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Vibrating Existence: Early Cinema and Cognitive Creativity

Edmonds, Guy

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VIBRATING EXISTENCE: EARLY CINEMA AND COGNITIVE CREATIVITY

by

GUY DANIEL EDMONDS

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Author's Declaration

At no time during the registration for the degree of *Doctor of Philosophy* has the author been registered for any other University award without prior agreement of the Doctoral College Quality Sub-Committee.

Work submitted for this research degree at the University of Plymouth has not formed part of any other degree either at the University of Plymouth or at another establishment.

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A programme of advanced study was undertaken, which included:

2014/15

- Research Methodologies, 6 June 2014
- Introductory Research Development workshop, 17 June 2014
- Transtechnology Research Seminar Series 2013/2014 - Mediation and Transdisciplinarity: Towards an Archaeology of Affection
- Transtech Research Seminar series 2014/2015 - Cognition and the Image of Affection: Instrumentation, Realism and Technology
- Transtechnology Research Updates
- Involvement in Transtechnology publications and Temporal Image Research Open Lab
- CogNovo Workshop series 2014-2015 – A series of 8 week-long workshops - Research Methods; Experimental Methods; Computational Modelling; Public Outreach; Entrepreneurship; Social Creativity; Humanities Perspectives
- CogNovo Topics and Concerns Programme 2014/2015
- CogNovo Research Leadership Training programme 2014
- H2020 Co-ordinating and Writing a Proposal, 8 October 2014
- Finance Overview training, 23 March 2015

Practical Skills training

- Nikon D7000 and Studio flash photography, 10 November 2014 (Helge Mruck)
- Analogue Colour Photographic printing, 12 December 2014 (Alan Winn)
- Letterpress printing, 18 May 2015 (Paul Collier)

2015/16

- Transtechnology Seminar series 2015/2016 - Objects of Affect and Affection
- Transtechnology research updates

2016/17

- Transtechnology Seminar series 2016/2017 - Tropes of Affect: Devices, Narrative and Illusion
- Transtechnology research updates
- CogNovo Grant Writing for post docs 2, 9, 16 February 2017
- *The Bioscope – object as text*. Workshop with invited film technology expert, Stephen Herbert, 29 and 30 March 2017

The following external institutions were visited for consultation purposes:

- Eye Filmmuseum, Amsterdam
- Nederlands Instituut voor Beeld en Geluid, Hilversum
- National Science and Media Museum, Bradford
- Academy Film Archive, Los Angeles
- Hugh M. Hefner Moving Image Archive, Los Angeles
- Bill Douglas Centre, Exeter
- Lichtspiel, Bern

Publications and public presentation of creative research outputs:

Publications

- 2018. 'Floating in the Hybridity Continuum', in *Film in the present tense: why can't we stop talking about analogue film?* Archive Books, Berlin
- 2018. 'Deviating Devices, or, the Camera with a Brain', *Transtechnology Research Reader* 2015/17, Plymouth University
- 2017. With Lewin, S., 'The Displaced Dispositif' in *Off the Lip: Collaborative Approaches to Cognitive Innovation* special issue of AVANT. Trends in Interdisciplinary Studies, Bydgoszcz.
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- 2016. With Wengström, J., Gant, A. & Ruedel, U. 'FoFA Case Studies 2012-2015', *Journal of Film Preservation,* no. 94, 4/2016, FIAF, Brussels
- 2016. 'Vitascope Movie-Maker: a ludic historiography' in, *Exposing the Film Apparatus: The Film Archive as a Research Laboratory.* Amsterdam University Press

- 2016. 'Electrophysiology of Cinema Spectatorship' in *Off the Lip: Transdisciplinary Approaches to Cognitive Innovation.* Conference Proceedings. Plymouth University
  PEARL (OA): http://hdl.handle.net/10026.1/4271

- 2015. With Rossella Catanese and Bregt Lameris, 'Hand-Painted Abstractions: Experimental Color in the Creation and Restoration of Ballet mécanique'. *The Moving Image*, vol. 15, no.1, University of Minnesota Press.
  DOI: https://doi.org/10.5749/movingimage.15.1.0092

- 2014. 'Reading "Hand-powered Mentalism"' in *Media Archaeology and Cognition: Transtechnology Research Reader* 2014/15, Plymouth University

Research Presentations

- 2018 February 24: 'Becoming an Archaeological Projectionist', The New Projectionists: VJing, AV Perfromance and Post-Cinematic Projection, Centrala Projects, Birmingham
- 2017 October 28: 'Frames and Rituals: The Mobile Borders of the Cinema Experience', Stories (Aesthetics and Politics) About Anonymous Cinema - International Seminar on Amateur and Orphan Films and the Concept of Authorship, Elias Querejeta Zine Eskola, Donostia/San Sebastian
- 2017 October 22: 'Floating in the Hybridity Continuum' Film in the Present Tense, University of the Arts, Berlin
- 2017 August 17: 'The Displaced Dispostif', Off The Lip 2017: Transdisciplinary Approaches to Cognitive Innovation. Plymouth University
- 2017 April 1: 'Saloon of Refuse: Only imperfection has a future, perfection is an end' Future Imperfect, Plymouth University
- 2016 December 2: 'Towards an Archaeology of Historical Audio-visual Perception' From Matter to Mind: Expanding the reach of film preservation to include the cinema experience, Eye Filmmuseum, Amsterdam
- 2015 September 9: 'Electrophysiology of Cinema Spectatorship' Off The Lip – Transdisciplinary approaches to cognitive innovation, Plymouth University, Plymouth, UK

Research Seminars

- 'Deviating Devices: the productive misuse of technology.' With Agatha Haines. Transtechnology Research Seminar Series, University of Plymouth, Plymouth, UK, 14 December 2016.
- 'The Knife Anatomised: A Forensics of the Inter-frame Space' Transtechnology Research Seminar Series, University of Plymouth, Plymouth, UK, 17 February 2016.
- 'The Ascetic Image: Technologies of Disavowal'. With Udo Hudelmaier, Jane Hutchinson, Abigail Jackson, Nick Peres. Transtechnology Research Seminar Series, University of Plymouth, Plymouth, UK, 18 March 2015.

- ‘Technophilia: Technologies for the Corrupted Body’. With Agatha Haines. Transtechnology Research Seminar Series, University of Plymouth, Plymouth, UK, 21 January 2015.

Public Engagement

- 2016 December 2: Organised and led expert meeting ‘From Matter to Mind: Expanding the reach of film preservation to include the cinema experience’, Eye Filmmuseum, Amsterdam
- 2015 October 26: ‘The Divorce of Eye and Ear is an Accident of the History of Technology’, podcast with Roger Malina, in honour of World Day for Audiovisual Heritage 2015, URL creativedisturbance.org
- 2015 May 4-8: Guest of Europe on Screen Film Festival, daily talks and discussions and media interviews about film preservation and restoration, knowledge transfer with staff at the Sinematek Indonesia. Various locations in Jakarta, Indonesia, including: Erasmus Huis, GoetheHaus, Institut Francais, Universitas Multimedia Nusantara.

Film Screenings

- 2018 January 15: 35mm film ‘The Great Train Robbery’ (1903) by Edwin S. Porter. Hand-cranked projection with accompaniment by the Imperfect Orchestra, Jill Craigie Cinema, Plymouth University
- 2017 May 20: found film performance, ‘Saloon of Refuse’ VIth edition, and Panelist on discussion of archival issues, Der Klingende Amateurfilm, Lichtspiel, Bern
- 2017 April 1: 16mm film ‘Keas Fenester’ by Guy Edmonds at Future Imperfect Symposium, Plymouth University
- 2015 June 7: 16mm film ‘Bugatti – Le Terrain Anglais’ by Guy Edmonds, Bugatti, Ferrari & Schnelle Flitzer, Ein Abend mit dem Filmer Guy Edmonds, Lichtspiel, Bern

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Abstract

'Vibrating Existence' – Early Cinema and Cognitive Creativity

By Guy Daniel Edmonds

This thesis collects together technical, historical and neurological evidence to examine how our perceptual and cognitive experience of cinema has changed diachronically and especially as a result of the transition from analogue to digital cinema projection. The slow arrival but sudden dominance of digital projection technology has provided a historic opportunity of renewed interest in the means by which cinema is created. This research attends to a particular aspect of the experience of cinema which has failed to survive the industry-wide changeover: the seemingly advantageous deletion of the shutter and its attendant flicker from the cinematic *dispositif* – the 'flicks' are literally no more.

The transdisciplinary approach employs a combination of historical film technological research, especially focussed on the Early Cinema period (1895-1915), experimental media archaeology, and empirical electrophysiological study, to investigate the cognitive impact of historical (flickering) and modern day (effectively flickerless) cinema technology. The research uncovers the prominence of the relation of the mechanical and the perceptual in the early cinema period and thickens our understanding of its texts and contexts, ultimately adding a new dimension to the substantial existing body of work on early cinema.

The argument of the thesis is situated particularly in the sector of film archives and museums (Film Heritage Institutes) where recent work has concentrated on transferring films of the analogue era to data files for display on an all-pervasive network of digital screens. However, while digitisation may preserve the content of these films it does not preserve the experience. These digital copies speak only to traditional film histories based on literary or auteurist ideas and do not communicate the visceral sensory impact on the late nineteenth century viewer. It is suggested that through reinstating the connectedness of the mechanical and perceptual our understanding of early cinema experience can be transformed.
The research also has further implications for other forms of moving image exhibition such as the continuing use of analogue film in artistic practice.

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Preface

<blockquote>
The whole history, not of this world alone, but of every sphere that is or has been, is still in vibrating existence, and one universal perception extending through the infinity would embrace within the tremblings of the boundless ether a consciousness of all that was or is, an eternal and universal living picture of all past events.

(Hopwood, 1899, 234)
</blockquote>

Henry Vaux Hopwood's *Living Pictures – Their History, Photo-Production and Practical Working* was published in the fourth full year of what would later be called cinema. The last page of his concluding chapter, 'Past, Present and Future', suddenly departs from what has otherwise been an earnest survey and technological history of the recent development of 'living pictures' to take flight on a fantastic imaginary voyage through space and reveal the material basis of the universe as one of eternal 'vibrating existence'. Indeed, unexpectedly encountering this passage, one almost imagines Hopwood as a latter-day Athanasius Kircher, guided on his *itinerarium exstaticum* by a personification of the omniscient 'universal perception'.[1]

Despite the novel macroscopic shift in his narrative, Hopwood's concluding fantasy nevertheless shares the conviction seen throughout his text that 'living pictures', whether theoretically ideal or working within the limits of the late nineteenth century

[1] The vivid frontispiece for *Iter Exstaticum*, 1671 edition, shows Kircher in the company of the angel Cosmiel viewing the orbiting planets from the edge of the solar system, in this case arranged geocentrically *à la* Tycho Brahe. See (Godwin, 1979)

technosphere, are above all a matter of perception. He begins his history with the assertion that it 'could never have been written were it not for the physiological phenomenon of Persistence of Vision' (1899, 2). Although this phrase was and remains contentious due to the nature of the persistence and its exact location in the human visual system, recognition of the role of perception is thus the frame within which Hopwood sets his discussion of the mechanical means of provoking the illusions of movement and constancy.

Inspired by the twin sources of Hopwood's epistemology, it is not difficult to infer a correspondence between the cosmic machinery of the universe and the whirring gears of a film projector. Such a connection may initially seem outlandish.[2] However, although not directly implied by Hopwood, his authorial move into discussing the mechanism of time and space cannot fail to have been influenced by the preceding tour through the intricate mechanical detail of a host of moving picture apparatus; by the 'tremblings' not just of the 'boundless ether' but of the prototypical devices of early cinema. This thesis concerns itself with the extent to which Hopwood's 'vibrating existence' was the everyday practical reality of the 'living pictures' to which audiences where regularly exposed, and to what extent it survives or can be recovered in present day performances of what we would now call early cinema.

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[2] Michael Punt has previously made a connection between the mechanical orrery and the cinema screen in terms of the spectator's viewing position. '[t]he orrery, is a three-dimensional schematic which places the observer in a very special position outside the universe, a position later replicated in the subject/object relationship in the cinema.' (Punt, 2008, 269)

A first encounter with Hopwood's book by a modern-day reader gives the impression of stumbling into a lost world of technological devices, collected together in profuse illustrations, descriptions and patent lists which collectively represent the existence of a fascinatingly diverse ecology of moving image experience. The remnants of this ecosystem are to be found like fossil fragments, scattered around the world in film museums and private collections. Just as with paleontological remains, they require extensive interpretation, contextualization and even reconstruction in order to reveal their part in the networked history of early cinema, although their current fate is more usually one of neglect or inert display. This thesis aims to make the case for their relevance and encourage engagement with their material fact alongside the more conventional study of the printed discourse such as *Living Pictures* itself.

Hopwood's concluding remarks also express another idea which is extremely apt to the film historical project which this thesis describes: The search for direct access to the past. Historians strive for the fullest account of the past and search for evidence which can help to provide it. History should be, according to Jules Michelet, 'a resurrection of the whole of life, not just of its surfaces, but of its inner and deep workings' (Michelet, 1974, 12). No matter how bountiful, however, the evidence is always insufficient for a full resurrection.[3] Hopwood's vision represents the dream of

[3] Certainly, for its first audiences, one of the responses to the new experience was to conceive of the device as a time travelling device or what I have previously termed a 'resurrection machine' because of its ability to preserve not just a moment in time, as with photography, but consecutive moments,

the complete recovery of the past through the visual sense and he applies it to the futurity of the first system that could lay claim to such an ambition. My ambition is necessarily more modest. A reclamation of the historical experience of the first audiences of cinema. It seeks not a window through which to peer at an infinite number of past events but a means of experiencing as closely as possible the sensory connection between a living human body and the huge variety of early cinema apparatuses described in Hopwood's book.

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excerpts of the flow of time which can be reviewed at a later date. See (Edmonds, 2008), also (Neale, 1985, 50-55) and (Christie, 1995) chapter 1 and 5.

Introduction

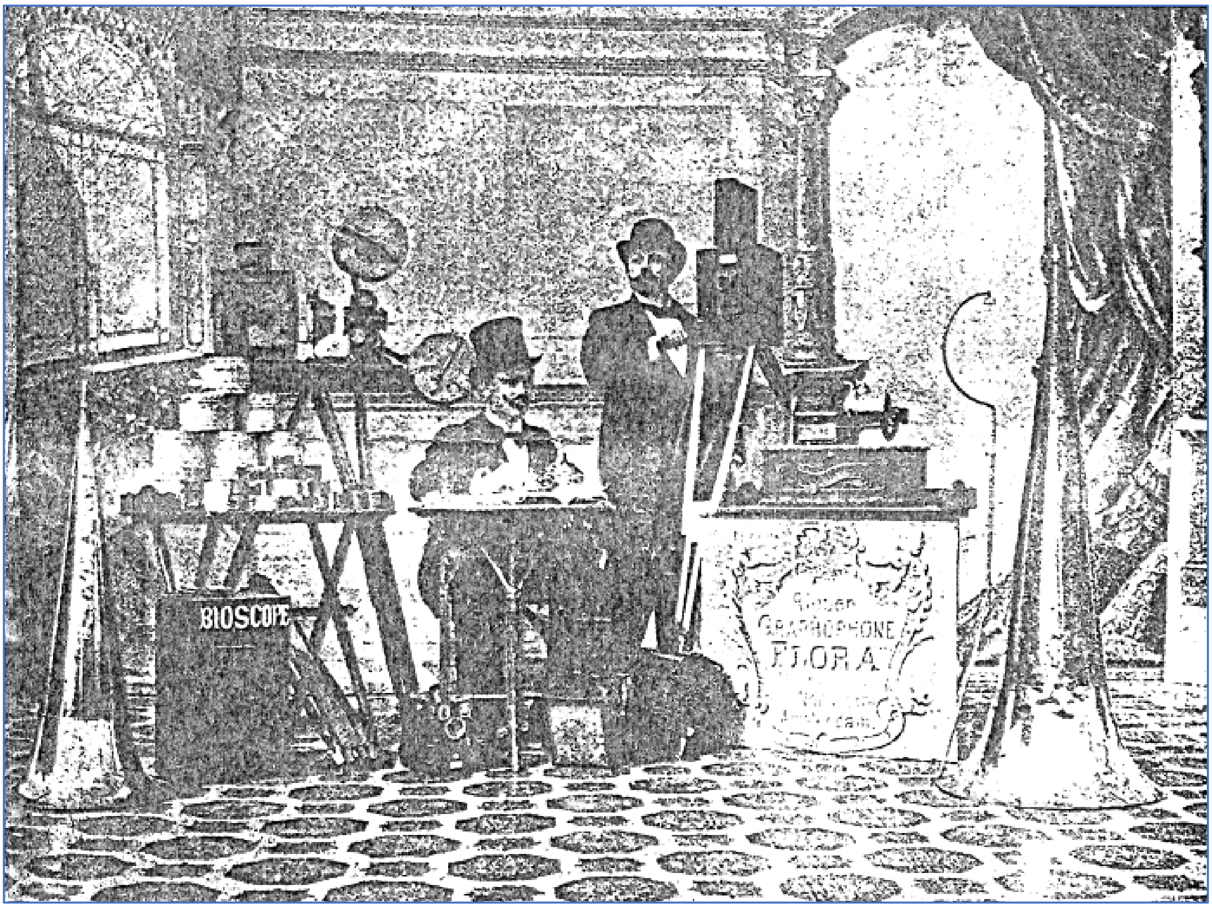

Figure 1. An image taken from an advertisement for A. Nöggerath’s Riesen-Graphophone “Flora”. *Der Artist*, no. 744, 14 May 1899.

The problem of the mechanical and the perceptual

This thesis is concerned with the relation of the mechanical and perceptual in the experience of early cinema in both its own era and the present day. Ultimately, it seeks to correct and enhance our understanding of one particular dimension of this relationship, namely the role played by the action of the shutter in the film projector and the effect of flicker which it produces in the spectator’s perception.

The contexts for the study are those responsible for informing our understanding of the historical experience of the original audiences of early cinema as well as those which create the conditions in which we experience the surviving products of early cinema today. These dual contexts are generally overseen by film historians of various academic traditions in the first instance and film archivists and curators in the second instance, with a certain amount of interaction between these professions. Neither set of specialists whether separately or in concert, have given sustained attention to the detail of the mechano-perceptual aspects of the experience, concentrating, instinctively and not without reason, on the content and quality of the film-based images which are the apparent visual focus of the screen-based experience.

I argue here, however, for a complimentary work, to create a shift in focus not so much away from the screen as, *additionally*, toward the parts of the screen experience where there is a trace or inscription of the projection technology, a shift which may also include the wider environment in which the screen is situated. Precisely because the lure of the projected image is so powerful, making this shift requires a conscious effort and a distinct approach but I maintain that it is an important corrective task in order to have a more accurate understanding of the nature and origins of that lure and to properly account for technology's contribution to the activation of the mental life of the spectator and the compulsion of the screen image, which has itself formed the basis of many psychological approaches to the study of cinema.

As Roland Barthes identified in a quasi-phenomenological analysis of his own movie going experience, there are two fascinations of the cinema which almost oblige him to have two different bodies; that of the image, (which appeals to the narcissistic body) and that of the surroundings, (which appeals to the perverse body).[4] The surroundings include 'the texture of the sound, the hall, the darkness, the obscure mass of the other bodies, the rays of light, entering the theater, leaving the hall' (1980, 4). Of these he is particularly attracted to the 'dancing' projection beam or 'rayons dansant' and for Barthes it is such artifacts which also include 'the flickering light of the projector' (1980, 2) which deliver the fascination and provide an 'amorous distance' (1980, 4) from the image.[5]

The dual engagement of cinematic experience has of course been noted by other theorists, a recent example being Francesco Casetti whose concept of 'filmic experience' (2009, 56) pairs absorption into the sensory world of the image with an awareness of the 'very fact of viewing' (2009, 56).[6] Numerous factors can be cited as conspirators in this fact of viewing, especially so in the heterogenous viewing environments of early cinema which on a purely architectural level encompassed small salons, stately variety theatres and travelling fairground tents. While

[4] (Barthes, 1980) See (Barthes, 1975) for the original French text.

[5] The fascinations of the image and its environment are, in terms of our attention, seemingly opposed to each other's efficient operation, but the human subject can, as in Barthes' case, train itself to hold them in balance and maintain a 'slightly disengaged imaginary' (*un imaginaire légèrement décollé*). My argument throughout this thesis is that the conditions of early cinema were already such as to promote this slight disengagement.

[6] 'Indeed, filmic experience is arguably both that moment when images (and sounds) on a screen arrogantly engage our senses and also that moment when they trigger a comprehension that concerns, reflexively, what we are viewing and the very fact of viewing it.' (Casetti, 2009, 56)

architectural elements were at times co-opted into the commercial proposition of mainstream cinema experience, perhaps most notoriously in the florid extravagance of 'Atmospheric' cinema theatre design, traces of the technological support of the experience were amongst the first artifacts to be hunted down and reduced to negligible levels through successive waves of standardisation and institutionalisation. Of course, all such distinctions of cinema experience that we might point to are subject to change or removal over time: Barthes' light cone did not survive into the digital era where it might have persisted in a less flickering state because public distaste for smoky atmospheres had already reduced the aerial pollution necessary for its occurrence.

It is the work of this thesis to investigate just such a modest artifact of the cinema experience. One which has variously fascinated and appalled but more often simply been ignored. One which, significantly, can be found in both the image and the surroundings. Flicker, originating in the light escaping the projector lens, was present in the screen image, the 'dancing' beam, and any reflected light returning from the screen and illuminating the interior of the projection space. Although more or less perceptible depending on the strength of the illumination, flicker was therefore part of the structural unity of the site of cinema, as much a part of the glue holding all elements in relation as the light itself, to which it also lent temporal structure.

It was a core of the cinema experience and a co-product of mechanical and mental technologies. It was most visible in the early cinema period, and attracted much attention and innovatory effort to bring it under control and reduce it to levels where it was unreportable for spectators. It survived at these more or less unreportable levels, hidden in plain sight, through later phases in the technological development of cinema including the traditional milestones of the introduction of sound in the 1920s and the mainstream debuts of Widescreen and 3D cinema of the 1950s. In fact, only with the arrival of digital projection technology, and its widespread adoption in 2011, was flicker finally deleted from the infrastructure of cinema experience, as the function of the shutter became obsolete.

My aim in this thesis is to excavate this now vanished and previously overlooked component of the fascination of the moving image as it existed in the earliest period of cinema when it was rather less easy to overlook and indeed sometimes painfully visible. In doing so I argue that we will not only gain insight into the experience of early film audiences but discover strategies for enhancing our own experience of early cinema at its most fundamental level, when we take part in modern-day screenings of its repertoire.

