL for a small video shown on Chinese TV: <http://www.visualfields.co.uk/chinareports.htm>

*⁸ In November 2012 I was involved in the worlds first HFR, HDR and HR tests in collaboration with Faculty of Engineering and Department of Experimental Psychology at University of Bristol and BBC Research and Development. At the time of writing (Jan 2013) we are constructing an immersion lab at UoB to test our first results on the public.

^{*9} Use this link for access to an online recording of the Symposium: The Look From Capture to Display - <http://www.visualfields.co.uk/KTTheLook.htm> or go to <http://www.visualfields.co.uk> click DIRECT, then click 'The Look From Capture to Display'. This 4 hour online video gives access to:

- i) The first session, Introduction and Capture, introduced the symposium and examined the film industry's transition from analogue to digital. Presentations, Professor Duncan Petrie (York University) and the Director of Photography Ben Smithard BSC, (who I had worked with on the Julien Temple feature, Glastonbury), who had shot Cranford and won an Emmy for his work as well as shooting various features, such as 'My Week With Marilyn'
- ii) The second session, Data Handling argued that unlike celluloid, digital film doesn't exist in a tangible format. This session looked at where and how data is stored. Presentations by Professor Sean Cubitt (now of Goldsmiths) and the Production Supervisor, Jonathan Smiles (Green Zone, District 9, Anonymous, Thor, The Dark World)
- iii) The third session, Editing and Grading examined the impact of digital technology on colouring film and the importance of colour grading in maintaining – or changing continuity. Presentations Dr Richard Misek and Luke Rainey (colourist on Man On Wire, Frozen Planet, South Pacific, The Natural World)
- iv) The fourth session Exhibition and Display, examined the benefits of grading, digital projection and distribution, and charted how many cinemas worldwide are converting to digital. Presentations Dr Charlotte Crofts (UWE) and Geoff Boyle, DP - and the man who started the world-renowned Cinematographers Mailing List – beside shooting staples, like Wallander.
- v) Was a summation of the above and the congregation of academics and industry professionals to discuss the pros and cons of digital cinema, and answer audience questions.

^{*10} Please go to <http://www.visualfields.co.uk> and click D I R E C T for a link through to news about this conference – we expect this to take place in Spring 2014. In Bristol in the UK we are currently re-organising and co-ordinating our moving image festival events to produce a month full of moving image celebrations. In 2013 the short film and indie festival Encounters, as well as the Wildlife Festival, Wildscreen will both take place in September. We hope by 2014 to also begin two new festivals: The Golden Hour Festival of Cinematography and The Festival of Experimental Moving Images.

^{*11} 'Cultivating Film-Makers: The Past the Present and Future of Film Schools' (Working title), Professor Duncan Petrie, Professor Rode Stoneman, (Publisher, Intellect, 2014)

^{*12} University of the West of England (UWE) has now stepped up to the baseplate and created the research unit in 2013 and we will be looking for creative collaborations with

other HEI's worldwide. UWE already has the 'Digital Cultures Research Centre' (DCRU), so the Data Imaging Research in Electronic Cinematography and Transmedia (or D I R E C T) will become the name. UWE itself now has 5 Digital Cinematography Units, University of Bristol has 4 DC Units, plus various peripherals post units such as redrockets etc plus we will run a national survey of DC equipment this year (Please see www.visualfields.co.uk and click DIRECT for further information on the survey).

I encourage anyone interested in this new medium or to contact the relevant person in your university or college to go the URL and fill in details of your Digital Cinematography equipment and become involved in helping to correlate an overall teaching strategy in lens based media through the introduction of Digital Cinematography. Part of this initiative will consider the potential role of research as introduced into the classroom. Please go to <http://www.visualfields.co.uk> click DIRECT, then click 'International Survey of Digital Cinematographic Equipment'.

*¹³ Workshop Evaluation Form. Either type this URL into your browser: <https://docs.google.com/spreadsheet/viewform?formkey=dHB1czFQekdSUWhwQUk5Skxoemh5bUE6MA> or go to <http://www.visualfields.co.uk> click DIRECT, then click 'Workshop Evaluation Form'.

*¹⁴ Online Text Resources on the Subject of Digital Cinematography. Either type in this URL to your browser: <http://www.visualfields.co.uk/KT2.htm> or go to <http://www.visualfields.co.uk> click DIRECT, then click 'Online Text Resources'.

*¹⁵ The Verbatim History of Digital Cinematography. Either type in this URL to your browser: <http://www.visualfields.co.uk/indexHDresource.htm> or go to <http://www.visualfields.co.uk> click DIRECT, then click 'Verbatim History of Digital Cinematography'. We welcome interviews gathered to add to this resource.

*¹⁶ Academia.Edu. Either type in this URL to your browser: <http://bristol.academia.edu/TerryFlaxton> or go to <http://www.visualfields.co.uk> click DIRECT, then click 'Academia Page'.

*¹⁷ American Cinematographer Magazine, December 2012, Either type in this URL to your browser: http://www.theasc.com/ac_magazine/December2012/current.php or go to <http://www.visualfields.co.uk> click DIRECT, then click 'American Cinematographer'.

*¹⁸ Das Kunstwerk im Zeitalter seiner technischen Reproduzierbarkeit, originally published in Zeitschrift für Sozialforschung (1936) Walter Benjamin

*¹⁹ Online Article at Movieline.com: The Science of Frame Rates, Or Why The Hobbit Looks Bad At 48 fps'. Either type in this URL to your browser: <http://movieline.com/2012/12/14/hobbit-high-frame-rate-science-48-frames-per-second/>

or go to <http://www.visualfields.co.uk> click DIRECT, then click ‘The Science of Frame Rates, Or Why The Hobbit Looks Bad At 48 fps’.

*²⁰ As an incidental, it’s reported that the Hobbit generated between 6 and 12 terabytes per shooting day on the Hobbit. With over 265 days of principle photography this means that between 1590 and 3180 terabytes – not including all the second unit shooting and pick up days would have been generated – but this pales into insignificance with the data levels generated on our current HDR, HFR research (not even 3D). We calculate around 1 terabyte *per minute* of *rushes* for the next level – if we can invent the means of recording this.

*²¹ Article in 3D focus magazine an online journal. Either type this URL to your browser: <http://www.3dfocus.co.uk/3d-news-2/3d-film/be-open-minded-says-schilowitz-from-red-about-hfr-3d/11469> or go <http://www.visualfields.co.uk> and click DIRECT then click “Be open minded says Schilowitz from RED about HFR 3D”