The problem as suggested by an image of early cinema

As an introduction to these concerns, the period of early cinema, and even as a kind of staged tableau of the entire thesis, I refer to a piece of documentary evidence, an image full of early film technology and its human exponents. The image is part of a full-page advertisement published in the German language trade journal, *Der Artist*, in May 1899 and depicts the Dutch film pioneer Anton Nöggerath and a collaborator.[7] In this picture, a calling card for his film making and exhibition business, Nöggerath has collected together the material components of the motion picture experience, which he is promoting under the name of *Riesen-Graphophone*. The major discrete items of film camera, projector, film cans (already being used to denote 'actual' film) and sound recording and reproducing apparatus are overseen by a top hat-wearing magus figure and a bowler hat-wearing camera operator. The audience is not depicted but a link is established with the space outside the image by the gaze of the camera operator who adopts a pose which has become familiar to us from other such promotional photographs: His hand lies in readiness on the hand crank and an attentive gaze is cast on his subject, just as when, in comparable images, the pose is adopted by a projectionist, whose gaze hovers on an imagined screen. The image in this advert is a literal staging – taking place in presumably their own film studio on a stage with a cloth backdrop – of the technology required to create the experience of a film show. But it is also a symbolic staging, the recognizable iconography of man and machine in harmonic action visibly implying

[7] Franz Anton Nöggerath (1859-1908) and his son Franz Anton Nöggerath junior (1880-1947) were film pioneers based in Amsterdam and London respectively. Although it would be tempting to consider this a picture of father and son, Anton junior joined Maquire and Baucus in London in 1897 and according to Blom, stayed in England until his father's death whereupon he returned to Amsterdam to take over his father's business. (Blom, 1999, 265)

the relation of the mechanical and perceptual which, I argue, was at the heart of the early film experience.

With the gaze of the camera operator now penetrating our 21st century space, we may ask, what is left of that experience for us to recover today? The answer, at least in the case of Nöggerath's film oeuvre, is fairly positive, given the losses suffered by silent cinema in general, because a number of the non-fiction films made by him in this period have survived in the archives of Eye Filmmuseum and the BFI National Archive.[8] Theoretically, they could even be amongst those implied contents of the cans on the table in the picture. In material terms, the 35mm celluloid nitrate films shot by Nöggerath would have been developed as a negative and then printed onto more nitrate stock to create a positive, ready for projection. It is these nitrate projection prints that have survived in some form to this day. After an unknown but probably hectic and traumatic early working life they have settled into a relaxed retirement (and decelerated eventual demise) on their climate controlled shelf in the archive. Further copies have been made using the projection positive as source, firstly onto cellulose acetate film stock using photomechanical means and latterly, using digital technology, through scanning and laser recording back onto polyester film stock. Various video and digital transfers have been made from these preservation elements for access and exhibition purposes.

[8] A 25% survival rate of silent film is often quoted. The survival rate of American silent feature film of the period 1912-1929 has been accurately calculated by David Pierce. See Pierce, (2013, 63). The fiction films of Nöggerath were destroyed along with the Flora Theatre in Amsterdam in a fire in 1902. (Blom, 2010, 78)

Happily, therefore, the images of Dam Square in Amsterdam and of the parade of Paul Kruger which Nöggerath's camera recorded in 1900 can still be seen today thanks to the work of their professional custodians, the archivists, film restorers, and curators. However, when a researcher, programmer or audience member views these films today, in material terms they will actually be viewing a copy of the archival original (the projection positive) via a technology which is also in some sense a copy of the original technology. The proliferation of copies and copy technologies is potentially enormous. Of course, any changes introduced in this 'copying' process have the potential to influence the reception of the film by the viewer and increase the distance from the experience received by the film's first audience to that experienced by a latter-day audience. In terms of material authenticity, we can sketch out a number of different scenarios: in place of watching the original projection positive on a hand-cranked Bioscope projector of 1899, as depicted in this image, the most easily achieved, best available scenario, may be watching a safety copy on a relatively recent 35mm projector, such as a Kinoton FP30, while a contrastingly modern but highly inauthentic experience would be watching the digitized file as it streams from the Eye website on a mobile phone. This last example lies outside the purview of this thesis as I limit myself to considering the effects of different projection technologies within theatrical settings, but given that the recent digital restoration of these titles has produced no theatrical 35mm print, the only means of watching it must be as a presentation of a digital file, whether on an electronic screen or delivered via a digital projector to a theatre screen.

In the latter case, the file format generally adopted is called a Digital Cinema Package or DCP. Given the use of the correct software, the information in the DCP is sufficient to build discreet frames of pictorial data – such as exist in sequence on the strip of 35mm film – and run them in sequence one after another to produce the same illusion of moving images as that achieved by the conventional movie projector. However, because this process is no longer part of a purely mechanical system, there is no need to mask the action of the machine in bringing the next frame into view.[9] The digital equivalent of the 'pull down' of the next image in an analogue projector is a mere refreshing of the pixels of the Digital Micromirror Device, the chip at the heart of a digital cinema projector. The switching is achieved not 'in the blink of an eye' but in a tiny fraction thereof and has no need of a shutter to hide its occurrence, its extreme rapidity being mask enough. Practically speaking, this means that there is no dark time on the screen produced by a shutter and no sensation of flicker from the interaction between the dark time and the bright picture.[10] The question explored by this thesis is how such changes to the delivery

[9] The data managed by the DCP is fed through the key component of the digital projector, the Digital Micromirror Device or DMD, an array of millions of microscopic mirrors which each control the appearance of one pixel. Technically, this is a Micro-Electro-Mechanical System (MEMS) or Micro-Opto-Electro-Mechanical System (MOEMS) in contrast to the opto-mechanical technology of early cinema projection. See (Lee, 2008)

[10] In analogue film projection darkness actually makes up about half the time of the screening with the exchange between dark and picture happening two or three times per frame of film, depending on the use of a two or three bladed shutter. As Paolo Cherchi Usai has said, 'This doesn't happen in digital projection. Think about it. The difference is just too big to be meaningless to our senses, let alone to our aesthetic judgment.' (Hughes & Heckman, 2012, 60)

of the image data may have altered the balance of the relationship of the mechanical and the perceptual and by extension the experience of cinema. More dramatically, one could ask, how much of the cinema experience can we change before it is no longer cinema?[11]

Fittingly enough, this image of the Nöggerath ensemble, an unusually comprehensive visual summary of the material components of an early film show, is limited by its own materiality. Just as the trail of analogue and digital reproduction complicates the archival life of film, so too is this image changed and challenged by its journey through the paper archive. The illustration comes from a microfilm record of a no longer available paper original. It has in all probability lost information in terms of the colour, definition, contrast and shadow detail of the original magazine image (which was itself a reproduction of a photograph, produced with the limited reprographic technologies of the late 19th century). These losses have the general effect of arbitrarily increasing the sense of distance between the time of the image and the present day but, importantly for the current study, they also impact its evidential value by casting doubt over the specification of the projector in the image. Sufficient detail remains in the image to be able to identify the projector as a Bioscope – confirmed also by our knowledge of Nöggerath's business connections and the presence of Bioscope cameras in the image.[12] However, insufficient detail is

[11] Certainly, for some, the changes introduced by digital projection warrant a change of name.
[12] Nöggerath became the Dutch agent for Bioscopes, having developed a working relationship with Maguire and Baucus and their manager, Charles Urban, in London.

available to be able to declare definitively whether or not it possesses a shutter, a key variable in Bioscopes of this date. Such a detail may seem of slight regard but it bears significant relevance as to the quality of the experience which such an outfit would have created, or, in other words, its functioning in the interplay of the mechanical and perceptual.

The crisis of materiality which compromises this image's documentary value is, in all probability, a consequence of archival procedures which privilege the preservation of information above other properties of the original such as image quality and materiality. A policy focus on the legibility of the literal text – the image shares page space with the printed word - has done a disservice to the legibility of the image, and therefore failed in preserving all the information. It has also ignored, even as a possibility, the fact that direct experience of the original journal can generate insights beyond a strict communication of information. The policies which claimed that a high contrast, colourless photograph of a trade journal would be sufficient record to pass down to future generations relate to comparable issues in the history of film preservation, perhaps the most startling of which was the failure to make colour copies of early hand-applied colour films until the 1980s when the orthodoxy began to be challenged.[13] Since then and the era of microfilm, improvements in both analogue and digital technologies have now made it possible, though still not

[13] Because colour balances would shift during copying, the impossibility of maintaining accurate colour was used as a justification for not copying in colour at all. There may be a similar reasoning behind the neglect of historical film spectatorship: the impossibility of recreating the exact conditions of spectatorship militating against efforts to employ any historical technology or conditions.

straightforward, to preserve the quantifiable information in both documents and films so that copy and original are as legible as each other. What we have not yet attended to in terms of parity of copy and original is the technical means by which they are experienced.

The problem introduced by this image is therefore greater than the mere obfuscation of critical detail. It also provokes reflection on the current understanding and practice of the technical, material and historical specificity of film projection itself. In its own materiality and in its own illustrated content, the picture dramatizes this twofold issue, the preservation of information and the preservation of experience, which in turn map onto the delicate balance responsible for cinematic experience, the dual sites of mental attention: the image and the surroundings. This thesis is an attempt to nudge archival practice in the direction of the latter without necessarily compromising the former.

Context: Film Heritage Institutes and the preservation of information

The regional and national organisations that look after the physical cultural remains of cinema (with the exception of the bricks and mortar of cinemas themselves) have recently been grouped under the term, Film Heritage Institute (FHI).[14] The remits of FHIs can vary and encompass a variety of functions including archive, museum, and

[14] For a description of the activities of the 'rather large and differentiated group' of FHIs see, Mazzanti, (2011, 10). The term is also adopted in Nico de Klerk's recent book on how such institutions deliver their mandate for the communication of film history to a general public. (de Klerk, 2017)

repertory screening space. More specifically, a film archive would usually be tasked with looking after the conservation, preservation and restoration of the film collections.[15] It would not generally offer a public visitor experience beyond welcoming individual researchers, although it may have some publicly available infrastructure for screening films. A film museum, on the other hand, would be commonly understood as providing a publicly accessible, managed display of artifacts related to film making and exhibition and it is highly likely it would also have infrastructure for screening films.

In this study, I use the term to encompass both film archive and film museum. An FHI can be either archive or museum or, ideally, it can be both. It is my view that separating out film material from other film related collections at an institutional level is epistemologically damaging, though I accept a certain amount of separation as necessary on conservation grounds. FHI as a term therefore holds within itself a reminder of the ambition towards a more connected approach between the wide variety of collections that can be considered as parts of film heritage. Those which I am particularly concerned with uniting in this thesis and the practice it encourages are film and film apparatus although film-related collections typically also include books, photographs, posters, props and costumes from film productions and other objects associated with film making and exhibition.

[15] In this work, I follow a definition of these three terms within the context of the work of film archives, see, for example, Read and Meyer, (2000, 1)

Eye Filmmuseum, the Dutch national body responsible for cinematographic heritage and archival partner of this project, is both archive and museum. Following its recent institutional transformation, this fact is almost literally embodied in its real estate which comprises, for the most part, two separate but closely situated buildings in Amsterdam North. The museum building which opened in 2012 has a range of public-facing presentation spaces: four theatres, a large temporary exhibition space, a small permanent exhibition and interactive installation and reception areas which can accommodate improvised projections. Since 2016, Eye Filmmuseum's archival functions have been housed in a separate purpose-built collections centre which is less public-facing: only the library is accessible without an appointment. The building houses the acetate (safety) film collection, a restoration and digitisation atelier, the film related collections, of which film apparatus is a subset, and a small theatre for internal use. The apparatus collection amounts to thousands of separate items, most of which are kept in closed stacks in the collection centre and only viewable by appointment. However, in the museum building ten highlights from the collection are on public view as part of the *Panorama* permanent exhibition. They are housed in specially designed interactive display cases which include short video animations that explain their function.

The concerns outlined in the previous section regarding a bias towards the preservation of information and prompted by thinking through the appeal of an image of early cinema, have of course also arisen in other ways and have not gone unremarked by archivists themselves, as noted in preliminary discussions with the archival partners of this project.[16] Already in 2005, anticipating the dominance of emerging digital technologies for the future work of the film archives, project partner and senior curator at Eye Filmmuseum, Mark-Paul Meyer, wrote about the differing aesthetic qualities of cinema experience, posing the rhetorical question, should not films be 'presented in the format – i.e., the aesthetic framework – in which they were originally intended?' (2005, 16) In the article, addressed to his peers in FIAF, the leading International organization for film archives, he advocated for the continuing analogue projection of born analogue film in the forthcoming age of ubiquitous digital projection. He felt that the 'cinematic appreciation of film' derived directly from the unique perceptual quality of projected film: 'The projection is essential in bringing film to life. It is the projection that constitutes the perception' (2005, 17). Although he recognized that digital techniques wish to emulate traditional film projection it was a fallacy to think, based on traditional ideas of the reproducibility of media, that such emulation could extend beyond duplication of content.

> Content is something you can easily duplicate, the narrative of a film may not be dependent on its presentation format, but as soon as the specific aesthetic qualities of a film come into sight, we all know that these are almost impossible to duplicate. (2005, 18)

[16] In April 2015, a project discussion in Amsterdam with Mark-Paul Meyer and Bas Agterberg, curators at the EYE Film Institute and Institute for Sound and Vision, respectively, raised in particular the possibility that the preservation of the experience has been neglected in favour of the preservation of its material remains.

Although Meyer's readership of fellow archivists may understand this argument, he admits that it is a modest if non-existent consideration for the cinema-going public already used to many varieties of digital media and different versions of their favourite films, and for whom the aesthetic distinctions that he mentions are verging on the theoretical. Nevertheless, he continues, it must be the business of the FHIs, or cinematheques, to use his term, to secure this territory as part of their evolving identity.

> Film archives are museums that can recreate the perception and the appreciation of cinema as it was intended. I think film archives should take their museological function seriously. They should embrace the new technologies, but also cherish the old techniques. […] The projection of film in a traditional way is part of this museological function, and this museological function is the essence of our future identity. (2005, 18)

Dino Everett, Archivist of the USC Hugh M. Hefner moving image archive expresses a similar view and explains why archivists have historically concentrated on the preservation of information over experience. He advocates a shift in thinking about what makes up a satisfactory preservation.

> We are keepers of history and that needs to be exhibited…the content was once everything because the carrier seemed universal, but now that the carrier is being changed I believe it should become part of the preservation. (Conner, 2013)

Everett is referring to the century-long prominence of standard gauge 35mm film as both the carrier of image content and the material basis of the projection experience and argues that the concept of preservation should not separate out these two roles. 35mm's apparent universality and status as the default projection format has now been taken over by digital and, just as in the past, less popular and well-established formats would be transferred to 35mm, now original 35mm content is transferred to digital carriers.[17] The longevity of 35mm, reaching back into the beginning of the early cinema period provided a degree of technological stability to content preservation efforts but also assisted the illusion that nothing had changed in over a hundred years of projection technology. Whether analogue or digital, the hegemony of default screening formats works against the ambition of historically accurate presentation which would seek to acknowledge the diversity of film technology. In this way, the concerns raised by Meyer and Everett, although inspired by reflection on the transition to digital projection technologies, are not simply a matter of the binary opposition of analogue and digital but have always been present, as the separated-out components of image and technology have tracked their own variously divergent courses through cinema history and archival exhibition.

To some extent it is part of the core sensed knowledge of an archivist to be troubled by such concerns but nevertheless institutional emphasis and the weight and habits of professional practice and expectation have fallen on the side of image quality, on the preservation of all the information in the image, above all else. The information is measured both qualitatively by the aesthetic judgement of the film archivist but also quantitatively by the amount of information produced, in digital

[17] Obstinately esoteric formats such as 68mm Biograph or 17.5mm Ernemann Heim-kino have been subordinated to 35mm standard gauge through processes of blowing up or down. In these cases, the preservation is regarded as complete despite the fact that both preservation and exhibition elements do not correspond to the original format.

work for example, in terms of pixel count and bit depth and resulting file size. Indeed, adoption of the concept of digital preservation was facilitated in part by the ability of digital technology to represent all the pictorial information in the film material, once scanning technology had achieved sufficient accuracy.[18] A similar process has been at work in film production where developing digital camera sensor technology was accepted as a widespread alternative for film when it achieved a comparable pictorial resolution. Archives have been used to work on the assumption of displaying the best copy possible on the best technology possible using the most original element as source. Only then, given the limitations of analogue film preservation and generational loss, will a result be 'good enough'. However, applying this mindset to digital restoration has meant that, ironically, it is now possible to produce results which are 'too good'.[19] The digital film restorer therefore has to judiciously limit the power of the available tools. They must also learn to distinguish original artifacts from damage occurring later in the film's life. Despite these recently evolved ethical challenges, however, the attention of the film restorer is still very much fixed on the image, with thoughts of its exhibition a secondary consideration, though increasingly one bracketed by the knowledge that

[18]Nevertheless, the term is still treated by some as a *non-sequitur* because of 'the need to periodically migrate the digital files, and the rapid obsolescence of the equipment used for storing them.' (Usai, 2013, 11)

[19] When original camera negatives are used as the source for a digital restoration there are no losses through print generation as with the analogue film production workflow and the images can therefore appear to be higher definition than the original prints. This has opened up a debate amongst film restorers and audiences about how far one should pursue a mantra of best available picture quality. Given that expensive film restorations are funded by studios with an eye on the revenues achievable from DVD and Blu-ray sales and television rights, archival film can be subject to commercial pressure to bring it up to a quality which the modern consumer has come to expect from technologies used in present-day film production.

the ultimate theatrical expression of the restored digital files will be as a high-quality digital projection.

This emphasis on the film material as a carrier of information is one reason – in terms of the challenge implied by the Nöggerath picture – that until now it may have been considered cinema 'enough' to preserve the content of the films on the table but not their means of presentation, as represented in the image by the Bioscope projector. Inevitably, there are also practical considerations for FHIs which would prevent the regular use of early film technology such as the Bioscope in their repertory screenings. There may also be a more existential issue regarding the preservation of the cinematic experience, given the Heraclitean impossibility of a complete preservation of any experience, let alone historic film experience. Just as the justification for copying early tinted and toned and hand-coloured films in black and white was due to the impossibility of making analogue copies with accurate colour reproduction, so may the impossibility of an absolute replica of experience satisfy some that a highly incomplete version is inevitable. However, the limited ambition of this former policy toward colour film preservation was overturned by a subsequent generation of archivists and I argue here that we similarly need to look again at the preservation of experience and, without assuming complete success, make generous room for improvement.[20]

[20] See Fossati, (2009, 156). Fossati also gives an alternative explanation of this oversight. Namely that the socially constructed dominant meaning of 'black and white film' from the 1930s, retrospectively extinguished the possibility of colourful earlier examples.

Context: The isolation of the apparatus: a fractured *dispositif*

In some notorious cases, such as that of Henri Langlois, the founders of FHIs have been avid collectors and have intuitively understood that everything with a relation to film should be kept. Resources have been devoted to salvage attempts while less attention was granted to what the end game might be, or even what we might call the middle game of decent storage and conservation procedures. Subsequent generations of archivists have imposed greater order on the established collections, introducing collection policies and conservation standards while easing back on a collect everything mentality, aware that shelf space in climate-controlled storage has a real-world cost that cannot be avoided.[21] Despite this, continued collection building often remains a highly contingent practice. Of all the collections typically held by FHIs, those of the technology of cinema are the least understood by the institutions themselves and the least resourced. The institutional ambivalence toward technology collections makes them potentially under even greater threat than analogue print collections facing accusations of obsolescence once digitised.[22] In the UK, public film technology collections are so dislocated from film that the British Film Institute (BFI), the national archive for film and television, has no technology collection. What can be considered the premier national collection of

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[21] For an institutional history of film archives see Houston, (1994) and for case studies of even earlier attempts to exhibit the history of cinema in the Smithsonian and the Science Museum see, Latsis (2016)

[22] Whereas the introduction of digital technologies as origination and production media was more attenuated, the sudden switch to digital projection has left the archives struggling to meet the demand for their content to be available as DCPs. At the moment, these large archives of projection prints, which almost overnight became obsolete, may seem like a liability, however, once the grounds for a significant experiential distinction are accepted, they actually become the rarest of treasures. Unlikely to ever be added to in significant numbers, they can be a USP of FHI programmes once taken off the vault shelf and carefully activated by archival projection.

film technology is conserved in Bradford at the National Science and Media Museum (NSMM). It, however, has no significant film collection. One could say therefore, rather pessimistically, that film technology is removed from the context of film and film is removed from the context of film technology with the result that two national institutions fail to provide even one complete picture.[23]

Eye Filmmuseum is rather better established as an institution with unique film collections and extensive apparatus holdings. The film technology collection has been present since it was founded as the Nederlands Filmmuseum in 1949, but until recently it has lacked a strategic aim. The collection was formed out of what was offered to the museum, rather than around the framework of a specific collection policy (Albers & van den Berg, 2016, 335). Reviews in 1995 and 2004 have begun to address this lack of direction and in recent years extensive cataloguing of the collection has facilitated its access as a resource for researchers. The opening of the new museum building in 2012, has even provided opportunities for its partial exhibition. The opportunity is rarely taken, however, to weave in items from the collection into the presentation of its repertory film programming, although there is certainly increased attention to the technological support of film in the museum's offering of select new releases. The museum has profiled itself as the only place in

[23] While FHI structures are not the focus of my research, I would say in passing that this problem illustrates the need for a National Museum of the Art and Science of Cinema. Photography suffers from a similar narrative which labels its production as art and its technology as science and then corrals each in separate institutions, the Victoria and Albert and the National Science and Media Museum, respectively.

the Netherlands which can project the latest releases of cinephile directors such as Christopher Nolan, Paul Thomas Anderson, and Quentin Tarantino in their preferred analogue formats, having maintained and invested in its ability to screen 35 and 70mm prints. It also screened the exceptional 'unrestored' version of *2001 A Space Odyssey*, overseen and promoted by Christopher Nolan as a chance to 'recreate the experience audiences had in 1968' (Deb, 2018).[24] However, more commonly, new studio restorations of classic film, including other Stanley Kubrick titles, are screened in the current *de rigueur* format of 4K digital.

FHIs are usually split internally into preservation and presentation activities. However, a preservation of the experience is itself a presentation and must therefore necessarily involve coordinated work across the organisation. Although inter-departmental collaboration has improved since the new organisational structure was established in 2010, these activities still take place in separate buildings, now purpose-built to the differing requirements of storage and display. Even within the same building, dedicated to the preservation of collections, further demarcation occurs in collecting policies which often separate films from the technology that created them. Of course, roles for staff follow this model with the result that, at least in the larger institutes, a film restorer is not also projectionist and

[24] Nolan worked with Warner Bros. studio to produce a new distribution print from preservation elements without recourse to any digital workflow. 'There was a singular aim to view the film in its first cinematic form. Instead of fixing several tears in the original negative, the team thought it would be more authentic to retain them.' (Deb, 2018) The 'unrestored' version was given a premiere at Cannes in May 2018 and screened at Eye Filmmuseum the following month.

a film curator is not also programmer. Demarcation at the levels of organisations, departments and personnel can therefore militate against the connected approach which a reconstitution of the experience requires and separate rather than unify the surviving fragments of a historical cinema *dispositif* and the knowledge required to reanimate it.[25]

A relative lack of attention to apparatus collections in FHIs also means that the survival rate of early film technology is an unknown quantity. It would appear to be even less than that of the silent films, although there are no statistics for this due to much less comprehensive cataloguing and analysis of technology collections. Unlike film material, there is no international body such as FIAF to oversee the different collecting institutions or promote joint projects in the sphere of apparatus collections. Perhaps the closest to this are occasional attempts by the Historical Committee of SMPTE to undertake the preliminary task of mapping the global stock of film technology collections.[26] In the wider field of science and technology museum collections a loose group of museum specialists, meeting annually under the banner of 'Artefacts' have recognised, 'that objects have not received sufficient attention in serious historical studies, and even in exhibits they more often serve as

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[25] Without necessarily adopting fully the psychoanalytic analysis of Baudry's *dispositif* or even the wider network of power dynamics suggested by the term's Foucauldian heritage, the utility of the concept of *dispositif* to this project is that it reminds us that in cinema there is something more than the image, there is, as Barthes would say, an image and its surroundings. The projected image is only the most obvious part of a system which creates cinematic experience. The other components which include the literal apparatus are of course subject to change over time although the system usually works to hide this change. To avoid confusion, I use the term *dispositif* in its original French and not its sometime English translation 'apparatus'. In this thesis 'apparatus' stands as a synonym for device.
[26] See Schuller, (1998). The work described did not continue beyond a second report released in 2002. (Schuller, 2002).

icons than as significant evidence.'[27] However, as a broad grouping of science and technology museums, they have not to date specifically considered the place of film technology in their collections.

In many ways, the default position of the FHIs simply follows the logic of the classical cinema paradigm which seeks to sequester the means of production of the illusion. As everyday cinemagoers, we are more than used to the dislocation of cinema from its technology, so much so that it goes entirely unnoticed. However, in terms of the open *dispositif* of early cinema, this default position has not just left a technology sized hole in our understanding but severed awareness of the link with the perceptual and cognitive apparatus of the viewer.[28] It has removed the friction from the flow of information and sensation between the projector (and projectionist), the screen (and its surroundings) and the mind of the observer. By separating early film technology from early film our conception of historical spectator experience can be informed only intellectually by first hand reports and not by our own visceral bodily responses.

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[27] The group's statement continues, 'The purpose of Artefacts is to help resolve this problem by providing an annual forum where historians from museums and universities can discuss issues, by publishing collections of articles (based on the meetings) through which an appropriate historiography can be developed, and by other means as may be determined.' See, www.artefactsconsortium.org

[28] Frank Kessler has applied the concept of *dispositif* in particular to the period of early cinema. See Kessler, (2006)

Bridging the gap: strategies to unify the relation of film and technology

Some recent initiatives can provide examples of ways to better account for historical film experience through attention to the mechano-perceptual. In 2016 the Charter of Cinematographic Projection in the 21st Century, invited institutions and individuals to sign up to the intention to 'favor photochemical film projection whenever a projectable print of a historic film is available or a contemporary film is made in this format', on the grounds that it is a 'unique and incomparable experience.'[29] The charter is a non-binding agreement to project film rather than a perhaps more commonly available DCP has been accepted by a number of FHIs, including Eye. This unequivocal statement of the unique experiential quality of analogue film projection ensures that the sheer ubiquity of the digital takeover of theatrical presentation does not have to imply that the assumption of equivalence is a settled issue. To this initiative, I would add the need to further differentiate the role of film technology away from the binary opposition of analogue and digital technologies to a more nuanced view that can take account of the dynamic changes within the century-long history of analogue film technology itself. Such a view would privilege the presentation of films from the era of early cinema using technology from the same era rather than the current practice which would for example, project a film copy of *Le Voyage dans la lune* (1902) at 16/18fps on a 'modern' projector with a three-bladed shutter.[30]

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[29] (*Charter Of Cinematographic Projection In The 21st Century*, n.d.)

[30] The analogue projectors at Eye are some of the newest in existence having been purchased specifically for installation in the new Museum building, which opened in 2012.

This technically ambitious position can too easily be frustrated by its not insignificant practicalities. It is most easily achieved on the basis of one-off screenings to specialist audiences – the experience of a cinematic extreme for a cinephile public – and has been attempted by various institutions in this manner. It has not to my knowledge ever succeeded in becoming a permanent feature of the programming strategy of an FHI, even under the guise of an occasional series. For example, the collection of both films and film technology formed by Jean-Pierre Verscheure, Cinévolution at Mons in Belgium, explicitly stated its potential to present certain historic films such as *Citizen Kane* or those of the Lumières on period appropriate technology.[31]

Unfortunately, like so many collections amassed by passionate individuals, mastering the evolution of a museum project into an establishment FHI proved impossible and the collection has now been absorbed into the French national CNC collections and placed on deposit at the Cinémathèque française. Here, however, its chances of a kind of 'activated' conservation are probably the best of any FHI in the world.[32] In 2007 a Conservatoire des Techniques was inaugurated as a component within the Cinémathèque française as a way of making sense of the technological collections amassed since the 1939 donation of Georges Meliès'

[31] 'Voir les films Lumière comme en 1895, entendre les sons Vitaphone comme en 1927, voir Citizen Kane avec le son RCA de 1940, bref voir et entendre les films de l'histoire du cinéma dans leur forme originelle est aujourd'hui possible dans une large mesure.' (Verscheure, 2010)

[32] The fate of machines in museum display or storage is often to become an inactive object. I use the terms 'activate', 'activation' or 'activated' throughout this thesis to describe the active use of such technological museum-bound objects.

camera and projector and also including the Will Day collection acquired in 1959. In this case, the concept of conservatoire indicates an extension of a simple museum collection. As stated by its curator, Laurent Mannoni, it is a tool for a means of better understanding, managing and valuing or 'valorising' the collection.[33] Perhaps the difficulty of finding a one word translation of 'valoriser' is comment enough: The value of an object is in the connections that it can make and archival systems risk denying its connectivity and prefer to isolate it. Too often collections of apparatus within FHIs are subject to less vigorous institutional growth and have remained depot bound, baffling the institution as to their value and entering a vicious circle whereby they are denied the resources necessary for the opportunity of public attention, which might otherwise justify increased resources.

One strategy employed by the Conservatoire des Techniques is a series of monthly seminars which have afforded the opportunity of demonstrating technical objects from the collection and are probably the closest approximation to the type of archival 'showing' event envisaged by Verscheure.[34] The Cinémathèque française has also been in the forefront of making its collections digitally accessible via the

[33] 'Il fallait créer un Conservatoire pour mieux comprendre, gérer et valoriser un tel trésor archéologique.' (Mannoni, 2016)

[34] The seminars are referred to in article 2 of the Conservatoire's mission which I quote here in full. '1) de collecter, conserver, restaurer et étudier tout ce qui concerne les techniques cinématographiques des origines à nos jours; 2) d'enseigner l'histoire technique du cinéma, en organisant une fois par mois à la Cinémathèque une conférence assure par les meilleurs spécialistes; 3) d'organiser des expositions sur le sujet; 4) de suivre attentivement l'évolution technique du cinéma et de préserver, dans la mesure du possible, toutes les traces (matérielles, orales, écrites) de cette évolution; 5) d'analyser tous les effets que le numérique exerce sur la technique et la production cinématographiques.' (Mannoni, 2016, 14)
It will be seen from the last article that the looming shadow of the arrival of digital was a major factor in the establishment of the conservatoire as the collection of comparatively recent technology became critical in the face of rapid obsolescence driven by industry change.

internet, putting details and photographs of 4500 apparatuses on line. This is the conventional work of a museum in the digital age, although to my knowledge none has succeeded in representing their entire collections in this manner. Similarly, a group of five German museums have taken the first step to the digital representation of its collections by making records and photographs of 850 film cameras available online. This *Kameradatenbank* project is acknowledged as a preliminary effort with the aims of seeking broader attention for the objects and filling a perceived gap in the coverage of film technology in media history.[35] In the UK, the National Science and Media Museum contributes data on its collections, which include the national cinematography collection, to a searchable section of its website. Although there is no permanent display of the collection, researchers can request physical access to the collections via the Insight visitor facility in Bradford.

At Eye Filmmuseum, a different approach has been taken. Despite, or perhaps because of a smaller collection and more limited resources for cataloguing, rather than passively seeking the engagement of researchers through an online illustrated catalogue, the archive has directly sought out relationships with key researchers. The establishment of a conservatoire has effectively been outsourced to ongoing collaborations with the scholarly community the most prominent of which has been

[35] 'First, it seeks to draw broader attention to these underappreciated archival treasures. Second, it establishes a foundation of information to plug a known research gap in the field of film studies. Film technology is without doubt one of the few underexplored chapters of media history. The database represents a first step toward comprehensive documentation of film-technical museum collections in Germany. In the future, all manners of devices (including those for film production and film editing) will be incorporated into the joint project for presentation online.' (Deutsche Kinemathek, n.d.)

the project ‘The Film Archive as a Research Laboratory’, carried out with the University of Groningen.[36] This has gathered a large number of International scholars into a loose group and has resulted in symposia and the publication of a ground-breaking anthology of scholars’ responses to individual items of apparatus. The methodologically diverse chapters intentionally display a great variety of approaches to the discussion of technological objects although most advocate a hands-on engagement with their subject.[37] This approach suggests that the key to filling the perceived gap in film historical accounts is a joint work of improved archival access working together with greater academic engagement, with both parties sharing methods and ultimately benefiting.

However, few of the 29 contributions, including my own, make the substantial interdisciplinary leap of combining the analysis of a technical object with a discussion of its perceptual effects. One exception is Benoit Turquety’s analysis of the Kinemacolor projector, an apt device with which to make such a connection.[38] In the same collection, Sonia Campanini’s study of the Biophon projector is notable because through the analysis of the system she is drawn to conclude that film exhibition is

> a *dispositif* situation where human actors (the projectionist, the audience) and technological actors (the devices, such as the projector and sound diffusion systems) interact and determine a network of material and symbolic relations

[36] See Fossati and van den Oever, (2016, 33)

[37] ‘we find that an investigative and explorative flexible approach to apparatuses is most suited for this transitional phase of archival practice and related hands-on research.’ Ibid, 37

[38] The Kinemacolor projector creates, in the mind of the observer, not only movement out of still images but also colour from black and white. (Turquety, 2016)

> that make each screening a unique cinematic event and experience. (2016, 254)

In short, the 'human actors' are an essential component of the study of technological objects – objects that only make sense when activated by human experience.[39] The framework of *dispositif* makes this clear and helps to counteract the dominance of the image in film preservation. Cinema experience is created by the totality of the *dispositif*, not just the interpreted contents of the projected image, or indeed any other discrete component. However, notwithstanding a general understanding of *dispositif* as representing the distributed cinema experience, there is still a discrepancy in the lack of attention given to the literal mechanisms involved. The structure of film material itself is one such example; as is a wide variety of projection apparatus. Each could be said to form a micro-*dispositif* of their own. When examined in combination with another component in the equation of cinema experience – the mind – (and its components) there is productive potential for new understanding in all these areas. The key to unlocking the meaning of the apparatus as artifact is in hitching it to the cognitive life of the human actors, the audience / operator / showman. This broadens the limited but for some, seductive, appeal of the materiality of old technology into something more interesting which can find relevance for the general population of interested cinemagoers who may simply be curious about the attractions and lures of the cinema experience.

[39] Tom Gunning has tentatively proposed the phrase, 'technological images' to draw attention to a class of visual experience which only exists through mechanical mediation. 'Through the device the observer is "made to see" something not otherwise visible.' (Gunning, 2012, 500)

The fact that much of the cinematic surroundings are reduced to liminal presences, mere traces left to balance on the edge of perceived existence does not disqualify them from consideration as key elements. What's more, in the case of early cinema, this reduction and negation often had yet to take place. Locations varied from small halls to large variety theatres but, for example, the presence of the projector would often be visible and audible to the audience. On early projectors, the shutter was often a prominent and exposed part of the mechanism which in some situations would be viewable by a spectator with a turn of the head and provide a direct link to the source of the flicker evident in the projected image. A full consideration of all the elements of the multi-part *dispositif* of cinema soon leads one to the inevitable impossibility of staging a complete reconstruction of any cinematic *dispositif* from an earlier period. However, this should not defeat a sensitive approach to the reclamation of some elements for the purpose of heightening awareness of the conditions of early cinema, as I discuss in section 1.3. Furthermore, it should not allow a lax attitude to the unacknowledged restructuring of the *dispositif* with new technologies. If one part is substituted for another, as in the case of the digital projection of born analogue film, the totality can no longer pretend to be the same, despite any lookalike pretensions.

Approach

As Michael Punt has stated, 'Our understanding of the invention of cinema has been driven almost exclusively by separating the history of the technology from the history of the image.’ (Punt, 2005, 49) Naturally, this separation has affected other periods of film history too. The preceding examples of institutional attention to apparatus collections are a measure of progress toward a more integrated approach to film history in which the history of the image can be informed by the history of technology but work still needs to be done in the archival and scholarly communities to raise awareness of the relevance of the apparatus as a source for film history. As Punt continues,

> it is the films - that is the software of the cinema that is considered to be the primary trace of human consciousness. What is excluded from this kind of history is the popular and individual imagination that is sustained by technology as hardware, and the act of engaging with technology (collectively and individually) as an extension of consciousness. (2005, 49)

The study of these objects can certainly inform the technological imaginary which it is Punt’s concern to reveal but this neglected archive is perhaps even more ideally placed to provide solutions to the concerns raised within the same institutions (and sections of their public) about the preservation of the cinema experience. We simply need to find ways to join the evidence to the experience. My contention is that this can be achieved through a focus on the faculties of the mind which are in any case the original connective tissue. We should begin by tracing back the quality of experience to the interaction of the mechanical and the perceptual, to the design of the apparatus and the confines of human physiology. Given a certain ahistorical dimension to experience based on such confines, the trace provided by the apparatus can provide a degree of access to past experience. The history of the technology and the history of the image can be united in this common ground represented by the 'human actors' in the *dispositif*. Not just the hardware and software, therefore, but what is termed by neurosurgeons, the wetware, especially that part directly exposed to the stimulus of projected light, the human visual system (HVS).

The apparatus collections therefore represent a tantalising repository of historical experience but one which needs specific skills and approaches to unlock its vault and interpret its holdings. Until recently the apparatuses collected by FHIs have not been seen as a text, or carrier of data but more like souvenirs of historical processes. However, this view is due not to a lack of data but to a failure of the means of revealing the data, effectively to the lack of a suitable method. In the following pages, I therefore seek to cross reference evidence drawn from the apparatuses with scientific research which throws light on its likely perceptual effects. I make use in particular of research carried out in the same period as the manufacture of the devices in order to map the potential correspondences between the perceptual experiments of the cinema and the scientific lab. However, because of at least a degree of timelessness to the nature of perception I include relevant commentary from other periods. Evidence is not merely restricted to the physical apparatus but also variously makes use of contemporary reports of screenings in the early cinema period, references in contemporary journals and the particular character of data present in the patent record. These additional sources thoroughly place the apparatus in the specific context of the period and the technological imaginary referred to by Punt.

The most productive reading of the 'text' of the apparatus in reference to our knowledge of perception and cognition requires an activated apparatus. I therefore apply, as the fullest expression of my method, a combination of literal media archaeology, with its more recent evolution, experimental media archaeology.[40] The literal media archaeology treats the object as a carrier of meaning that can be interpreted through close observation, description and commentary, much as if it had been dug up out of the ground. It is related to the movement towards material history which has been advocated in the context of film history by, for example, Ian Christie.[41] However, for the fullest revelation of meaning the machine, designed for active use, must be read while it is in use. Jean-Francois Gauvin has recognised this in connection to objects exhibited in science museums. When such objects appear in static museum display, 'The performing object then becomes a "pure object"', he says, referring to Baudrillard's concept, 'an object pushed onto an aesthetic plane that no longer belongs to the practical and tangible space of functionality.' (Gauvin, 2016) Gauvin's solution is for museums to

> adapt their discourse and presentation to […] the history, philosophy, and sociology of experimentation, in which instrumentation and laboratory performance play a crucial analytical role in our understanding of scientific

[40] (Fickers & van den Oever, 2014). A loose grouping of scholars and archivists interested in this approach have formed the Network for Experimental Media Archaeology (NEMA).
[41] See Christie, (2007).

> practices. (Gauvin, 2016)

While Experimental Media Archaeology is more narrowly concerned with media devices, it too advocates moving the artifact out of storage or display and into an exploratory lab environment.

> In creating such a space for creative exploration and tinkering with either original artifacts or replicas, the researcher will get a first-hand experience of the heuristic difference between studying textual and visual representations of past media technologies and experiencing their performative qualities and limitations in real-life interaction and re-use. (Fickers & van den Oever, 2014, 274)

In other words, the researcher will become aware of their place as a 'human actor' (Campanini, 2016, 254) in a cyclical system of stimulation and perception and of the parameters of technology in influencing that system. Similarly to experimental archaeology and the history of science, EMA applies a process of re-enactment, and specifically engages with historical artifacts in order to stimulate 'our sensorial appropriation of the past […] thereby critically reflecting the (hidden or non-verbalized) tacit knowledge that informs our engagement with media technologies. (2014, 273)

I apply these experimental media archaeological techniques in particular to the analysis of a 'performing object' in chapter 4, an example of the Bioscope projector similar to that in figure 1. In place of 're-enactment', however, I favour the terms 'enactment' and 'activation' which do not necessarily imply an equivalence to a previous version of experience but simply the acting out of a procedure. It therefore emphasises the fact that no matter how precise the conditions, a complete return to previous experience is impossible. While the Bioscope was returned to a semi-functioning state, it was not rendered fully operational. However, my approach to a partial recovery of cinema experience has been further informed by the practice of projection itself and participation in it both as an audience member and a projector operator. In Chapter 1, I report on the novel sensory experience of a rare demonstration of early cinema projection. In other cases, my research has included enacted projections within various analogue and digital comparative situations including one which was embedded in an electrophysiology experiment (see chapter 3), and one in which data from the experiment was re-imported into a theatrical performance of the projector. (See appendix 3.) On another occasion, projections of analogue and digital versions of the same film formed the basis of a guided discussion between audience members reflecting on their heightened awareness of their perceptual faculties. The practice of projection has therefore been a heuristic tool to explore the diachronic modulation of the meeting point of minds and moving images. This meeting point is brought into even closer view by narrowing the focus of the study to the single component of the shutter within the micro-dispositif of the film projector. Although only a modest piece of hardware the shutter nevertheless represents a collective perception.

A study of flicker not only drives engagement with the oft-neglected perceptual aspects of cinema which are self-hidden from conscious thought but, in developing a more nuanced critical awareness and in undergoing the training required to carry out this project, the collective weight of these experiences has helped me to acquire an extended perception which is also more sensitive to other aspects of cinema experience, such as the ambient lighting environment or certain screen bound features, among which the fine residual movement of the projection mechanism, known as 'jitter', is perhaps most notable. The very specific case of the film projector shutter is a prime example of how this approach can be applied to the whole archive. The study of early cinema should not just be a cultural one – there are also neurological phenomena which paradoxically give greater access to the experiential dimension of the first film shows than the immense effort required in recreating the lived experience of a 19th century film spectator. The evidence is already there, sitting dormant in the modest chill of the apparatus archive in the vault next door to the film print archive. It awaits activation and interpretation through our senses.

My hypothesis is that the just visible and barely sensed trace of technology resident in a flickering screen image, this analogue and extension of 'vibrating existence', frames the experience of the spectator and underscores, promotes even, an oscillation in the focus of mental activity from image to surroundings. If this is the case, then evidently flicker's slow slide out of view in analogue projection and eventual removal in digital projection affects rather more than a simple discrete issue of image quality. It suggests a viewing experience which is more one dimensional, which allows the image to exert a monopoly of attention and which militates against the special circumstance of the dual awareness of cinematic experience.

Summary

As in the preface and this introductory chapter, I employ a loose structure whereby either visual or textual epigraphs ground the discussion in a key piece of evidence. I do not intend this to convey the impression that I invest any universal truth in these sources, rather that I simply find them productive for the discussion which follows.

Having surveyed the archival context of early cinema content and experience in this introductory chapter, the following chapter 1 examines the historiography of 'early cinema' and introduces the term itself as a post facto designation of the 20-year period during which it evolved into an institution. Writers began looking back to earlier forms of cinema already within the early cinema period long before the academic study of film history developed. Some such as Gilbert Seldes recalled a quality of 'uncertainty'. The tremulous state of the projected image seemed to be analogous with the slice of 'vibrating existence' which was offered forth on the screens. §1.1.2. The variety of the sites and surroundings of early cinema further complicate the reception of its unstable stimulus. §1.1.3. Equally issues of its terminology indicate flux in the understanding of its function, amid the expanding numbers of competing designs. §1.1.4 .The protagonists of early cinema, the pioneers and their audiences, are not always portrayed as engaged in an open-ended process of technological change, rather early cinema is (and has been) understood and accessed through the technology *de nos jours*. This needs to be emphasised in order to accurately reflect the experiential dimension of early cinema and not merely its textual analysis. §1.2. The influential model of the cinema of attractions has acknowledged the foregrounding of technology in early cinema but has not sought to differentiate effects between alternative technologies when considering aesthetic experience and 'psychological impact'. Other historical methods have attempted to recover experience through assembly and analysis of significant datasets. Yuri Tsivian's concept of the 'medium sensitive viewer' is particularly helpful in characterising early cinema experience. Coupled with his in depth research, it allows a high degree of sensual access for those who would trace such experience and it would be salutary for modern viewers of early cinema to aim to inhabit. The idea behind Gunning's 'technological images' needs to be extended into early cinema technology not just pre-cinema devices. §1.3. A degree of access to past experiences is gained from screenings of early cinema at modern restoration festivals: recent efforts to combine restored prints with historical technology create visceral impressions of a multi-sensory experience and of the connection between the mechanical and the perceptual. Such experience is hidden from view in modern museum displays but is essential for building historically-nuanced medium sensitivity in present day audiences.

Chapter 2, 'The Flicks and the Jumpers', is about the signs of technology that were visible and sensible during early cinema performance and which were remarked upon by the 'medium sensitive viewers' of the era. One of these was flicker and others included jerky images that were caused by imperfect registration and inexact manufacture of film and projection mechanisms. In fact, given that flicker was defined less narrowly than it is today, it is shown that some reports of flicker may have been a response to spatial instability rather than temporal variations in light intensity. §2.1. A review of the first-hand reports of attending Veriscope shows, as well as the surviving records of its design, suggest that early cinema technology can be seen as an extension of the human nervous system with a degree of its own autonomy. The on-screen struggle of the prize fighters, Corbett and Fitzsimmons is seen as a parallel to the struggle between the audience and the technology. Valuable new evidence of the inter-relation between cinema and contemporary flicker research is provided by the experience and experiments of Thomas Cunningham Porter. §2.2. The definition of flicker in period was broader than we are currently used to. There was a tight imbrication of flicker with mechanical movement and reference to flicker in the 1890s may merely have indicated the presence of a regularly repeated artifact. The diverse sources of mechanical instability in the projected image are briefly discussed. §2.3. As context for the detailed discussion of flicker originating in the action of the shutter in later chapters, there is a brief acknowledgement of flicker sources in film projection which had different origins – such as poor film development or flickering subject matter in the profilmic reality. In conclusion, flicker is seen to have a potential to unify the many signs of the artifacts of film experience.

Chapter 3 charts the variable factors which contributed to the perception of flicker in early cinema and coins the term, 'flickerscape', in order to allude to the varied conditions of early film screenings which were themselves set in the wider landscape of the experience of 'vibrating modernity'. §3.1. It charts a natural history of flicker and 'wheel phenomena' occurring before the introduction of the 'living pictures'. The spinning discs and episcotisters of the vision researchers of the nineteenth century were early versions of projector shutters and cinema became an extension of empirical flicker research. §3.2. The very first film shows often featured a standing start technique in which still images sprang into life as 'animated pictures'. The brief low frequency flicker apparent in this practice associated flicker with life itself and made it analogous to vibrating existence. §3.3. The close association of flicker with the phenomenon of apparent movement may have been a cause for the erroneous belief that persistence of vision was the means by which the illusion of movement in projected film was achieved. §3.4. The relation of flicker frequency to luminance, which is characterized by the Ferry-Porter law, was discovered by T.C.Porter at the same time that he was engaging in the mass public perceptual 'experiments' of early film shows. §3.5. Further factors affecting flicker perception, such as light source technologies, ocular physiology and input from non-visual senses are discussed in reference to their impact on early cinema experience. §3.6. This extensive consideration of the components of the flickerscape along with certain contemporary commentary allows consideration of reception of flicker as pleasant and playful as well as the more commonly attested negative reactions. §3.7. The final element in the flickerscape is the correspondence between flickering light and electrical activity in the human cortex which is unseen and unfelt but which can be revealed by electroencephalography. Research into these fundamental physiological phenomena reveals an unusual level of parity with the operating rhythms of early cinema technology, specifically.

Chapter 4 applies the understanding of flicker acquired in the previous chapter to a physical example of early film projection technology and is a case study of the kind of material culture approach advocated in this introduction, in which a literal and experimental media archaeology can reveal the influence of the nuts and bolts of technology on the historical perceptual experience of cinema. §4.2. A surviving Bioscope mechanism is assessed for condition, completeness and originality and examined as a 'text' embodying evidence of cognitive traces. In combination with research into the conventional text of printed materials its model designation is identified. An activation of the mechanism affords a link with its first users. §4.3. Research into other surviving mechanisms enables the construction of a narrative of the evolving design of the Bioscope in its first ten years and highlights a particular attention to the placing and specification of the shutter. §4.4. The need to apply sensory access to the object in order to reveal knowledge is emphasised and the proposal made to evaluate activated mechanisms so that their perceptual and aesthetic impact need not be a matter of conjecture.

Chapter 5 returns to the wider flickerscape of early cinema to investigate strategies to manage and control flicker throughout the period and beyond into the 1920s. §5.1. addresses interventions which were not directly related to shutter design while §5.2. concentrates exactly on this fundamental component. The counter intuitive notion of the three-bladed shutter occurred only belatedly to, among others, Albert Smith and John Pross who were inspired in their thinking by models of modernity represented by the visual experience of railway travel and the flow of energy, respectively. However, shutter design in early cinema technology continued in an experimental vein long after the successful solution to flicker reduction was found. This startling anomaly is investigated through the contemporary patent record as well as a surviving example of an after-market shutter produced in the mid-teens which displays a seemingly eccentric materiality. The implication of these largely ignored alternative shutter designs is found to be that, at least in some cases, flicker was tolerated and manipulated rather than despised and that the period of creative interaction between operator, technology and audience extends from the 1890s into the early 1920s.

1. The Experience of Early Cinema: What it was and what it is

> The long, dark, narrow passage set out with uncomfortable chairs; the sharp almond odours, the sense of un-certainty, and the questionable piano; and then upon the screen, in a drab grey and white, jiggling insecurely, something strange and wonderful occurred.
>
> Gilbert Seldes, The Seven Lively Arts. 1924

Introduction

In order to bracket what can be understood as the experience of early cinema, this chapter first clarifies what is meant by 'early cinema' and how this understanding is itself historically dependent. It considers the When? Where? Who? of the historical period which the research has as its focus and keeps in mind the way in which answers to these questions are conditioned by the period in which they are posed.

The first twenty years of public screenings of projected photographic moving images are surveyed with regard to the impression received from primary literature, the first accounts of film-going as an activity occurring in the past and subject to rapid change, such as Seldes' fond memory of the cinema of the 1910s. Significantly, he communicates this experience not just by mention of the colourless and 'jiggling' image but through a broader sensory appeal: The sights, sounds and smells, which I have previously introduced as the Barthesian surroundings of the image. One might even nominate his awareness of a 'sense of uncertainty' as an extra-sensory perception. As I have suggested in the introduction, both surroundings and image taken together make up a workable definition of the cinema experience. The richly evoked description which Seldes delivers in one sentence underlines the poverty of an image-based approach to film preservation which entirely neglects these additional sensory inputs received at the time of exhibition.

The chapter continues by considering the strategies employed in attempts to recover experience not through memoir but through historical perspectives provided by the practice of film history and the modern day 'enacted historiography' of the continuing theatrical presentation of the films of early cinema through the programming streams and exhibition practices of FHIs and specialist film festivals. By contrasting views of those living in the period in which cinema emerged, with latter day historicised concepts of the same period, which, since the 1970s *only*, has generally been referred to as 'early cinema', discontinuities between these accounts are made clear. Idealisation or post-hoc rationalisation in the case of the literature, has contributed to the understating of the significant role of technology in co-producing the perceptual experience of early cinema. The chapter draws attention therefore to this often-disregarded component of the *dispositif* hidden within the less specific purview of the What (was early cinema)? The secondary literature has created a view of early cinema which has not felt the need to fully examine the encounter with technology that is often explicit in the primary literature. What can we learn, for example, if we look again at the reports of insecure jiggles?

The chapter employs as method a review of written discourse, including contemporary responses to the beginnings of cinema and later retrospective memoir. From the academic tradition, the influential concept of the 'cinema of attractions' (Gunning, 1986) is seen to transform our idea of early film experience following the New Film History's revision of the earlier idea of 'primitive' cinema. Equally, Yuri Tsivian's concept of the 'medium-sensitive viewer' (1998, 216) is found to be particularly helpful to the context of the relation of the mechanical and perceptual in the experience of early cinema. The chapter then moves on to consider, at times through the personal experience of the author, the means by which the experience of early cinema is received in the tradition of cinema itself, that is, the theatrical presentation and exhibition of the surviving products of early cinema to modern-day audiences.

While advancing this evidence, it suggests the utility of an intervention that would draw attention to the specifics of early cinema's non-standardised, heterogeneous technologies. This would generate the potential to inflect studies which choose to focus on film content analysis and social and economic context with added dimension. The chapter concludes by suggesting that greater attention should be given to the framing effect of film technology in conditioning the early cinema experience which it defines as a non-standard, free-forming, co-produced spectacle with an essential but easily underestimated neurological component.

1.1 Early cinema before it became 'early' or 'cinema'?

1.1.1 When was it?

Henry Hopwood's *Living Pictures* of 1899 was re-issued in a revised and expanded edition 16 years later. Its new editor took the opportunity to survey the intervening years, coincidentally the period which we would now loosely recognize as 'early cinema'. Foster looked back with less sentiment than Seldes but not without a little sense of awe.

> That year marked the transition from history to actuality; it was the period of search for new types of machines, for new methods, and attempted forecasts of the future. Yet I think it very doubtful whether many of those most interested at that date foresaw the actual commercial development which has taken place. Putting technical matters aside for the moment, we may safely say that in 1899 the Living Picture was a popular music-hall "turn." To-day it has established its own theatre, its own personnel, its own audience. Technical advance has been great. The more effective types of machines have been perfected; the actors of the day act for the screen, just as they do for the auditorium; a whole network of recording energy is spread over the entire world. In this year of grace the Living Picture is possessed of an organization so complete, so far-spread, that its future existence and expansion is assured. It has entered into the life of the peoples; it has become a permanent part of their recreation and education. (Hopwood & Foster, 1915)

Foster's remarks are a useful reminder of the vast gulf in conditions between the beginning and end of the early cinema period. Early doubts over cinema's longevity had been proved wrong although rather because of its ability to reinvent itself than because it had arrived fully formed into human experience. Having 'entered into the life of the peoples' in many different ways, what, in 1915, was already archaically termed 'the Living Picture' was beginning to consolidate around an individual identity, with, as Foster points out, many individual attributes, although not, as yet, a unique name.

In terms of experience, Foster's summary carries the implication that this too has been transformed and is becoming less fitful and unreliable. It does not however explicitly convey what it was like to see a show of living pictures in either 1899 or 1915. To provide insight into the question of how cinema was seen by its first audiences requires a different kind of evidence. As has been noted, the sole evidence of the films themselves is not helpful in this regard.[42] The primary source material of personal accounts of cinema attendance in the early period, which I use throughout this thesis, is the most valuable evidence of the reception of the first screenings. Such evidence need not always be strictly contemporary, although once significant elapsed time is added to a recollection, its subjectivity should be treated even more cautiously.

As cited in this chapter's epigraph, Seldes is looking back from 1924 to something like Foster's present where despite the establishment of a dedicated industry there is much that is still contingent about exhibition. Seldes has a fascinating temporal standpoint. His vivacious memoir of what we might call 'late' early cinema was written long before the term 'early cinema' existed but equally at a point when many of its unique features had already changed beyond recognition or slipped into

[42] See, for example, Michael Chanan, (1996, 6), as cited later in this chapter.

the past. Indeed, he feels, perhaps over-sensitively, that the slapstick form about which he writes is under threat from gentrification – 'the remorseless hostility of the genteel'. (1924, 4) Thus, his motivation in writing is not just to claim a new art for culture but to do so before it has been expunged. 'That is where we are now: too early to write an epitaph-late enough to pay a tribute.' (1924, 4) Seldes' 'now' is therefore informed by an awareness of cinema's mutability, which it is as well to bear in mind whichever type of cinema in whichever 'now' is under discussion. His habitual attendance over the previous decade and his ability to reflect upon it has enabled him to perceive the passing of a distinct earlier form of filmmaking and a distinct earlier exhibition environment that together formed an earlier cinema.[43] Whether slapstick survives the genteel onslaught or not, it will no longer be experienced in such surroundings or subject to the fitful operation of a developing technology. Although clearly not an attempt to write film history, it does provide for us one of many snapshots of *what cinema has been* and of the impulse to describe and record an earlier form of what it has been, what it was before it became 'early' or 'cinema' or 'early cinema' but once it was already an experience closeted in

[43] In general, Seldes' book, *The Seven Lively Arts*, advocates turning critical attention to newly emerging forms of low culture. His chapter on moving pictures, 'The Keystone the Builders Rejected', is an appreciation not simply of cinema but specifically of slapstick, and, even more particularly, the Keystone comedies of Mack Sennett. These are distinguished for praise, in contrast to the higher brow artistic dramas of Griffiths and Ince, which together made up the three parts of the Triangle Film Corporation, for the primary reason that rather than aping previous literary or theatrical cultural forms they were made by, 'doing with the instruments of the moving picture precisely those things which were best suited to it - those things which could not be done with any instrument but the camera, and could appear nowhere if not on the screen.' (1924, 7) Thus, using the argument of medium specificity, Seldes finds the purest expression of the film in the lower end of its already culturally dubious reputation.

memory (and emotion).[44]

I would not claim that Seldes' experience in this passage is anything but generalized. Rather than the account of a specific cinema visit as one might find, for example, in a diary entry, it is likely to be a summation of many different visits to different establishments to witness this 'form of entertainment' from which he has derived so much pleasure. Although we may distrust the refining processes involved in reporting such experience, in terms of veracity, this use of considered hindsight also has the benefit of drawing together key details that might have been lost in the thicket of experience of the present and, combined with later experience, these can help to distil what was special about earlier experience. I would suggest therefore that this process and a measure of temporal distance has helped Seldes create in this one sentence a convincing and concise multisensory phenomenology of the early cinema experience.

Indeed, extending the film historian's qualification of source material into a hermeneutic analysis, this perhaps gives a clue to the jittery quality of the conjured memory, which serves as an introduction to a discussion of the slapstick film form

[44] Of course, Seldes is conscious that he is writing a reminiscence and also admits his affection for his subject, so that there is no difficulty in perceiving potential bias in the source. 'I have had no greater entertainment than these dear and preposterous comedies, and *all I can do is remember*.' (1924, 3) [my emphasis]. In other words, there is the same risk of a nostalgic look back as with for example Quentin Tarantino's well-known regard for the flea pit cinemas of the 1970s and 1980s. In both sentiments, however, we find the nostalgic yearning is not for a perfect past state but for an unpretentious warts-and-all honesty which respects the unique materiality of the medium and perhaps relates more to *nostalgie de la boue*. Nevertheless, as Russell Merritt wrote, reviewing some standard American film histories, 'the nickelodeon era has been the epoch of film history easiest to sentimentalize.' (Merritt, 1976, 60)

that takes as its modus operandi: ‘everything capable of motion set into motion’ (1924, 13) including its means of delivery. In fact, as I shall discuss in chapter 5, it is interesting to speculate that the motion of the chase films may have been developed as an antidote to, and distraction from, the technologically induced spatial and temporal motion and instability imparted to the projected image by the operation of the intermittent movement and shutter. It is certainly remarkable in this passage that everything seems to be on edge, the piquant, high-frequency stimuli, and the subject’s sense of unease, skirting around the abyss of chaos before finding a highly-strung temporary refuge and corollary in the ‘strange and wonderful’ revelations on the screen. I have reflected in some depth on this passage because it helps us to see how the projected image can act as both a conduit and a container for my proposed expansion of Hopwood’s notion of ‘vibrating existence’. It is a sense which is generally missing from later descriptions of the cinema experience, both those of later cinema and those of latter day programmes of early cinema. It is however characteristic of many of the contemporary responses to projected moving images, even if the vibrations are often greeted with alarm.

1.1.2 Where was it?

An important element of Seldes’ description gives the exemplary flavour, almost literally, of one of the most characteristic settings of early cinema; that of the storefront cinema or nickelodeon, the first hastily converted spaces given over solely to film exhibition in the latter half of the early cinema period, from 1905-1914. They were especially a feature of the US exhibition environment, though comparable establishments existed elsewhere. In the UK, empty shops had been turned into 'penny gaff' theatres since the mid nineteenth century.[45] By 1900 this trade had dwindled but was revived by the arrival of film technology looking for a home. The first shop-show cinemas in London of 1906 would have therefore appeared as 'a throwback to the penny gaff era' (McKernan, 2006).[46] However, within five years the much grander designs of the purpose-built Picture Palaces swept them away.[47] This short-lived period bridged the gap between the cinematograph's residence in variety theatres and music halls – being 'guests in other people's houses' (Harding & Popple, 1996, 207) – and the first purpose built cinema theatres. The variety of converted spaces is indicated in Leslie Wood's 1937 memoir *The Romance of the Movies* and included, at one end of the scale, 'a converted stable in Soho which retained not only its cobbled floor, but also a manger and horse stalls underneath the screen.' (Burrows, 2004, 62)

The transient nature of these rapidly evolving urban locations, was matched and indeed exceeded by the even more temporary, hastily erected and dismantled canvas walls of the fairground travelling cinematograph show, which also helped disseminate the experience of moving pictures away from urban areas. Thus, early cinema, an exceptionally portable entertainment, took place in an eclectic variety of

[45] See, Harding and Popple (1996, 207-209)

[46] See also McKernan's assertion that 'What took place in the auditorium was as much a part of the paid-for experience as what took place on the stage or screen.' (2006a)

[47] The phenomenon of the shop-shows of London has been researched by Jon Burrows (2004). Earlier research by Nicholas Hiley disregarded these smaller venues and argued for a more top down expansion of the cinema business in this period. (Hiley, 2002)

venues, always subject to constant revision. In its very earliest days, as one of many items on the bill of an evening's theatrical entertainment, the moving pictures could be experienced in both the grandest of settings and the most prosaic, from the major variety theatres of the world's capital cities to the aforementioned humble stable with its manger. Naturally this variety of location had enormous potential to impact the experience of its patrons, not just as a result of physical dimensions of the space but in myriad ancillary factors which would connote meaning for its audience through sensory experience of the type evoked by Seldes.

What is perhaps most significant is that none of this array of locations was purpose built to show films and therefore the *dispostif* had to be flexible enough to fit into pre-existing architectures. The early cinema projectionist was still often a projectionist for hire and would have to be skilled at assessing the potential of a certain space and installing the projector and screen. Practice was therefore more akin to the itinerant magic lanternist and projection apparatus needed to be light enough to be portable and strong enough to be resilient. It was usually supplied with sturdy wooden travelling cases that would protect the mechanisms while on the road and between engagements. From the nickelodeon era onwards, although the spaces still needed to be adapted from prior use, the position of the projector achieved a degree of permanence and the projectionist or 'operator' began to receive a modest regular salary. Cinema was gradually becoming less temporary and investors were daring to believe, against the famous prophecy of one of its most prominent inventors, that it might have a future or, at least, one beyond the next engagement.[48] This growing confidence unlocked the significant capital investment required for the massive expansion of cinema's real estate that took place in the early 1910s and saw it acquire 'its own theatre, its own personnel, its own audience.'[49]

1.1.3 What was it called?

If the locations of early cinema resist easy summary, then other features are no less easy to pin down and perhaps the most fundamental of these is its name itself. As projected moving images began to appear all over the world in 1896, there was no immediate consensus over how to refer to the practice. For example, the early technical writers Hepworth and Hopwood chose, respectively, 'animated photography' and 'living pictures'. The flux of terminology is an important indication of a technology whose imaginary was also still in development and full of potential especially when modern day presentations are likely to be subsumed under the one name of 'early cinema'. It also points to the fact that there was no generally agreed idea of what its function was.

Although already in use for L's first public screening, at that point the word 'Cinéma'

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[48] "Le cinema est une invention sans avenir". Possibly apocryphal. Thierry Frémaux believes that if these words were said by Antoine Lumière to George Melies then it was with the motive of limiting competition for the commercial development of the cinematographe, plans for which had already been formulated with Louis. (Frémaux, 2017)

[49] The rise of the Picture Palace was so swift that it astonished some contemporary observers: See *The Sphere* reporting in April 1913 in (Harding and Popple, 1996, 207)

can at best be said to describe simply the exhibition of the device (the Cinématographe) brought to the public in its projection form by the Lumières. Although the device was the design of the Lumières and physically manufactured by Jules Carpentier, it is worth noting that the neologism, cinématographe, did not originate with them. The name had previously been used by Leon Bouly in 1891 and although effectively a trade name, it was not seen as a unique property in the way that a patented design was.[50] Many of the names of the devices of early cinema were not trademarked and were seemingly plucked from a communal pot with little regard for their prior use.

The exhibition of early film was often billed as a demonstration of a particular device, the trade name therefore standing in as a term for the viewing experience. As many have noted the proliferation of trade names amounted to a truly fantastic compendium and when seen collectively the bizarre linguistic soup appears like a nonsense verse.[51] The lively flow of language charted different courses in different territories. 'Cinema' only gradually acquired a more generic meaning, not just in France but also in Anglophone cultures, becoming more widely used in the UK in the 1910s.[52] By contrast, in the Netherlands, for example, the term Bioscope – the

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[50] The device is described in Hopwood. 'On the 12th February, 1892, Bouly took a French patent "pour un appareil photographique instantané pour l'obtention automatique et sans interruption d'une série de clichés analytique du mouvement ou autres, dit le Cinématographe."' (1899, 186)

[51] See Hopwood (1899, 187), for one such example.

[52] Valentia Steer's 1913 book, *The Romance of Cinema* was an early example of its use in British publishing. In UK English usage, the long-held habit of referring to Kinema and Kinematograph as general terms signified a distinction between the Lumière device and a general motion picture machine as well as a preference for the Greek origins of kinema over the Francophone cinéma. According to E.T. Heron, the publisher of *The Optical Lantern and Kinematograph Journal*, the

trade name for a particularly successful early projector – found favour and consequently, 'bioscoop' remains the Dutch word for cinema to this day.[53]

Hopwood's 1899 volume is still the best single collection of the various devices of early cinema. It attests to the sheer variety available in late 19th Century Britain, although it is by no means a complete record.[54] This extraordinary variety of apparatus and its bizarre nomenclature represents more, however, than the startling scale of the collective endeavour of the inventors of the 'Living Pictures'. It serves to emphasise the extraordinary variety of experience available to the late nineteenth century public as the mechanical specification of each and every one potentially created a different perceptual response.

1.1.4 Who made it?

One of the exciting distinctions of the first decades of cinema is that the people who made the machines – the technical means of production – were often also making the films. The later tendency for film and media studies and to a lesser extent film history to place emphasis on film content as the object of analysis has a disproportionate effect on the situation of early cinema in which technology was

decision to print the word with a K rather than a C was introduced 'towards the end of 1906'. (Low & Manvell, 1948, 121)

[53] Adriaan Briels states that by 1911 Bioscope was at the point of becoming a 'soortnaam', having been promoted by Anton Noggerath who had first imported Bioscopes in 1898 when the term 'levende photographie' was in currency. (Briels, 1971, 31) Nöggerath and his Bioscope are pictured at the beginning of the introductory chapter of this thesis.

[54] 'Hopwood describes 60 different artefacts under the heading of "Present-day Apparatus". This represents only a small selection of the apparatus and apparatus-concepts actually in existence at the time.' (Zielinski, 1999,42).

foregrounded in every stage of its execution. It means that the likes of Robert Paul, James Williamson and Cecil Hepworth are retrospectively cast first and foremost as pioneer film makers and producers and their roles as engineers and technologists diminished.[55] One receives, for example, a more rounded impression of Paul when perusing his 1901 Catalogue, the 55 illustrated pages of which are divided more or less equally into an exposition of his laboratory, fitting shop and studios, projector, descriptions of his camera and perforator designs and listings of his film titles and subjects. In other words, a nose to tail outfit with only film stock manufacture outside the scope of his offered services.

We should remember that there were no specialised practitioners of cinema in 1895 because there was no cinema. There were only those with certain sets of skills and predispositions living in a moment in which the various potentials of cinema appeared as emerging possibilities. The moment arrived for Hepworth at the beginning of his working life and engulfed Paul, a few years his senior, when he was already an established instrument maker. Although Hepworth became one of the most important British film producers of the teens, a role which scholarship has awarded him and focused attention upon, one might say that his journey in film actually begins with his father's gift of a lathe along with the strong hint that he

[55] Williamson recalled in 1926 that thirty years earlier 'film producers were recruited largely from the engineering profession' (Low & Manvell, 1948, 115). Williamson himself was, in his own self-deprecating words, 'floundering about with home-made apparatus' before being introduced to the Brighton-based 'clever engineer' Alfred Darling. US based examples of this tendency would be, for example, Albert E. Smith and Edwin S. Porter, film maker / engineers for Vitagraph (Smith) and Edison and Simplex (Porter).

should acquire a trade.[56] It was also obviously of some consequence to his formation that his father was a celebrated magic lanternist, but in Hepworth's biographical assessment his early work designing and making improvements for the early devices of animated photography is given less regard than the (generally unfavourable) analysis of his films in terms of authorial style.

The technical side of Hepworth's personality, which one finds concentrated in his 1897 book *Animated Photography – The ABC of the Cinematograph*, a key text of the very first years of cinema, is therefore side-lined by the tendency of film criticism to make auteurs out of anyone with a name even when, as in Hepworth's case, he is generally not served well by the subsequent criticism. Hepworth's book, actually the first 'on the subject to be published in England' (Barnes, 1996a, 170) and significant enough at the time to warrant a second edition in 1900 implies extensive empirical research into film making and exhibition already having been undertaken by its 23 year-old author. It is not, however, even mentioned as context in Simon Brown's recent history of Hepworth and the early British film industry. Indeed, such is the way everything becomes distorted by what happens next, in Hepworth's case the creation of a successful film production company that can map onto narratives of

[56] Hepworth received the lathe in 1895 from 'dear old pater' who was concerned that his son should have a useful skill to fall back on if necessary. He used it to make an arc lamp of improved design which he patented (Cecil Milton Hepworth, 1896) and which was then brought to market by Ross Ltd.(Hepworth, 1951, 28-9) Interestingly, the cover of Simon Brown's *Cecil Hepworth and the Rise of the British Film Industry 1899-1911* uses a photograph of a perhaps middle-aged Hepworth, sleeves rolled up and at work, not at a desk or behind a camera but at a lathe, as though making a part for a new invention. The picture is credited only as 'Cecil Hepworth copyright BFI' and there is no further discussion in Brown's text of the image or its potential significance to the Hepworth persona.

national cinema as well as auteurist approaches, it is even as though it went disregarded by Hepworth himself who admits in his 1951 autobiography that he has not consulted his own historic book as he long ago lost his personal copy! This neglect for one of the few book-length primary sources of early cinema in the biography of one of its key individuals points to the retrospective diminution of early cinema's technological function. Although less comprehensive than 'Living Pictures', by the standards of the time it is still a substantial contribution, a guidebook to the necessarily technical process of animating photographs. Perhaps it should not be surprising that, as the paradigm of first resort, there are teleologies in terms of the careers of key individuals as well as in histories of technology.

Although I have concentrated here on the case of Hepworth, a similar process has been at work on the reputations of even relatively established industrialists such as Edison and the Lumières who were subsequently recast as default film makers.[57] Evidently, these were all creative individuals but their creativity cannot be contained by the sort of categories established by later modes of filmmaking with its hierarchies of specialized workers and separation of technical and 'creative' roles. Nor should they be considered entirely responsible for the work of creating early cinema. There is a much wider argument which proposes that early cinema was a phenomenon co-produced amongst the whole of society. Thus, although I want to

[57] Roland Cosandey points out that especially in the case of the Lumières, with their large band of associates, assignation of auteur status to Louis Lumière as entertained by George Sadoul and Vincent Pinel is particularly inappropriate. (Cosandey, 1996, 87)

stress the undervalued technical literacy of pioneers such as Hepworth, I also want to remember that the prospectus of the technology would be nothing without its appeal to a spectator. Their response both for themselves and their fellow spectators, including the projector operators and film and apparatus makers, actually completed each experience of early cinema while also indicating directions for development in subsequent iterations. In this regard, Luke McKernan makes a distinction between the invention of film and the invention of cinema,

> Moving picture film was an invention of the late nineteenth century for which we can cite a few significant names: Edison, Dickson, Marey, Lumière. Cinema, however, is an altogether wider phenomenon and its inventors are many more in number. Among them we must name the entrepreneurs, the enthusiasts, the subjects of those first films, and the first audiences. The invention of cinema was a collective activity by a broad selection of late Victorian society, the first people to leave their mark to future generations on moving picture film. (McKernan, 1996, 107)

Equally, Michael Punt has expressed the idea that the invention of cinema couldn't have been otherwise. The collectivity or, at least, 'the very lack of conclusive evidence of individual responsibility' was in fact 'a necessary condition for its invention'. (2000, 16).

It is the contribution of the first audiences which I particularly want to highlight in this statement and which I believe we can gain access to through a thorough investigation of surviving technology and informed knowledge of the mechanisms of human perception. Such an interpretation of the archaeological record can then also be cross-referenced with eyewitness reports of the operation of early cinema technology. As members of those 'future generations', we are in danger of misinterpreting that heritage bequeathed to us by late nineteenth century society if we do not take care to understand the period specific relation of technology and perception.

1.2 The historiographic territory of early cinema experience

Although cinema as a commonly understood cultural practice can be said to have been in continuous existence since 1895, it is only with hindsight that we have been able to assign it both a name and a starting point.[58] Likewise, early cinema as a commonly understood cultural practice can be said to have been in existence for the first 20 years of its life, up to 1915, but has only been referred to as such in retrospect.[59] In fact, the now commonly used conjunction of 'early' and 'cinema' has very little precedence before the 1970s. Up to that point the term silent cinema would have been used to refer to everything from 1895 onwards that was not a talkie. In the 1980s new approaches to researching and writing about early cinema gathered currency having emerged from the ground-breaking FIAF Brighton conference in 1978 at which archivists and scholars collaborated to present the archives' holdings of fiction films made between 1900 and 1906. Before Brighton

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[58] While acknowledging the potential for alternative candidates and criteria, I do not take particular issue with the consensus view that the Lumières' December 28 1895 screening in the sous sol of the Grand Café, can be considered the first example of a successful projection of moving images to a paying audience.

[59] I adopt here the nearest to an 'official' period of early cinema as defined by the international society for the study of early cinema, Domitor. 'Broadly, "early" cinema includes the period of international film history spanning from around 1890 through 1915, that is, from the emergence of motion pictures as a "new" medium to the large-scale institutionalization of narrative feature filmmaking practices.' (*Early Cinema Overview*, n.d.)

access to the totality of surviving early cinema had been very limited and often through inferior quality 16mm prints. The archives worked to make new 35mm prints available and these were shown in the Brighton Film Theatre while papers were presented. The increased attention to the detail of the films of early cinema led to a willingness to begin to judge it on its own merits. There was a realization that the first twenty years of film production should be seen as more than the 'childhood' and 'adolescence' of the mature art form of late silent cinema and indeed that there should be a renunciation of anthropomorphising and teleological approaches to writing history that the often-unthinking use of metaphors like childhood and adolescence encouraged.[60] Similarly, the reductive term 'primitive cinema' as employed by the previous generation of film historians, fell out of use and the less pejorative but still post facto term 'early cinema' was adopted.[61]

The now 40-year history of early cinema as a term referring to a twenty-year historical period has seen further refinement within the specified period as the work of historians revealed more and more confounding variety. Some historians now confine their specialist knowledge to Victorian cinema for example – a term which necessarily has connotations of a national context as well as a specific temporal limit

[60] It is however interesting to note that this powerful metaphor was shared by the pioneers themselves and has precedence in the very first book on the subject in Great Britain, Hepworth's *Animated Photography* of 1897 which concludes of the three or four-year-old 'infant prodigy' of animated pictures that it, 'trembled violently, was most erratic in its movements, winked and blinked and quivered, and otherwise exhibited evidences of its immaturity and incapacity.' (Hepworth, 1897, 105)

[61] The revisions of earlier teleological historiography which emerged in the 1980s have been termed the New Film History by one of its leading exponents, Thomas Elsaesser, and its techniques have further evolved into the so-called media archaeological approach. (Elsaesser, 1986) and (Elsaesser, 2004)

(1901) while others have found that early cinema as a period, despite already being a subdivision of a greater concept, itself requires further demarcation.[62]

The key conceptual reference point for this period has been Tom Gunning's formal description of it as the 'cinema of attractions', as set down in his 1986 essay. The concept has a 'subordinate binary twin' (Elsaesser, 2007, 205), the 'cinema of narrative integration' which divides the period of early cinema roughly half way in 1907 as one period gives way to the other. The 'cinema of attractions' is much more than a post facto periodization of film style, however. It refers to the attractions not just of representation but also of address. The films of this period took delight both in showing their audience spectacular sights and engaging them with direct looks from the on-screen performers. This habit of display and engagement also applied to the projection technology which was present in the same space as the audience. As Gunning himself put it, 'in the earliest years of exhibition the cinema itself was an attraction' (Gunning, 1986, 65). We see this clearly in the posters of film screenings for Edison and Lumière in which we are invited into an interior space with an audience and screen as well as, in some cases, an image on the screen. These visualisations introduced audiences to what cinema was, a new system of experience. The projection technology was not usually depicted in posters but it did appear on the billing. As Gunning continues,

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[62] Charles Musser argues for periodization within early cinema particularly as a critique of the broad designation of Gunning's 'cinema of attractions' which he feels should apply only to a 'novelty period' from late 1895 to early 1897. (Musser, 2007, 400)

> It was the Cinématographe, the Biograph or the Vitascope that were advertised on the variety bills in which they premiered, not *The Baby's Breakfast* or *The Black Diamond Express*. (Gunning, 1986, 66).

In contrast, then to modern viewers whose instinctive conceptualization of early cinema is characterized by certain iconic films such as, indeed, *Le repas de Bébé* or *L'arrivée d'un train* or *The Big Swallow* or *The Great Train Robbery*. Even given the acknowledgement, by such as Gunning, of the display of film technology during performance as one of the attractions, film historians have not generally sought to evaluate likely differences in the aesthetic qualities of the varied technologies in circulation. Nor have they separated out the role of technology as spectacle from the potential effect of the technology itself, once the show started. In short, could flicker, or other technological effects originating in the operation of the projector, ever be considered as a component of the attractions of early cinema, despite so many reports of the alienating qualities of early cinema experience? Well, perhaps, given the origins of Gunning's term in the work of Eisenstein, who, though applying it to theatre, took it, in turn, from the fairground and his favourite ride, the rollercoaster. (Gunning, 1986, 67). Attractions, according to Eisenstein, it transpires, 'aggressively subjected the spectator to "sensual or psychological impact."' (Gunning, 1986, 66).

Gunning has gone on to unravel the modernist attractions of early cinema in a number of other essays. The most apt in terms of this current study is a framing of early cinema within the 'chaotic dissolution' and 'systematic organisation' of modernism's culture of 'shocks and flows.' (Gunning, 2006)

> We could visualize this process as an interaction between the explosive shocks of modernity as motive force and the transformation of these shocks into a regularized and consistent motion, a transformation of shock into flow. The piston in the gasoline motor provides a model: a contained explosion is converted into consistent motion. (Gunning, 2006, 310)

The railway, which punctuated novel experiences of flow with occasional sudden stoppages and horrific accidents, is a further example of this dialectic cited by Gunning which he then applies to early cinema's transformation of the shock of attractions into the flow of narrative. However, he neglects to mention the obvious candidate for 'a transformation of shock into flow' which was lurking in the technological heart of early cinema itself: the shocking flash of each new frame as it is revealed by the projector shutter and then converted into apparent continuity of action by the human visual system.[63] It is the 'sensual or psychological impact' of this micro temporal experience of shock co-mingled with almost simultaneous flow which I explore in this thesis.

Many examples of the New Film History seek at least a partial recovery of the experience of early film spectatorship. This was the implied goal of Michael Chanan, who, when constructing his history of the early years of cinema in Britain, felt the available evidence could not tell the whole story.

[63] Gunning has however turned his attention to the action of flicker and shutter, this very 'juncture of mechanics and perception' (Gunning, 2017, 55) in a recent paper, in which he also states that 'the flicker represents a new mastery of the flow of time and a manipulation of human perception through its interface with mechanical apparatuses.' (Gunning, 2017, 57)

> In spite of the extensive documentation which exists concerning the early days of film there is a sense in which the origins of film are obscure. Film has taught us to see the world anew, but it seems that the one thing it could not properly picture was its own birth. What we see in the earliest films is the beginning of a new way of seeing. What we don't seem to see is how that way of seeing was first seen. (Chanan, 1996, 6)

It is certainly true that it is bordering on reckless to view a film from say, 1905, and without any contextual information suppose that we might pretend to a view of 'how that way of seeing was first seen.' However, while the film object itself may hide its own reception from view, evidence from other media can help to extrapolate likely experience and indeed Chanan goes on to employ an anecdote from Hepworth's autobiography in this fashion in the subsequent paragraph. Apart from memoirs of pioneers, other 'extensive documentation' in the form of contemporary reviews, fictional writing and even non-verbal media such as painting can supply extra insight into the first perceptions of cinema.[64] Furthermore, it is the argument of this thesis that through the analysis and activation of surviving elements of film technology, such as the Bioscope mechanism examined in chapter 4, an opportunity can be created to bring a sense of that first 'way of seeing' into lived experience. It should be admitted of course that seeking out a single way of seeing for the vast heterogenous audience of early cinema would be entirely wrong footed. What we can aspire to is a portfolio of representative instances based on known individual data.

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[64] Andrew Shail and Stephen Bottomore have both edited anthologies of turn of the century fiction which reference cinema and cinematography.(Shail, 2010) (Bottomore, 2012) In reference to painting, I am thinking of Sickert's dim view of *The Gallery at the Old Mogul* (1906), where the shadowy figures of the audience and not the occluded screen are the main subject of the image.

A pioneer of social film history, Robert Allen, has sought to recover the experience of attending early film shows through analysis of very specific datasets. In the case of his 'Going to the Show' project, he and his colleagues practice a forensic sifting of surviving primary documents which illuminate the social and economic context of film exhibition. This includes the likes of fire insurance maps, newspaper clippings, photographs and architectural records which collectively reconstruct a sense of the experience of movie-going in an era of racial segregation in the American South, in particular, Wilmington, North Carolina.

> 'Going to the Show' is an experiment in re-locating the experience of cinema, of resituating movies and moviegoing within a few of the hundreds of thousands of places in tens of thousands communities where people went to the show. (Allen, n.d.)

Like Chanan, he finds the record of the film itself similarly inadequate as historical document and indeed, echoing Mark-Paul Meyer's concerns as related in the introduction, he characterises the preserved films of the period as 'souvenirs' and 'mute tokens'

> The relatively few extant versions of old films tell us nothing about who saw them, where they were seen, when they were seen, under what conditions, or to what effect. They tell us nothing about who was prevented from seeing them or who could see them only from a balcony or at midnight on an occasional Saturday. (Allen, n.d.)

This method, a synthesis and micro study of local history, does not pretend to be universal but rather accepts and embraces the heterogeneity of historical experience. It produces local variations on the idea of what cinema was while advancing its results as evidence of the rich array of factors potentially affecting global cinema experience.

A similar intention lay behind the creation of the Dutch project, Cinema Context.[65] Karel Dibbets and colleagues at the University of Amsterdam collected comprehensive information on film exhibition and distribution in the Netherlands from 1896 to 1960 and made it publicly available on the internet. The site is simply a tool with analysis of the data left to individual researchers' projects. Although Dibbets died in 2017, the collected data lives on and is intended to be employed as part of an even more ambitious project to digitally reconstruct a visualisation of the daily life of ordinary people living in several European cities. Using IT systems developed for gaming applications, 'time machine' interfaces will be created that enable the user to explore reconstructed cityscapes in the manner of a diachronic Google Earth. For the lead academic on the Amsterdam Time Machine, Julia Noordegraaf, the potential of the project is epitomized by the theoretical ability to enter the (now demolished) Hallen Theatre and along with other visitors see a screening of *Modern Times* as it was shown in the 1930s.[66] Whether this entails donning a virtual reality headset or simply navigating a computer screen is not yet clear but it is an interesting *in extremis* example of the ambitious reach into past

[65] 'Cinema Context demonstrates that the heart of film culture is the screening. Without audience members, cinemas and distributors, a film does not exist; only during a screening does it come to life. The context in which a film is shown will provide a better insight into local film culture.' (*Cinema Context - About*, n.d.)

[66] 'Ik verheug me erop straks het Hallen Theater binnen te kunnen gaan en er samen met andere bezoekers Modern Times met Charlie Chaplin te bekijken, de film die daar in de jaren dertig ook echt draaide.' (Los, 2019)

experience that is envisaged for digital humanities. It seems unlikely that the simulacrum *Modern Times* will feature period appropriate simulated flicker, although this would be an interesting challenge for the programmers.

A different approach to mining the experience of early film audiences has been carried out by Yuri Tsivian in his highly regarded study of early cinema reception. He places the abundant sources of first-hand picture going unearthed by his research into the wider context of cultural movements operating in Russian society, resulting in a uniquely insightful study. Similarly to Chanan and Allen, Tsivian's project is one of 'historicising the viewer' (Tsivian, 1998, 217). Crucially for my purposes, Tsivian's analysis enables him to resurrect not just the social, economic and political context of spectatorship but 'to revive a historical spectator not yet deadened to the novelty of cinematic discourse – the medium-sensitive film viewer.' (1998, 216)[67] Tsivian collects reactions from spectators who specifically attend to techniques of projection and the soundscape of the screenings. He even tracks what he calls 'the reception of interference' (1998, 104) in which viewers comment on material imperfections such as scratches and blotches in the film prints, breaks in the film, vibrations in the image and the noise of the projector. Although purely text based, this archaeological work vividly communicates the historical viewer's direct experience. As Tom Gunning enthuses in his foreword to Tsivian's book, 'Rarely has

[67] This highly productive concept has somewhat surprisingly only been occasionally employed by film historians. Robert Spadoni has applied it to the discourse around the reception of early sound film and Ariel Rogers has cited it in a highly relevant discussion of journalistic responses to digital projection. (Rogers, 2013, 131-2)

our sense of the film viewer been so sensual and physical, so attuned to the actual environmental pressures of the film show.' (1998, xxi) For Gunning, Tsivian's approach also reveals 'the uniquely creative powers of film viewers who do not simply passively decode film texts but create new thresholds for aesthetic experience.' (1998, xxii)

It is one thing to cultivate an understanding of the historical medium sensitive viewer through Tsivian's careful contextualization and sifting of the documents of film reception. However, we also need to encourage the modern-day viewer of early cinema to become a medium sensitive viewer themselves. Practically this means critically inhabiting the screening environments of their own time simultaneously with those of the late nineteenth century. An important element of this strategy is to collect the knowledge and lived experience required to bracket historical experience in with the varied (and constantly changing) ways in which we currently consume early cinema.[68] As I will show in the last section of this chapter, we can build such an approximation by directly engaging our own experience with *dispostif*-accurate (re)-enactments.

The tendency to separate out the history of film technology from the history of film mirrors the issue raised in chapter 1, in regard to the organization of FHIs. It is a

[68] I have published elsewhere on this process of creating a flexible but informed mental viewing space, in which spectators are aware of the diachronic passage of media through multiple technologies, each capable of applying its own variously gross or subtle effect. (Edmonds, 2018)

deeply rooted phenomenon and has rarely been successfully challenged. The History Research Committee convened to tackle the 50th anniversary of film in Britain by initiating the multi-volume project, *The History of the British Film*, and chaired by no less than Cecil Hepworth, makes a kind acknowledgment but excuses itself from the task of researching 'the invention or later history of cinematographic apparatus, for which some body such as the Science Museum is better fitted.' (Low & Manvell, 1948, 5)[69] In other words, there is no attempt at synthesizing a history using both technological and textual evidence or even at adding technology to the roster of available 'texts'. In practice, this demarcation not only impoverishes their own history project but sanctions the continued sequestration of film technology and cuts it off from mainstream culture, limiting flows of support and access that could be used to promote its valorisation. It may seem retrograde to use a seventy-year-old text to make this point but unfortunately it is still representative of an existing divide in scholarship. Notable exceptions to this tendency are the classic works of Barry Salt and Bordwell, Staiger and Thompson which make a point of relating developments in film technology to changes in film style.[70] However, in terms of early cinema history these are incomplete attempts, the former making no mention of exhibition technology and its crucial role in the reception of the moving image and the latter concentrating only on the period of classical Hollywood

[69] The committee is supportive of it receiving attention but adamant that it should be a separate project and perhaps over-cautious regarding the claims for priority which they feel it would attract. The subject is 'extremely controversial and must ultimately receive separate treatment.' (1948, 6)
[70] Salt, (2009). Bordwell, Staiger, & Thompson, (1985)

cinema.[71] Only John Barnes has managed to consistently insert the technological into the history of early British cinema.[72]

Not only are works combining analysis of early film technology and other sources for early cinema rare but the role of perception and cognition in coproducing the experience of early cinema is absent from the discussion as well. However, a recent contribution by Tom Gunning is notable. He has followed on from his influential conceptualization of early cinema by taking a step back in the nineteenth century and turning his attention to hand operated optical toys: 'The possibility of a Victorian cinema extends beyond the first decade of cinema's innovation at the end of Victoria's reign if we include the flourishing of optical devices know as "philosophical toys" in the nineteenth century.' He has adopted an exploratory method, a handling of apparatus which is both playful and phenomenological. Currently, however, it is limited to perhaps the most accessible of moving image technologies, the pre-cinematic device of the thaumatrope. As Gunning says

> By returning to its early stages, I hope to glimpse the appearance of a modern image culture, at once profoundly technological and perceptual: one whose novelty may lie in how deeply it coordinated the perceptual and the technological. (Gunning, 2012, 497)

There is certainly logic in beginning at the 'early stages' – and the thaumatrope of

[71] Only one paragraph in Salt's chapter on 'Film Style and Technology 1896-1899' concerns itself with projectors and only then in reference to the development of the Latham Loop and its role in enabling the compilation of films into larger reels. (2009, 36) Following chapters do not consider projection technology at all.

[72] The five volumes of *The Beginnings of Cinema in Great Britain* cover the period 1894-1901 in unprecedented detail.

1827 has been recognised as one of the many nineteenth century beginnings of cinema. It also comes very easily to hand – quite literally so being designed for operation, almost instinctively, by a pair of hands. It therefore has few of the practical issues – most notably performance readiness – with which the surviving apparatus of early cinema complicates the exploration of the technological and the perceptual through the artifact.

> One of the great advantages of dealing with artifacts lies in our ability to handle and operate them and to watch them work; they provide us with an experience, not simply a discourse. (Gunning 2012, 509)

Gunning has proposed the term, 'technological images' to describe experience which only exists in the conjunction of the mechanical and perceptual such as that conveyed by an activated thaumatrope or film projector. What I wish to suggest is a practical extension of this work into the early cinema period despite the fact that its devices may not come quite so easily to hand as the literally hand-held ones of pre-cinema. On the one hand they are esoteric objects, easily dismissed as of interest only to a small group of mechanically minded film enthusiasts and collectors, on the other hand they are the key to unlocking the historical perception of moving images.

1.3 Theatrical practice of early cinema today

In this section, I turn attention away from the methods of film historians as they contend with the recovery of early cinema experience to consider the position of the modern-day spectator as they come to experience early cinema not on the page but as a kind of enacted or performed historiography in a variety of venues.

A fusion of film experience and scholarly attention awakened the new paradigm of archivally-informed, academic film history – the so-called New Film History – that emerged from the FIAF Brighton conference of 1978. At Brighton, actual 35mm film projection of hundreds of fiction films from the period 1900-1906, proved the catalyst for new scholarly interest and attention.[73] The irony in this is that these mass projections which brought about a historiographic revolution in the study of early cinema did little to draw attention to the materiality of film projection, the primacy of which at that time was in no way challenged by any alternatives, despite a parallel strand at the conference entertaining the notion of preservation of film on videotape. The scholars returned to their universities and reconvened now and then for further screenings.[74] The most influential and extended of which were the annual week-long gatherings in Italy of *Le Giornate del Cinema Muto* and *Il Cinema Ritrovato*. Archives supplied these festivals of film history with 35mm projection copies of their preserved and restored films. The result of this vastly improved access to early cinema was still however an excessive attention to the image over experience as a generation of new wave cinephiles immersed themselves in the remediated screen experience of their grandparents. It was albeit a subtle remediation that kept within the bounds of 35mm projected film but employed up-to-date projection technology. The less subtle remediation of early cinema into

[73] see (Gartenberg, 1984) and (Thompson, 1984) for reviews of the conference and its publication as well as the extensive preparations leading up to it.
[74] As described by Musser, (footnote 413. 1994) and Elsaesser, (1990, 6)

digital projection has provided more cause for reflection.

The practical work under consideration in this section functions as a kind of performed historiography and is obviously highly informed by the forty years of research carried out by film historians in the previous section. They will often be in direct collaboration with the archivists, curators and programmers who realise the public facing activities which promote a concept of early cinema to the publics of the FHIs. There is much that is promising and positive in this work and my review in general proposes that the work should continue but with a more explicit focus on developing the spectators' awareness of the relation between the mechanical and the perceptual.

In the best scenarios, the presence of working film technology as a part of live demonstrations of early cinema is already nearly sufficient to make the case and merely needs some extra introductory remarks to place mechano-perceptual issues within the framework of the event. Indeed, given the attractive materiality of the technology, often constructed out of mahogany and lacquered brass and immediately recognisable as coming from another era, it may even be necessary to draw attention away from the device, lest it receives a surfeit of attention at the expense of the appreciation of the screen image: The aim, in so far as possible when enacting the conditions of early cinema, should be to hold the two in balance, such as we may reasonably conjecture was the case when neither technology nor film content had the additional complicating attraction of appearing out of its time.

Theatrical screenings of early cinema, such as are occurring around the world as I write, will typically refer to nothing more than the exhibition of film content that was made before 1915 in the early silent period. As is 'usual' in programming practice, the technical specifics of such shows will not be mentioned in publicity or programme notes, as initiatives such as the Charter of Cinematographic Projection in the 21st Century are relatively recent and not universally adopted. Screenings of early cinema are in any case not numerous, perhaps not just because of their obvious specialist interest but in part because of their failure to fit into the convention of feature film programming and the attendant emphasis on choice of film content over film experience. While screenings of silent classics such as *Nosferatu, Man with a Movie Camera* or *The Cabinet of Dr Caligari* may typically be available at a local level as one-off shows projected from DVD or DCP often featuring live musical accompaniment, films from within the strict period of early cinema are considered even more specialist fare and opportunities to see them tend to be collected together in archival film festivals or within theatres run by FHIs.

The film heritage festival scene has grown many fold in the last decade with the established festivals of *Le Giornate del Cinema Muto* and *Il Cinema Ritrovato*, running annually since the 1980s and constantly increasing attendances. They have been joined on the international stage by newer festivals with a shared emphasis on archival film. Thus San Francisco, Rochester, Paris, Toulouse and Berlin can now boast of their own festivals of archival film.[75] Bristol in the UK has its own *Cinema Rediscovered* festival, a closely related *Cinema Ritrovato* spin-off. Screening practice at these festivals has been a constantly evolving situation but increasingly 35mm is being replaced by DCP.[76]

The example of the *Nitrate Picture Show* at the George Eastman House is particularly noteworthy because its exclusive use of original cellulose nitrate prints is behind its claim to deliver an authentic experience.[77] It argues that the use of original prints rather than restored films brings audiences closer to the experience of a film's first audience and terms itself a festival of film conservation rather than preservation or restoration, indicating that the films it screens have simply been passively preserved and submitted to an archival health check for their fitness to project. Its catalogue is a model of philological information that would not usually be publicly available but exist only within an FHI's internal catalogue.[78] The

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[75] Even the first rank of major international festivals now have restoration showcases, as in the case of *Cannes Classic*, although the focus is usually on classic Hollywood and World cinema not early cinema.

[76] For example, from the programme for *Zoom Arrière* festival, Toulouse, 2-8 April 2016 archive presentations are from both DCP (Eye; Cineteca di Bologna, Cinémathèque française) and 35mm (BFI; NFA) (*La Cinémathèque de Toulouse*, n.d.)

[77] The slogan from the 2nd Festival in 2016 ran, 'Celebrating the Original Cinema Experience'; 'The idea behind the Nitrate picture show is that we are preserving not only the film but we're also preserving the original cinema experience. The films you may have seen on 35 of *Casablanca* or *The Man Who Knew Too Much*, those were copied from nitrate. It's like instead of looking at an image of the Mona Lisa on your phone you're going to the Mona Lisa.' (*We Meet the Film Buffs Flocking to New York's Nitrate Picture Show*, n.d.)

[78] For example: '*Blithe Spirit*, David Lean, UK 1945 / Print source: Museum of Modern Art / Running time: 96 minutes / About the print - This is Martin Scorsese's personal print, on deposit at MoMA. Though the print has some wear, including scratching, the Technicolor imbibition process has kept the

emphasis on the film material means that conventional programming according to the perceived quality of the filmmaking, falls by the wayside and attendees sign up for their festival passes without knowing which titles they will be watching. Its selection of prints made only on cellulose nitrate film sets an upper limit to the goal of recovered cinematic experience of the mid-fifties after which the material was no longer produced. There is a practical lower limit of the 1920s given the importance of ensuring that the prints are mechanically sound enough to withstand the rigours of projection.

Of these festivals, none deal exclusively with early cinema and only *Le Giornate* and SFSFF specialise solely in silent film. However, as the sector has grown, so too have the opportunities to see early cinema. An excellent example are the extensive annual reviews of production of a single year, precisely '*Cento Anni Fa*', curated by Mariann Lewinsky in Bologna, since 2003. While the programmes are constructed around the curator's assessment of their content in relation to film historical interest, technical specificity is also noted and set in the context of the vastly changed media landscape of the last 15 years. Where initially it was a privilege to be able to see the rare preserved content, the privilege now is to be able to see it projected as film.

> The past has not changed since the creation of the series A Hundred Years Ago in 2003. The present did. Due to new image technologies there are now more silent films available than ever. YouTube is full of them, and some archives make parts of their collections available online. In its first years, our

colors pristine. There are several areas of edge and perf damage that have been repaired for this screening. A handful of splices per reel and the amount of projector oil and dirt on the film show a healthy lifetime for this print. Shrinkage: 0.8%' (*Nitrate Picture Show Catalog*, 2016)

> section presented films impossible to see elsewhere; in 2017 most films will be presented as films, in the original 35mm format very difficult to see today. (Cineteca di Bologna, 2017, 46)

The expansion of the archive festival sector has increased opportunities to develop more experimental approaches to programming occasional examples of which have met the need which I claim exists for greater technological authenticity at the moment of exhibition.

Since 2013, *Il Cinema Ritrovato* has made a specialty of select screenings presented by a mid-century projector with carbon arc lighting. The shows are held in an open courtyard and are very atmospheric, with not only the projector on display but its chimney and ducting removed so that the smoke from the gradually disintegrating carbons exits directly into the open air. Although the curatorial emphasis is placed on the aesthetic quality of the light produced by the carbons, as a counterpoint to the xenon arc lighting used in modern film projectors since the 1960s and in the festival's other theatres, the sight of the projector itself, not hidden away in a booth but anachronistically on display at the back of the flat seating area, also proves a draw for the curiosity of the patrons and their smartphone cameras.[79] Indeed, given that the aesthetic distinction between these two systems is marginal, and judging from audience reaction to it as a major attraction, it may be said that the greater

[79] The significance of this particular change in film technology, which produced a light of similar intensity and colour temperature, (Enticknap, 2005, 152) was to remove the need for the regular 'trimming' of the carbons, the active maintenance of the light source that was one of the projectionist's important roles. The change therefore had more effect on the experience of the operator than that of the patron although the cinephile audience of Bologna may claim otherwise.

part of the added value of this particular form of event cinema derives from the presence of the projector, its sight, sound and smell. It is an attraction imported from the earlier *dispositif* of the cinema of attractions and here applied to productions of a later date and utilising a projector that was never designed to be exhibited in a space shared by the audience.

Since 2016, a further innovation has been incorporated at the beginning of the carbon arc screening which is more historically consistent in its use of film content, technology and *dispositif*. It consists of a 15-minute demonstration of a much earlier hand-cranked projector by Nikolaus Wostry, the curator of the Austrian Film Archive. In 2017, I witnessed Wostry and an assistant demonstrate a circa 1905 Wrench AA projector from the collection in Vienna using safety film preservations of hand-coloured films from the 1900s. The two operators controlled the hand fed carbon arc lamp and cranked the mechanism of the projector from a position in the central aisle which was much closer to the screen than the newer projector. It was therefore more typical of the early cinema period in being on display and co-present in the space of the audience. In terms of authenticity, the situation was the reverse of the Nitrate Picture Show, the emphasis falling on projection technology rather than film material. Although a little bit lost in what has become a large festival, this screening played to a capacity audience. The film scholar, Kristin Thompson, was among those to see the show.

> The films were charming, but the star of the show was the projector. It looked like a magic lantern dressed up with special attachments that allowed for

> moving pictures, including a shutter sitting in front of the lens rather than within the body of the lantern. Indeed, the thing looks like a magic lantern converted into a film projector.
>
> This projector cast a much smaller image than the later carbon-arc projector used for the second part of the show. The image had rounded corners and it flickered distinctly. At times, despite Wostry's obvious expertise at hand-cranking, the image would briefly go to black. Watching this presentation, it became easy to grasp how early audiences might have been constantly aware of the artifice, the machine, creating these images and have marveled at any sort of moving photographs that were cast on the screen before them. It was a magical few minutes, making almost real the section of the program entitled "The Time Machine." (K. Thompson, 2017)

I can confirm Thompson's account and would add that the flickering, though distinct, was not unpleasant, albeit for a relatively short presentation. In this situation factors influencing the impression of flicker included the external shutter with a single blade producing a flicker frequency of approximately 16Hz, the light output of the carbon arc, the distance from the screen, focal length of the lens (affecting the size and therefore the brightness of the picture) and the ambient light of the Bolognese evening. Of these the single bladed shutter remains the most significant. Of course, this situation allowed for a comparison of the two eras of projection technology sharing similar lighting technologies although the comparison was in series rather than a more ideal 'side by side' concurrent one. Unlike the flickering image projected by the Wrench, the much larger and nevertheless much brighter image produced by the 1950s projector, with its multi-bladed shutter, displayed no visible flicker. The moments, mentioned by Thompson, during which the image momentarily turned black were caused by an over-cautious safety shutter – a device designed to protect the film from catching alight if it should become stationary in the projector. The mechanism holding it open failed and Wostry was obliged to hold it open manually. This issue was perhaps a result of the projector's age or performance-readiness, although equally a fault which could have occurred when new.

As Thompson states, an experience such as this leaves no doubt as to 'the artifice, the machine' from which it springs. It is impossible to forget that the experience is mediated by a complex technology controlled by a human agent. If, from our temporal standpoint, it is possible to find the technology even more curious than the screen image, then one can at least postulate an original audience whose attention would have been very much split between the two, between witnessing the phenomenon of living pictures and investigating the evidence of the device from whence they came. What this demonstration also powerfully conveyed was that the experience of film technology appealed to senses beyond the purely visual. The audience was stimulated not just by the visual spectacle of moving images but by the sight, sound and even smell of the technology used to create them. Seated with the Wrench projector alongside to my right, I witnessed the elaborate preparations required to conjure and control the light from the carbons, which once 'struck' would hiss and spit and give off a smell, logically enough, like a steam engine. Still earlier projectors which, in common with magic lanterns of the late nineteenth century, had lamp houses made from mahogany rather than 'Russian iron', would have further contributed to the show's carbon footprint, burning not just the light source but its means of containment as well. As Will Day recalled of his exploits as a projectionist in the earliest days of cinema, 'The smell of burning mahogany was always a very necessary part of the entertainment.'[80] Although used to the mechanical sound of the projector, it was novel to be listening also to the sound of the light source. This was noted in contemporary reports as a distraction and even a possible danger, in the case of the often-used alternative to carbon arc, the gas-powered limelight. Its inexpert handling could produce popping noises that 'may excite the latent panicky feeling of the audience and with disastrous results.' (Jenkins, 1908, 67)

The aural and olfactory impressions which I received in the Bologna screening served as a kind of overture to the actual projection which, once underway, intermingled the sounds of the regular mechanical ticking of the projection mechanism, with the occasional hiss from the carbons as they were 'trimmed'. Simultaneous with the hiss, the screen would grow visibly brighter. This technological noise, at least from my position close to the projector, seemed to exist on an equal level and curiously mingle with the piano accompaniment which, in common with nearly all archival presentations of silent cinema, had been commissioned by the festival organisers. The demonstration therefore offered some

[80] Day is quoted in Bottomore, (1999, 83) [The loose pile of unspooled nitrate film] 'never received a thought. It was the fact that I had to keep my lamp house from catching fire, and the smell of the burning mahogany was always a very necessary part of the entertainment, to overcome which I always kept handy a wet sponge, with which to put out the smouldering wood, and prevent it bursting into flame ...'

empirical evidence for arguments that musical accompaniment of film shows developed in order to mask the sound of the apparatus as well as to subdue the uncanny presentiments prompted by the mute images, such as those famously received by Maxim Gorky in 'the Kingdom of Shadows'.[81] Although there is debate about the universality of musical accompaniment, it is clear that where it existed it was itself yet another kind of shutter that came down on the experience in order to hide the naked reality of the technology.[82] It was albeit an imperfect mask – just like early shutter designs – and was swiftly superceded by a more literal and effective negation: the entombment of the projector and projectionist, firstly in a fireproof box and then behind the purpose-built wall of the projection booth, primarily in the name of safety, but nevertheless effectively rendering the technological means of projection inaudible and invisible.[83]

This demonstration of early film technology at *Il Cinema Ritrovato* provided me with a valuable measure of its sensed presence in performance, needless to say one which could neither be derived from a traditional museological display of the

[81] Tsivian couches this opposition in terms of mechanism and organism suggesting cinema needed music in order to hide its bourgeois origins. (Tsivian, 1994, 85-6). Altman, (2007, 89) quotes an advertisement for the Optigraph which states its 'absence of noise is a feature of great value… with other machines the noise is so great that, as a rule, it is necessary to keep a piano or other musical instrument going while the motion pictures are being shown.

[82] Rick Altman presents evidence that many early film shows were unaccompanied, in contrast, he says, to the received opinion that 'the silents were never silent.' (Altman, 2007, 193-6) He doesn't however consider in detail the soundscape of technology that would have accompanied all shows in this era or attempt to differentiate it beyond simple 'noise'. In fact, his plea for greater attention to the detail and variety of early cinema sound, which had been assumed to be simply uniform in its otherness, is comparable to what I would like to achieve for the case of early cinema technology.

[83] As part of the recent AHRC funded Projection Project, these sounds have been sought out and uncovered. Recordings of the inside of projection booths have been made at the point of the industry's transition to digital. (Pigott, 2017)

objects of film technology behind glass nor a screening of a film of early cinema period in a theatre employing modern projection practice, be it analogue or digital.

The conditions that I witnessed in Bologna may have already been familiar to the first patrons of film shows who would also have been in the habit of attending magic lantern shows but they have long been removed from the common cinema experience. They are absent from the codified conditions of museum theatres run by FHIs which have concentrated attention on the 'text' of the film alone and have assumed a default position of honouring modes of late silent and sound film, of the 'cinema of narrative integration' or the 'institutional mode of representation'. Such default screenings do little to promote the perspective of Tsivian's 'medium-sensitive viewer'.

I have concentrated on providing a detailed account of my experience of this event because it was the most satisfying from the point of view of transmitting a concept of the connectedness of the mechanical and perceptual which I claim drives the cinema experience. It is not however a unique instance of a re-enactment type screening of early cinema. Some years earlier in 2008, I attended a show supported by the Cinematheque de la ville de Luxembourg. Claude Bertemes and Nicole Dahlen, the curators of the 'Crazy Cinématographe' wished to re-create the experience of a travelling cinematograph show of the 1900s and had gone as far as securing a pitch at the town's *Schueberfouer* – a large open-air fair held annually in late August and early September – in order to contextualize the film shows within fairground culture. Many of the unique aspects of such screenings were recreated, including the use of barkers and *bonimenteurs* who firstly attracted patrons' attention away from competing attractions and then interacted with and interpreted the films as they were screened inside the tent.[84] Indeed, the event was created in open collaboration between these performers from the world of theatre and the curators with their knowledge of film history. The films themselves were new 35mm safety copies bought for the purpose from European archives and selected to make thematic programmes but they were projected on a modern era electric motor-driven projector accompanied by the sound of its characteristic efficient hum. This was a concession to practicality given that the event called for many different screenings per day. However, from my point of view, with a particular interest in the effect of film technology, the effect on historical validity was regrettable. The Crazy Cinématographe project which ran for four seasons from 2007-2010, and over 600 individual shows, should certainly be complemented for its ambition and innovative setting within a modern-day fair rather than a specialist festival where the audience could be guaranteed to be more interested and sympathetic to the endeavor. Its organisers wished to avoid a 'historicising perspective' (Bertemes & Dahlen, 2012, 103) conscious that cinema's first audiences were pioneers of the new. They rather sought 'to communicate fairground cinema to present day audiences, by analogy

[84] Joe Kember describes a full list of the different types of performer a spectator at a British fairground cinema would have encountered. (2006, 5)

with historical ones, as an experience in which the moment of the novel, the never seen before, dominates.' (2012, 103)[85] Nevertheless, the Crazy Cinématographe can be seen as an enactment of socio/cultural film historical research just as the Bologna screening was an enactment of material/technological film historical research. A combination of the two approaches would seem to offer the best chances of success for an enactment of early cinema practices that appeal to all the senses. It is also likely that the spectacle of other timeliness inherent in each part would balance each other out rather than placing undue emphasis on one or the other.

However, the rare category of early cinema screenings which engage with any attempt at recreating original elements of the early cinema *dispositif*, beyond that of musical accompaniment, suffers as much from selective realisation as other forms of historiography and I am not aware of any such complete attempt at restaging early cinema although certainly worthy of mention in this regard were a number of re-creations of very early cinema screenings conducted by Museum of the Moving Image staff at the time of the centenary of cinema celebrations. (Herbert, 1996) [86] A series of events called 'Countdown to Cinema' and a course for students entitled 'Beginnings of Cinema' afforded both general and specialist audiences regular

[85] The citations are drawn from note 17, p. 103.

[86] A further example, which I have not personally witnessed, would appear to be the series of screenings conducted at MoMA called the Living Nickelodeon in which the emphasis was on extending awareness of the varieties of musical accompaniment. Other examples of recreations include Loughney, (1999) and the 'revival' of Kinemacolor. (Jackson, 2010)

remarkable access to early film technology and its demonstration.[87] Herbert explains the MOMI approach as a mix of hard and soft elements, not specifically related to the hardware and software analogy previously applied to the system of cinema, but where soft now refers to the 'human actors' in the system.

> By using the surviving technology, or – where this is not practicable without compromising a scarce or fragile artefact, a replica – the original effect 'on the screen' has been reproduced as closely as possible, and has added an element of novelty and 'theatre' which interests specialist and general audiences alike. As well as the hard technology there were always the people: the inventors, the showmen and women who brought the moving image to the audiences of the world. With their special training in interpretation and skills in public interaction, the actors – all ex-members of the MOMI Actors' Company – have added the 'soft' element of history. (Herbert, 1996, 167)

The interpretive skills of the MOMI Actors' Company and the performers of the Crazy Cinématographe certainly had an appeal to broad publics and both aimed to create informed, sensed knowledge of historical film experience in the present day. However, Herbert perceives a charge that reconstructions can threaten a devaluing of historical scholarship, which he defends thus, 'a well-researched period presentation or technical demonstration can make visible some aspects and take an audience a small step towards the original experience, without devaluing scholarship.' (Herbert, 2016, 372) It is, of course, important to distinguish what is meant by 'reconstruction'. MOMI practised both technical demonstrations and more 'Wigan Pier' style interventions from 'actor-guides, keeping within their period

[87] One of Herbert's students recently recalled having taken part in the Kinemacolor course in an article written on the twentieth anniversary of the closure of MOMI. It was 'a vivid lesson in the importance of doing film history, not just theorising.' (Domankiewicz, 2019)

roles.' (Herbert 2016, 362) Personally, I want to place the emphasis on the experience of a scene rather than the look of scene and I therefore prefer the concept of enactment to re-enactment, re-creation, revival or replica. It indicates the performance is not attempting to approach the impossible status of an exact repeat and allows a focus on the contribution of subtle details that are essentially ahistorical, that have the chance to be rendered historically accurate but which would lose attention in a more theatrical attention-seeking setting. The participant can be kept in a phenomenological 'now' and yet still make an informed judgement about historical experience.

These demonstrations of early cinema technology and reception are experiences that I can carry with me and use to calibrate my senses as I watch other examples of early cinema presented in the full range of possibilities provided by 21st century technology. They help to build medium sensitivity in modern viewers and allow them access to the parameters of experience of the first audiences of early cinema. The memory of this experience then becomes a tool which can help with the work of paraphrasing and interpreting subsequent experience.

Conclusion

This chapter has shown the extensive existence of a desire to understand the lived experience of early cinema as manifested in various forms of historical research and participation in archival screenings.

The preservation of experience is of course an impossibility: We cannot step into the same river twice. Although such power has been claimed for cinema's ability to record a filmic representation of past events, it is clear that the totality of experience is beyond seamless capture and replay. This is especially the case with any attempt to preserve the experience of early cinema which was provisional, mobile and heterogeonous. With the arrival of institutionalisation and standardisation, the pace of change slowed but in the early period when there was no consensus even on the name of the practice, no specific setting for it to take place in and a large variety of cultural frameworks in which it occurred, where the tributaries of what cinema would become had yet to join together, it would be like trying to step into multiple different rivers twice.

Film history was written first by word of mouth, then by reference to a paper trail, to which the study of film prints was added. Later iterations of film history have widened the scope of the research to include the position of the spectator within a wider social and economic context. Film-making technologies and their effect on aesthetics and film form have received some attention but especially the technological factors governing historical film experience have not received wide attention.

This thesis is a call to bring that scale of attention to the apparatus of cinema that the restored film prints began to receive at Brighton in 1978 and which has since led to the recovery of vast tracts of lost and neglected early and silent cinema. Now, 40 years later, can we imagine discovering a comparable large-scale treasure trove in the archive, and a re-cranking of the apparatus collected in museum stores but never activated? I argue that the key to unlocking this vault and gaining access to a vast new collection of 'texts' is in the application of contextual information from the science of perception which can bring us in direct contact with the experience – interior life, even – of the first spectators of the world's first moving images.

2. The 'Flicks' and the 'Jumpers'

> The cinematograph seems to share in the excitement of the audience, for it wobbles to such a degree that it is hardly possible to make out what the men are doing at times; and one's head and eyes ache with the effort of watching the maddening jig of the pictures and trying to follow the details of the duel.
>
> Véra Tsaritsyn [Lady Colin Campbell AKA Gertrude Blood], 'A Woman's Walks. No. CXXXVIII. Modern Gladiators', *The World*, 20 October 1897.

Introduction

This chapter is concerned with factors impinging on the reception of early cinema that arise from specifically technological sources, the various artifacts of its opto-mechanical essence, their presence on screen in varying degrees, and their origins within the system. Its primary concern is with the projection apparatus and its inherent issues of flicker and stability. Photographic quality and film material are also considered along with flicker sources not directly related to the projector shutter but present, for example, in the camera negative or the light source used in projection or even within the subject matter of the film. This chapter is therefore about the noise in the system and not just the system itself.

These artifacts of the technology of cinema were gauchely laid bare at the point of exhibition and are easily found in contemporary spectators' responses to the new experience of moving pictures. Some effects could be painful, others merely irritating or distracting. Gertrude Blood's comment, made in response to a screening of *The Corbett-Fitzsimmons Fight* (1897), reminds us that it was not just the photography that was animated in many early performances of 'animated photography'. Flicker was not the only lamentable quality of the screened image and was often joined by complaints about image stability. In 1897, the engineer, Arthur Newman, was working on his first camera and projector designs. He later reminisced that the early film shows immediately after Lumière 'earned the name of "The Jumpers" which they well deserved' (1930, 538).[88] The jumping of the image was an issue that concerned all the mechanical components of cinema. There was no one source for mechanical instability. It could be found in all corners of the various mechanisms as well as the film material itself, in as much as inaccurate and non-standard perforation was often a significant drawback. Camera, printer and projector design and use were also all potentially culpable, although many early devices, such as the Cinématographe, served as all three. However, the Veriscope technology that powered Gertrude Blood's experience appears to have been separated out across all three devices, as later industry convention would have it. Progress was incremental and the result of myriad minor mechanical improvements as well as eventually agreed film format standards.

In some reports by contemporary observers, little distinction was made between flicker and instability. They were seen as essentially the same fault. One way or another the 'head and eyes' were left aching and as in the case of the Veriscope performance that Blood witnessed, the audience may have felt that the corporal

[88] Reference to this term should be qualified. It is not clear how widespread its usage was. Addressing an industry audience in 1930, specifically about camera mechanism, Newman would have prioritised the issue of stability over flicker given its application to his subject and his area of expertise.

assault of the prize fight that they were watching was all too effectively transferred to their own sensorium. The first section of this chapter examines this productive, if extreme, example of early cinema experience as mediated by technology; the Veriscope system of Enoch Rector. The popular commentary of Blood is compared with the expert view of another Veriscope spectator, the scientist and flicker researcher, Thomas Cunningham Porter.

Cinema began by combining pre-existing technologies of light and image projection with newly developed mechanisms that could synthesise movement. Were it not for the act of projection, the challenge would have been modest. Edison and Dickson's Kinetoscope had already risen to brief commercial success by offering a peep show style photographic moving image experience for a single individual and its mechanism sufficed for that small-scale ambition. Massively enlarging the postage stamp-sized frame of 35mm film for projection, however, required an extensively redesigned apparatus. The Kinetoscope featured continuous running and an almost entirely opaque shutter, save for a tiny slit – much like a rearranged zoetrope or phenakistiscope.[89] In nearly all the projector designs which were employed in the first film shows, these were replaced by the stop/start of an intermittent mechanism and the use of a more open shutter which would hide the operation of the mechanism but still allow much more light to reach the screen.

[89] A British Kinetoscope agent timed the exposure of a frame of film to the view of the spectator as 1/1240th of a second. (Barnes, 1998, 3) In stark contrast, the open sector of projector shutters varied but was typically between one half and one sixth, meaning the film frame was visible on screen for the major part of a second.

The massive enlargement of the image also had the effect of enlarging any movement or mis-registration of the image in the mechanism or bodily movement of the projector.

The material traces encountered during its journey through the tripartite apparatus of camera, printer and projector would also be mercilessly magnified. Specks of dust introduced while making a positive print from a camera negative would appear on the screen as random flashing white spots in dark areas of the image. Oil necessary for the smooth running of the mechanism would attract dirt creating an environment around the projector which would sooner or later contaminate the filmstrip itself and launch the screen debut of a multitude of foreign bodies.

Through this discussion, the problem of flicker, while seemingly centred on the single component of the shutter, is shown to have potentially wider sources. In order to properly situate the later discussion of shutter-based flicker and interventions in shutter design in chapter 5, these alternative sites of flicker in film material and content, will be briefly acknowledged. The intention in this chapter is therefore to create a refined and, at times, broadened definition of flicker that accurately captures its place in the experience of early cinema. Perhaps because in the technological imaginary of cinema the flicker of the ‘flicks’ is inextricably linked with a synonym for cinema itself, other components and artifacts of the technological experience of cinema are less notorious. The chapter attempts therefore a certain amount of disambiguation of not only what flicker was but what it was understood to be.[90] It sets the stage for the focus on flicker in the remaining chapters 3 and 5 as well as the framework for my insistence on the actual study of the ironwork, or nuts and bolts, as applied in chapter 4.

2.1 Veriscope: the mechanical and perceptual struggle of early cinema

The extract from Blood's review of the *The Corbett-Fitzsimmons Fight*, which she saw at the Royal Aquarium Theatre in London is a mediated remnant of a particular perceptual response to early cinema occurring in 1897.[91] It is another example of the insecure jiggles and general animus of technology which in some cases seemed to crash on the audience of early film as much as the waves of the *Rough Sea at Dover* (1895) or the thrusting pistons of the train arriving at the station in La Ciotat, or in this case, the punches and lunges of the combatants. That Blood assigns some degree of agency to the mechanism itself is particularly noteworthy and seems to accord it a fully active and expressive part in the intimately connected trinity of operator, projector and spectator.

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[90] The slang term 'the flicks', as in 'going to the flicks', may not have been used concurrently with Newman's term 'the jumpers'. Although clearly applicable to the flickering reality of early cinema, it seems that it only became a term for cinema going once flicker had been reduced to mostly unreportable levels. According to the lexicologist Eric Partridge, use of 'the flicks' is first recorded in 1927 in *Contemporary English: A Personal Speech Record* by W. E. Collinson. Slightly obscure by the 1980s, the term was very common in the UK in the 1940s. See entry in Partridge, (1984). Assuming a first use in the 1920s, therefore, it would appear to be yet another retrospective addition to our conception of early cinema, a mostly affectionate term tinged with nostalgia for the nickelodeon days. The opposite, in fact, of the urgent critique implied by 'the jumpers'. In modern usage, there is a telling irony in that the term, and its singular form, denoting 'movie', is more popular than ever, and often used by film journalists to describe the products of digital cinema from which flicker has been entirely removed.

[91] The quote is gleaned from a long and lively review, the entirety of which can be found on Luke McKernan's 'Picturegoing' website. (Blood, 1897)

This screening is also a good example of an almost forgotten outlier in the vast and varied flickerscape of early film technology. Shot by Enoch J. Rector and assistants in a unique 63mm widescreen format with a one-off proprietary technology that he called Veriscope, the film was remarkable on many different levels perhaps the most obvious of which was its running time.[92] The film ran for 75 minutes but with 6 short breaks for reel changes, programme length was at least 100 minutes. The spectacle that it depicted, the world heavyweight championship prize fight between James Corbett and Bob Fitzsimmons, was a hundred times longer than the average film of its era although in common with them, it remained a tableau of continuous action recorded in real time occurring within a fixed frame. The film was as long as the fight and would have been even longer had Corbett managed to recover from the fateful blow to his solar plexus in the fourteenth round before his ten seconds were up. Such duration, to which of course the term 'feature length' has subsequently been anachronistically applied, placed unheard of stresses not just on the filmmaking and projecting technology but also on the endurance of its spectators. Atypical as it was in terms of other experiences of early cinema, it is nonetheless interesting as a limit case of what was cinematically possible in this early period.[93]

[92] The film is an exemplary anomaly amongst already heterogeneous company. 'Its format, fame, controversy, longevity, and profitability distinguished it from other motion pictures in 1897.' (Streible, 2008, 95)

[93] That the endeavour was at the limit of what was technically and humanly possible at the time is proven by the failed attempts to film other prizefights in this period. The only other such comparable success was by Biograph in November 1899 with the Jefferies-Sharkey fight achieved only after the proving ground of abject failure of Vitagraph in June 1899 at the Fitzsimmons-Jefferies fight, where an electrical surge knocked out the lights. Indeed, one could claim that the human-powered Veriscope's independence from electricity was essential to its success in 1897.

There was only ever one Veriscope film title and yet it was seen by a vast audience in the United States and around the world in 1897. Its wide dissemination has at least left a rich record of its promotion and reception in the print media of the time although the film itself has been less fortunate, with only about a third of its original length surviving. An even greater lacuna has engulfed the physical technology of Veriscope – the cameras, printers and projectors necessary to deliver the experience to an audience. These specially designed devices are not known to exist anywhere and so our impression of its impact on audiences must rely on surviving reports of factual details as well as vivid commentary such as Blood's. Additionally, experience of comparable surviving technologies – such as that generated by the demonstration of the Wrench projector, as mentioned in chapter 1 – can provide a framework for the historical reconstruction of experience. This pre-existing informed experience can then be mentally adapted to suit the known facts and first-hand reports of the technology, such as the Veriscope, which no longer exists.

Apart from receiving a typically breathless chapter in Terry Ramsaye's romantic early history of film, Veriscope and Rector were until recently little more than a footnote in technological histories of cinema.[94] Cynically, one might suggest that their exile

[94] See Ramsaye's chapter, 'When Corbett fought "Ruby Robert"' (1926, 281–289). The first attempts at a history of film technology covered Veriscope in a few sentences. For example, F. H. Richardson, editor of the Motion Picture World, wrote, 'The Veriscope film and projector were made especially to "take" the Fitzsimmons-Jefferies [sic] prize fight. It was, so far as I know, never used for anything else.' (Richardson, 1925) While Carl Gregory ventured slightly more detail. 'In the fall of 1897, Enoch J. Rector, an inventor and promoter, showed pictures of the Corbett-Fitzsimmons prize fight in the Academy of Music on 14th Street in New York City. His apparatus was called the Veriscope and the same mechanism used to show the pictures was employed in the camera with which 11,000 feet of film were taken at Carson City, Nevada, March 17, 1897. Thereafter about twenty machines for

from film history was due to the inconvenient truth of it having been a popular widely-distributed feature length widescreen film fifteen years before feature film presentation took off and over fifty years before the widescreen revolution of the 1950s. It failed to fit into film historical narratives and depicted unlovely and tedious subject matter, at least for those same historians.[95] However, recent effort in scholarship and restoration has returned the film to, if not notoriety, then a status more fitting to its deserved place in film history. Surviving 63mm positive footage was restored and transferred to 35mm in time for its centenary and screened at the National Film Theatre in London. Textual research, based on the rich sources of press reports, which covered the preparations for the fight and its filming as well as its distribution and reception replaced the perfunctory assessment of its technological novelty with a far thicker account of its place in late nineteenth century American culture. This comparatively recent research has understandably attended to the film's social context, particularly the fascinating opportunity that it provided for proxy female assembly and spectatorship at what had been the all but exclusively male preserve of the boxing ring (Musser, 1994) and (Hansen, 1991). A yet more recent re-evaluation cautions that press reports of female attendances may have been exaggerated by the promoters as a means of disarming critics and creating an aura of wholesome entertainment (Streible, 2008). These authors and

projecting this large size film were mamanufactured and these fight films were exhibited all over the country. (Gregory, 1930)

[95] Paul Rotha's comment quoted in Streible, 'Exceptionally dull as this enormous length of film must have been, its novelty was probably astounding.' (2008, 53)

especially also Luke McKernan noted the importance of boxing in establishing a mass audience for cinema: 'one may even go so far as to say that the mere mechanical construction of a film projector has been overestimated, and that it was boxing that created cinema.' (McKernan 1996, 107)

However, in the case of Veriscope, its mechanical construction is a matter of some interest because only by understanding the technology used in the photographing and exhibition of the film can we approach a full understanding of its reception which in turn can be used to accurately frame our potential experience of the surviving footage today. In formulating such a mechano-perceptual oriented account, the extensive research of Dan Streible and Samuel Hawley has been particularly useful in supplying critical detail missing from earlier accounts.[96] In particular Hawley's reference to a rare technical description of the Veriscope from 1897 is invaluable in constructing an understanding of its capabilities.[97] The article, in the trade journal, *The Phonoscope*, describes the camera in the text and illustrates the projector. The camera took 'twenty-four photographs a second' and was 'operated by means of a revolving hand crank gear instead of electricity.' The projector, on the other hand, used electricity for both running the mechanism and feeding the carbon arc lamp. The diagram depicts a shaft with bevel gear holding a

[96] Hawley has also given some attention to the effect of latter day mechano-perceptual systems on modern versions of the film. He begins his book with a prologue describing the restoration screening in 1997 and concludes with a comment on the impoverished quality of the film in a version currently accessible on youtube. (Hawley, 2016)

[97] *The Phonoscope* of Jan-Feb 1897, Vol.1 no.3, p.12.This resource was only digitised and made available on the internet in 2014. ('Varioscopes [Sic] to Be Operated at the Corbett-Fitzsimmons Contest', 1897)

shutter. Although the side view unhelpfully conceals the form of the shutter, at this time it is likely to have been a single blade. The audacious plan for the shoot entailed building a ringside camera in the form of a large wooden shack, containing three camera mechanisms placed in parallel and operated by Rector himself and multiple assistants. Working under red light darkroom conditions, the cameramen cranked away for 8 minutes at a time before changing reels within a four-minute time window and then resuming shooting. By staggering each camera by four minutes, this ensured a final result of two complete records of the entire match.[98] *The Phonoscope* concluded its report on the elaborate plans for the relay filming thus, 'This mode of procedure will be followed until either the fighters, the instruments or the films give out', to which one might also add, the camera operator. Through his imaginative reconstruction, Hawley also envisages the stresses endured by the technology and its operators. His comment that the Veriscope was a 'living, breathing, thinking camera' (2016, 231) is apposite enough although perhaps not sufficient to distinguish it from the typical experience of filming in 1897 which would often have involved the symbiosis of an operator hand cranking a camera mechanism. Of course, in the case of the Veriscope, the living, breathing and thinking took place inside the camera body, amongst the exposed film, its intelligence distributed between the three teams of three men cranking the camera mechanism and the feed and take up reels of wide format film. The

[98] Based on details supplied in *The Phonoscope* (ibid), Hawley dramatizes the likely scene inside the Veriscope shack as the cameramen cranked through 22,000 feet of film in seventy-five minutes.

important point, however, is surely that the extreme conditions of the shoot and its attempt to contain the unspooling reality would very likely have contributed, through forced errors or simple mechanical or human fatigue, to the uneven results witnessed by its first audiences. [99] The excess nervous energy in the ring and inside the camera shack then found a continued embodiment in the *projected* Veriscope experience.

The one-off proprietary technology was both a help and a hindrance when it came to exhibiting the film. It helped to ensure against piracy which was rampant in the nascent industry but required the establishment of an entire distribution and exhibition system. Rector and his business manager and producer Dan Stuart, used the Edisonian model of selling rights to show the film on a state by state basis. However, they were not well placed to satisfy demand for what became a sensational and unique property – the motion picture record of the entire heavyweight world championship contest that had played out in a controversial manner and had led to the defeat of the popular American defending champion. Nevertheless, Veriscope managed to put together eleven functioning outfits and have them ready for exhibition two months later, in the meantime keeping the

[99] Colin Bennett claimed that a certain 'expenditure of nerve force' on the part of the cameraman is necessary for a successful take. (Bennett, 1911, 34). My impression of the Veriscope shoot is that the expenditure required exceeded these salutary limits.

match in the public mind by stoking the controversy and supplying a steady stream of publicity.[100]

The gala premiere in New York occurred on 22 May 1897 and despite significant technical issues, audiences were enthralled. Dan Streible provides a summary of much of the reaction to the technical quality of the production:

> "The machine," complained the New York Times, "leaves a good deal to be desired." Its "constant quiver" "destroys the illusion" and operates "unpleasantly on the nerves of the spectator." Despite technical improvements to the projectors and better prints being struck in June, most reviews complained that "continued vibration and coruscation," "sudden jumps," "flickering," and "too much blur" were "trying on the eyes." The films often broke in mid-reel, some prints being "chipped and cracked, or worn so as to present many flaws and imperfection." (2008, 78)

Issues of flicker and instability were joined by problems with print quality that may have been introduced by the process of printing from the negative and the developing of the positive. Certainly, surviving footage displays a host of artifacts that could be caused in this manner, although discerning the precise origin of them from a digitisation is almost impossible. For example, blotches on individual frames could have arisen from initial processing of the negative and positive or have occurred later in the film's life as damage to emulsion from poor storage. Notwithstanding the attempted fixes, Veriscope was clearly not a fully developed technology even to the extent that the Cinématographe was on its public debut. It was rushed into the theatres because to have delayed further would have risked the

[100] For the number of initial outfits see Streible and Musser, who also credits Gregory's claim of 'about 20' as the maximum. (Streible, 2008, 78)

timeliness of its unique selling point: complete footage of the controversial fight. Perhaps what is most remarkable about the reception of *The Corbett-Fitzsimmons Fight* is that audiences put up with its technical issues, below par even for 1897, and were still gripped by its spectacle. Gertrude Blood even concluded her review by suggesting a return visit: 'though we leave the theatre with aching heads, we regret that so little that we determine to return as soon as we can, to witness again this combat of modern gladiators.' (Blood, 1897) Fundamentally, it is an early example of public desire to witness the content of a film rather than the technology or the illusion and indeed of Bill Gates' more recently formulated adage, 'content is king'. The notoriety of the fight and the additional publicity generated by Dan Stuart about its filmed record meant that audiences wanted to see for themselves the disputed calls of the referee and the deciding blow itself.[101] They soon found that while the camera didn't lie, it was certainly open to interpretation, all the more so because of the obfuscation of Veriscope's intrusive technique. This active interpretation and decipherment by the audience is worth noting because it complicates the new medium's claims for astonishing realism.

With American audiences to some extent catered for by the franchisees, Rector himself spearheaded the international distribution of his film by setting off on a tour of Australia and South Africa. While he was touring in the southern hemisphere, the film and by implication its exhibition technology crossed the Atlantic and was shown

[101] These two key moments in the contest attracted partisan interpretation.

in London at the Royal Aquarium Theatre (Barnes, 1996, 150) for the first time on 27 September 1897, six months after the fight itself on 17 March 1897 and four months after its premiere in New York. This is the screening which Gertrude Blood attended and which still seems to have been blighted by the jumping present in the earlier screenings in the US. The distribution model from our time would assume a conversion to standard format (35mm or DCP) for a widely-distributed film, with subtle consequences for the character of the viewing experience. Of course, this would have rendered the anti-piracy function of the format void and it is likely that it was easier simply to send over a spare projector along with the voluminous reels of film. There is however some evidence from Hopwood's *Living Pictures* that would suggest a change of apparatus to the somewhat mysterious 'Anglo-Continental Company's Kinematograph.'

> This apparatus was used at the Aquarium for the exhibition of the celebrated prize-fight, the negatives of which were secured by the "Veriscope." The instrument was electrically driven, intermittent motion being obtained by means of a variable-screw acting on a cogged wheel attached to the sprocket-roller. (Hopwood, 1899, 166)

Whether this was indeed a different device or just the electrically driven Veriscope projector operating under another name is unclear. It also sounds rather like the Rigg's Kinematograph known to be in use at the Aquarium already in April 1896 which also employed a variable screw movement but which used standard 35mm film. (Barnes, 1998, 130) Although the exact identity of the device used at the Aquarium is obscure, we can say that the jumping experienced by Gertrude Blood could have been introduced or exacerbated by any one of four different stages in the journey of the Veriscope images to the screen of the London Aquarium: 1) the photography of the negative in the ringside camera shack as up to nine operators wrestle with the prototypical technology against the clock, 2) the printing of the negatives, including the possibility of two different versions, 3) the projection of the prints by a team of travelling Veriscope operators and franchise holders, 4) the unknown quantity of transferal of the 63mm negative to the Anglo-Continental Co. Kinematograph system which would in fact introduce three new phases of transfer, printing and projection.[102] Careful inspection of the original film elements (held at MoMA in New York) would help to shed light on this question but from the evidence already assembled here, I would expect the gravest issues to have occurred at the time of the high stakes, marathon-like photography, with every subsequent phase contributing more instability and acquired damage.

With this in mind it is interesting to examine another eyewitness account of a Veriscope spectator, not least because its author was an expert in the scientific study of flicker. Thomas Cunningham Porter was a physics and chemistry tutor at Eton College and a keen amateur photographer.[103] Amongst his many various interests and achievements, he held a patent on a means of projecting stereoscopic pictures which involved the use of rotating shutters held before the lantern lens and

[102] See Cleveland and Pritchard, (2015, 55) for a discussion of the aesthetic effects and issues involved in duplicating film in this period.
[103] See Porter's obituary in the *Journal of the Chemical Society* for a fuller biography. 'a man of so many parts, an adventurous traveller, a clever photographer, a capable painter, a competent organist, one who had knowledge of the stars, of the forces of nature, of the elements, and indeed of the classics.' (Egerton, 1933)

the eyes of spectators.[104] In 1897, the same year as filing his patent, he made a tour of the United States and wrote a book-length travel memoir that doubled as a showcase for his stereoscopic photography. While staying in Colorado Springs he wrote,

> At dinner, some printed notices laid by our plates reminded us that the kinematoscope was at work in the town, showing in several separate scenes the fight between Fitz-Simmons and Corbett. Wishing to see how such exhibitions in America compared with those at home, I took a seat, perhaps rather too near the screen, and witnessed the struggle between the two athletes. The flicker was unpleasant throughout, which means that somehow or other more pictures should be thrown on the screen per second; and what is more trying to the eyes is the want of correct "register" in successive views, which causes the whole view on the screen to wobble up and down through a small distance, perhaps two or three inches. This often made it impossible to follow any rapid action, and I should think might be partly due to the nature of the film on which the pictures are taken. On the whole, I do not think this particular show was nearly so good as the "Biograph" entertainment in London. (Porter, 1899, 193-194)

Clearly Porter's impression was that the Veriscope's 'want of correct "register"' was its defining ill and that the issue of flicker was secondary. His diagnosis also points to the instability originating in the negative: 'the nature of the film on which the pictures were taken.' This is an important comment, not only from someone who saw an original print of the film but who also has the ability to dissect the flicker from the wobble in terms that other reviewers could less confidently address. Porter also provides a rare comparative remark on the visual quality achieved by two early cinema technologies. The Biograph system which he mentions was the outstanding moving image technology of its day by virtue of its large image area and high frame

[104] Patent No. GB189712921A. (Porter, 1897). Ray Zone incorrectly states that it describes electromagnetically controlled shutters in the viewer's spectacles (Zone, 2007, 86). Instead, the patent implies a rather cumbersome *dispositif* in which viewers look through large rotating disks.

rate. London audiences recognised its superior quality over other technologies such as the Bioscope, Animatograph or Cinematographe all running on 35mm film at lower frame rates and with less perfect registration. The unwieldy Biograph camera accepted unperforated stock and only punched perforations after exposure. The projectionist was therefore delivered a film with a very stable image and had only to manage the controls of the even more unwieldy projector. Arthur Newman had seen the Biograph show at the Palace Theatre in London and recalled that, 'The registration on the screen depended upon the skill of the operator, and the condition of his nerves at the time. The show, however, was usually a very fine one.' (Newman, 1930, 538)[105] It is therefore not surprising that the hastily assembled Veriscope, despite having a frame area nearly as wide as the Biograph (though not as tall) should fail to live up to this gold standard. Porter's solution for easing the unpleasant flicker – more pictures per second – was precisely met by the Biograph with a frame rate of 30-40 frames per second. However, the Veriscope's professed rate of 24fps was still substantially more than the generally adopted rate of 16fps of most 35mm systems such as the Bioscope and the Cinématographe. Assuming it used a single blade shutter, the 24Hz flicker produced would certainly have been noticeable, all the more so because of his presence close to the screen. Although he doesn't mention the length of the film, perhaps because as reported elsewhere the reel changes gave some modest respite from the visual ordeal, he does say that

[105] Billy Bitzer also describes the nerve-racking ordeal of the Biograph operator. (Spehr, 2008, 453-4) See also Hopwood: 'the perfection of the mechanism demands extreme ability on the part of the operator' (1899, 139)

the flicker was unpleasant throughout. It is therefore worth considering what this 'throughout' actually meant relative to other 19th century cinema experiences which would have required much less stamina on the part of the audience.

While battling the flicker and wobble, Porter was intrigued by the behaviour of a fellow spectator. His account continues,

> One thing interested me a good deal. I noticed that a man sitting next to me viewed the pictures through two small holes, cut out in a sheet of dark-coloured paper. He told me it notably lessened the flicker. I tried the plan, and found it work, as my informant said: but it cut off too much light to my mind, so I did not use it long. Several of the scenes which happened just after the wrestling were shown. A man passing in the foreground looked up for an instant towards the audience with a tragically woe-begone expression, whilst the conductor or expositor, whichever he should be called—simply remarked, "That is Mr. So-and-so; he has just lost 70,000 dollars!" Perhaps that is not the exact sum mentioned; in any case it was large enough to provoke most unfeeling mirth on the part of the spectators. (Porter, 1899, 194)

The observation of his neighbour's ad hoc solution to bothersome flicker may seem rather incidental. It is, however, astonishingly pertinent to researches with which Porter was engaged at this time and for which he is still most famous. The following year he would publish the first of a series of papers that would establish the experimental proof for the relation of flicker frequency to luminance, resulting in what would become known as the Ferry-Porter law. This law describes in more precise values exactly the effect one could expect by looking at a flickering light through two small holes punched in a piece of paper, to wit: a substantial decrease in perceived flicker due to the reduction in luminance. Equally, the other variable of this same law, flicker frequency, also lies behind Porter's more sophisticated solution to the Veriscope's flicker problem, the aforementioned need for a higher frequency of pictures per second. Porter is a figure unknown in studies of early cinema and yet in many ways he was at the very heart of the action, not as a showman or film maker but as a flicker researcher and, like so many others, an unassuming and almost forgotten member of the audience. We shall have cause to return to his work on flicker in chapter 3, which looks in more detail at the relation of flicker perception to luminance.

While my primary interest in this passage is Porter's experience of unpleasant flicker and instability, it is worth quoting in its entirety partly because it has not to my knowledge been published as a source pertinent to film history before. It is also a good example and reminder of how any comment on the technological quality of projection will be embedded within the wider context of picturegoing. From the initial impetus to attend, when he saw a handbill in his lodgings, to the framing of the presentation by the repartee of the 'conductor or expositor – whichever he should be called', Porter sketches in something of the totality of the experience.[106] In fact, the conductor was a significant part of the Veriscope show because, unusually, the film was presented without musical accompaniment. This is not to say that screenings passed off as uneventful lectures. Apparently, any gaps in the oration would be filled by members of the audience all too willing to take the place

[106] It is interesting to note this contemporary evidence for the unstable terminology surrounding the role of film interpreter, a situation which continues to this day.

of the mute ringside crowd of the film (Streible, 2008, 80). The Veriscope audience was effectively solicited to provide its own soundtrack and responded with enthusiasm. Of course, the many performances of *The Corbett–Fitzsimmons Fight* around the world would have varied in detail because of this live component, but through the first-hand accounts of its spectators, a sense emerges of a highly motivated audience staring intently and with fixed attention at the scene of combat, as though through a glass *wobbly*. In the struggle of the pictures to deliver their meaning and the audience to interpret it, the Veriscope screenings seem to be exemplary of the collective work carried out by the machines, showmen and audiences of early cinema. Work that was mechanical, perceptual, cognitive and indeed physical, and which found an apt embodiment in the onscreen 'duel' of Corbett and Fitzsimmons.

2.2 Flicker and mechanical movement

With Porter's comments in mind, we can declare precisely that the Veriscope suffered from both flickering and jumping. In this section, I will work to disambiguate the various categories of technological artefact to be found in early cinema performance, much as Porter did in his reflection on the fight film, so that we may ultimately better understand the direct contribution of flicker to the motion picture experience. This is necessary because in the popular imaginary the term flicker was often applied rather broadly and even seen as a shorthand for all of the technical issues besetting the moving image of the 1890s. It could denote onscreen effects of jittery mechanical movement and inexact registration, even damage and blemishes in individual frames which would flash by momentarily. In short, there is the possibility in early discourse that any instance of 'flicker' may simply be describing something which has made its presence felt unwelcomingly to the visual system of the observer. For example, while complaining that 'The chief defect […] from which projected animated photographs suffer is the 'flicker' of the image on the screen,' the editor of the British Journal Photographic Almanac of 1898 went on to describe what appears to be a startling expansion of the term.

> Numerous are the theories put forward to account for this unmistakeable drawback. The alternation of light and shadow caused by the use of the shutter; the inaccurate perforation of the film and its consequent inability to engage in the sprockets; non-registration of the pictures as they pass the projecting lens and unsteadiness of the apparatus in taking and showing the pictures are among the explanations advanced. (Bedding, 1898, 659)

That the BJP editor, Thomas Bedding, a technically literate, specialist author should conflate flicker from the projector shutter with inaccurate perforation, misalignment of the film frame in projection and mechanical instability in the camera and projector, implies a loose application of the term across a wide public, even if his specialism was photography rather than animated photography.[107] He compared the visual quality of animated photography, unfavourably, with 'all the purity and brilliancy of a first-class lantern transparency' (1898, 659). It seems likely therefore that, predisposed toward static projections, he was objecting to a global impression

[107] C. Francis Jenkins corroborates this view. 'The difference between flickering and shakiness of pictures is not generally understood.'(1908, 84)

of instability, what one might call both temporal and spatial flicker, but which he defined simply as ‘flicker’ in opposition to the stable quality of lantern projection.

However, it is important to acknowledge that not only cinema but language too has changed since 1898. The Oxford English Dictionary, published in 1933, gives two definitions of flicker. 1) an act of flickering, a flickering movement and 2) a wavering unsteady light or flame. While the second definition is now the most commonly used, this was not the case in the period of early cinema when flicker could describe a single or repeated movement as well as a continuing fluctuation in light intensity. It seems likely that the increase in the technological sources of flickering light has colonised the definition more fully so that the earlier usage of flicker as movement (of a bird’s wings, for example) is today hidden from view. If, however, one imagines the flicker of a flame, in a hearth or at the candle’s tip, it is difficult to disassociate the fluctuating light from the movement of the flame: one sees simultaneously a moving light source and the flickering light it gives off reflected from the surfaces around it. The use of the word flicker was therefore evolving at the same time – and because of – the development of cinema.

Bedding’s decidedly broad definition of flicker also has some traction in the sense that each of the defects that he mentions would have caused a regular pulse in the visual stimulus of the onscreen image which, along with the audible mechanical noise from the projector, would have established the multisensory rhythms of early cinema. After all, as delivered by the projection apparatus, instability in the image was a kind of spatial flicker correlated with the temporal flicker of fluctuating light levels.

Sources of instability

The numerous sources of instability in projection are summarised into four main categories by Herbert Maclean, writing in 1900.[108] They will be recognised from the previous discussion of Veriscope performance. Although not fully comprehensive, he says that nearly all 'motions not found in the original scenes portrayed' can be traced to

> 1) Movement of the taking machine, produced by vibration set up by the mechanism, by a shaky stand, or by carelessness of operator in handling the camera; (2) "creeping," or other irregular registration of the positive and negative films during printing; (3) the feed of the projecting machine is faulty, or the film is improperly perforated; (4) the stand on which the projecting machine is supported lacks stability. (Maclean, 1900, 113)

Of course, mechanical vibrations could afflict the projection mechanism as well as the 'taking machine'. In fact, there is irony in the fact that the shutter itself, already prime suspect in producing flicker, could also be a source of mechanical vibration. Even a slightly unbalanced shutter could result in a fuzzy picture or, in Hepworth's colourful phrase, 'a photographic product of a Salonic disciple of astigmatism'. (Hepworth, 1897, 57) Equally, stout construction of the arc lamp was also necessary to avoid 'sympathetic vibration' of the carbon holders causing the light to be

[108] Maclean contributed an extra chapter as an update to Hepworth's original 1897 text in the revised 1900 edition of *Animated Photography: The ABC of the Cinematograph*.

unsteady (Hepworth 1897, 72). It should be noted too that mechanical vibration could be exacerbated not just by inherent flaws in the mechanism but the need to feed human motion into the machine by turning the crank. Although only moderate force was required to turn the projector crank over, it required a stand of surprisingly sturdy construction to prevent any surplus energy from making its presence felt on screen, once subjected to the great magnification of the lens. Maclean actually found the elementary issue of the stand to be the 'principal offender' especially in the case of 'occasional displays by peripatetic operators' who would have been working with more portable equipment of lighter construction. (1900, 114).[109] In fact, sheer substance became a general trend in projector design although it has received little mention, perhaps because it is such a basic issue.

As well as the common vertical 'jumping' arising from poor tolerances in both the projector mechanism and the film strip, Maclean mentions the still irritating but less unpleasant 'creeping', a gradual rising of the image out of frame which would require continual compensation by the projectionist. Yet another type of movement was caused by the need to accommodate a variety of non-standardised film widths. Despite Edison gauge films – that is to say all 4-perforation per frame and nominally 35mm wide – only varying in width by fractions of a millimetre, projector makers needed to ensure that the widest varieties would run through the gate, where film needed to be held as tightly as possible during the dwell period to ensure good

[109] Hopwood, too, emphasises the need for 'absolute rigidity of the apparatus.' (1899, 207)

focus and registration. This meant that less wide film stocks would develop a slight weave, or a lateral movement of the film known as 'rock'.[110] Moy and Bastie's patent of 1911 was granted for providing a simple solution to this problem of a guide roller with tapered flange, positioned just before the gate, the taper holding fast a range of different widths. Gradual improvements such as this and developing standards slowly removed the sources of instability from the projection apparatus, eventually to a point where it was no longer noticeable. Much like flicker, however, a miniscule residue of instability has remained in analogue film projection and has only been thoroughly removed from cinema experience by the introduction of digital projection technology. In analogue projection, a slight blurring from the mechanical movement of the film softens and reduces the resolution of the screen image in the perception of the viewer. The potential information available in the print is therefore not wholly delivered to the viewer. However, being barely perceptible it does not read as soft, at least not until directly compared to the hard stability of digital.[111]

A further source of instability is worthy of note: Common or garden mechanical wear which would cause a gradual denigration in the ability of the mechanism to operate to its design's best potential. Although easily overlooked in a theoretical

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[110] (Moy & Bastie, 1911) The taper on the roller is so slight that it is almost imperceptible when seen in situ on the device. The term, 'weave' is more usually applied today.

[111] Interestingly, in the last ten years of the commercial availability of analogue projection an electro-mechanical means of removing jitter and weave was proposed as an add on technology to existing projectors. Maxivision projection technology was extensively developed but never fully rolled out. It facilitated the display of a more stable, therefore higher resolution, image by individually registering each frame of projected film. By compensating for miniscule errors of registration it even smoothed out instability in the printing process as well as projection. See Ebert, (1999) and (Goodhill et al., 2002)

engagement with the mechanical problems involved in projector design, it would have become apparent during the sustained practice of the showman. It is also likely to affect many of the devices which have survived to this day, although so few are in an operational state of any kind that it is an almost hypothetical problem. The mechanisms of early projection devices were usually made out of brass, a relatively soft alloy available in different compositions for different specifications. For small scale engineers and toolmakers running modest workshops it was relatively easy to work with but its workability also meant that it would wear faster. Towards the end of the early cinema period manufacturers began to replace the use of brass with steel, a situation alluded to in the 1910s sales literature for the Zar 'made of steel' projector which warned buyers to ask 'How long will the Machine last, and How long will it give a Steady Picture?'

> […] machines are usually made of brass or other soft metals, which wear out in a few months, and are the cause of continuous troubles. This class of machine, although often showing a very fair picture on the screen at first, commences to show an unsteady picture within a few weeks, and at the end of about nine months finds its way to the scrap heap. (*The Zar, Is an Abbreviation for 'Czar': The King of Projectors*, n.d.)

2.3 Flickering and flashing in film material and content

Whether considering the narrower and now commonly understood definition of flicker, as also used by Porter, or its wider definition as used by Bedding, its fundamental origin in the shutter or projector mechanism was indisputable.

There were however, other sources of flicker in cinema experience which should be at least briefly acknowledged. Most of these can be traced to phenomena within the image itself and the material condition of the film strip, its cellulose nitrate support. One exception of note is the potential for power flicker to cause disruption to the light source. Different types of light source were used by early showmen but practically speaking only limelight and carbon arc lighting were powerful enough to enlarge the tiny image source sufficiently for exhibition in halls and theatres. Where electricity was supplied, carbon arc was preferred over the gas-powered limelight. Both required careful control and the arc lighting in particular would flicker if the carbons were adjusted badly, that is if placed too far apart, or if it was used with the less suitable alternating current supply where the light could, 'vary from minute to minute in point of brilliancy.' (Hepworth 1897 69)

When viewing the surviving Veriscope footage, even as a video file on the internet, we can see a host of common image artifacts resulting from damage and blemishes in the emulsion and base layers of the film. Although it is difficult to distinguish between the sources of such damage without viewing the original film element, at least some of them will have been present in the film since its first public showings because printed in dust and damage were virtually inevitable consequences of the production process. If managed diligently, such features could be minimised but never eliminated. Their visibility to the audience would depend on the type of artefact, whether it covered multiple frames, and its position within the frame. Issues with significant lengths of film – such as poor processing or, occurring later in a film's life, emulsion loss from water damage – could, depending on the position of the damage in the spooled film, produce long duration effects with their own low frequency flicker.[112] On the other hand, artifacts which were discretely present within one frame would flash on and off within the split second of projection and would only be visible if they were a white spot on black or vice versa.

Uneven development could produce semi-random low frequency variations in the tone of negatives of prints that would appear in projection more as shifting veils than flicker. The problem attracted Cecil Hepworth's attention and during his short-lived collaboration with Charles Urban, he solved it by improving the process, acquiring a patent for his suggested apparatus in 1899.[113]

The sensitivity of film stock in the early cinema period worked to increase flicker in the projected image. Orthochromatic stock, in use until the mid 1920s lacked the tonal range of Panchromatic stock and accounts for the high contrast look of early cinema prints. The consequent tendency for highlights in the image to be washed out, thereby exposing larger areas of clear film to projection, would have increased the perceptible flicker. This effect could be further exaggerated by poor technique in printing or, as was common, pirated duplicate prints made from another print

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[112] Classical nitrate decay can also produce this effect which found footage filmmakers such as Peter Delpeut and Bill Morrison have used to good effect. Even with gross damage of this extent the content of the film can still be surprisingly intelligible.

[113] Patent No. GB189813315 (A)). 'Hitherto there has been a lack of uniformity in the development of the different pictures of a series on a film, so that the moving picture produced by such a series changes its tone when being exhibited, in a manner which is unpleasing.' (Hepworth & Urban, 1899)

rather than a negative. Franck Maguire, whose business was directly affected by such copies described their aesthetic effect thus.

> A duplicate film is worthless. The outlines of the picture which are clear cut in the original become ragged and imperfect when duplicated. The difference shows perceptibly even in the small kinetoscope where the film is magnified but slightly, but when the picture is thrown up on the screen and magnified 600 or 800 times, the imperfections make a duplicate film absolutely worthless. ('London Office of Maguire and Baucus', 1898)

Loss of resolution and detail would, to some extent, be compensated by the increase in contrast, but the loss of delicate greys would also have made flicker more keenly felt.

Theoretically, the most elementary source of flicker in cinema occurs long before any applied by the projector shutter or even present in the film material, when objects photographed in the profilmic reality exhibit a flickering appearance. This can be an issue for cinematographers when shooting in artificial light or when composing shots in which television screens – especially those of the cathode ray variety – are seen. However, practically speaking, in early cinema there were no such sources of flicker to contend with in the typical subject matter. Nevertheless, there were plenty of scenes which were subject to fluctuating cycles within space and time and apparently these were some of the most popular spectacles with the very earliest audiences of cinema. For example, reports of the first show in the US at Koster and Bial's music hall implied that those films which were simple records of vaudeville acts were upstaged by the imported natural delights of *Rough Sea at Dover* (1895). An early Edison catalogue advises on the placing of film entertainment within a vaudeville show, describing the drop curtain falling for the intermission, the sudden darkening of the house lights, and then, 'before the eyes of the audience a huge window appears to open.' It goes on to describe a bucolic scene with subtle photographic effects of natural movement, before the story descends into slapstick

> A light breeze is evidently stirring, for the boughs of the trees overhanging the pool are swaying to and fro and the surface of the water is covered with little ripples. A fisherman appears. […] He is smoking. The blue wreaths are seen to curl upwards from his pipe. (*Edison Projectoscope or Projecting Kinetoscope*, 1897)

Here the profilmic reality, the swaying boughs, rippling water, and curls of smoke, while too low frequency to be literally flickering, is certainly engaged in rhythmic activity over time. This content-based feature of early cinema should be borne in mind while examining the spatial and temporal instability inherent in its mechanical devices. Was there, for example, an interaction between the semi-regular action of the crash of waves and mechanical flicker and instability?

Flicker could also arise in the camera negative due to irregular exposures given by poor crank technique and/or unbalanced mechanism.[114] These slight irregularities would be increased in terms of contrast when the negative was printed, potentially becoming visible in projection. In practice, other flicker sources were more severe and this type of what one might call the most original flicker would only have been

[114] 'Most individuals in the course of every revolution, arrive at a kind of dead point, usually when the handle is at the lowest part of its circuit.' (MacLean, 1900, 120)

sensed in the already flickering context of early cinema in extreme cases. Usually it only becomes apparent when transferred to the stable environment of the digital workspace where, along with image stability which can also be affected by the shrinkage of the film over time, it is adjustable within the parameters of digital restoration software. In applying the powerful techniques made possible by the film's reconstitution in digital space, the restorer will generally try to avoid the complete removal of these artifacts and make an estimate of likely amounts of original shake, flicker and dust that should remain.[115]

Further flicker effects could be introduced by early processes of adding colour to film that followed on directly from the tradition of adding colour dyes to lantern slides. Introducing hand-applied colour to the black and white emulsions of tiny 35mm frames inevitably caused frame to frame differences which would be magnified in projection. Whether strictly hand-applied or using the later semi-automatic stencil process adopted by Gaumont and most famously, Pathé, the techniques aimed for uniformity but could not prevent small dimensional variations at colour boundaries or slightly different densities of application of the coloured dyes. When the individual frames were animated by the projection mechanism, the inexact registration would produce extra local jitter and weave within the picture

[115] Giovanna Fossati discusses the use of these digital tools and their moderation by the film restorer. 'As in the case of stabilization, de-flicker sets an average value, which is not necessarily what it was originally. On the other hand, the amount of original flicker is impossible to establish unless an original element is available where no additional flicker has been introduced by duplication.' (Fossati, 2009, 89)

and the varying densities add marginally to the existing fluctuating light intensity. Furthermore, a practice whereby certain large sections of image were only removed from every other frame would have set up a colour flicker at a frequency half the projection rate.[116] The effect of these flickering colours on screen could potentially be rather lively as indicated by the Russian author Kornei Chukovsky, writing in 1908 about his impressions of a Pathécolor Féerie film

> The pianist starts the matschisch, and in a flash all the shells open, with a rose emerging from each one. The roses turn instantly into girls of different colours – orange, lilac, crimson, brown – and they flicker so much that it hurts your eyes. (Tsivian, 1998, 174)

It is worth noting the dual assault on Chukovsky's attention, the uneven flicker of the colour making its unwelcome appeal to his senses along with occasional flashes of action, courtesy of the substitutions made during the stop-motion filming. Of course, both flicker and flashes were highly artificial effects, rupturing the continuity of existence and the seamlessness of natural motion – not that the Feérie genre was particularly concerned with realism.

Applied colour is an interesting example of flicker tolerance. It seems plausible that an increase in flicker artifacts were accepted in exchange for relief from the grey world which so oppressed Maxim Gorky in his famous 1896 review of a Lumière show or which Blood expressed elsewhere in her review as presenting, along with the extinction of sound, a 'bowdlerised' (Blood, 1897) reality. Elsewhere, colour is

[116] This procedure ensured the structural integrity of the stencil. An example can be seen in a 1912 Pathécolor film illustrated in Fossati, Gunning, Rosen, & Yumibe, (2015, 33)

seen even more directly as a salve for the high contrast black and white assault on the visual system. Kinemacolor, the first widely exhibited natural colour system was presented in theatres towards the end of the early cinema period.[117] It was sold partly on its provision of a moving image experience in the restful qualities of natural colour.

> It has been found that the eye, accustomed to the glare and flicker of black and white subjects, experiences a sense of relief whenever Kinemacolor pictures are interspersed. This result would naturally arise, first, from the fact that the Kinemacolor film is running at twice the ordinary speed (which reduces "flicker", as every operator knows), and, secondly, because the introduction of natural color is in itself restful to the eye. (*Handbook / The Natural Color Kinematograph Co.*, 1910)

Kinemacolor is notable for the fact that, unlike stencil colour or modern chromogenic colour stocks, its effect was achieved through psychological illusion and 'brought into visibility at the moment of exhibition,' not so much on the screen as in the mind. In fact, just as movement and a sense of continuity are conjured from discrete static images by the action of the projector, the Kinemacolor process reconstitutes colour from where there is none. Despite the confident assertions of its sales literature, however, it is debatable how soothing the experience would have been.[118] Although shot and projected at 32 frames per second, alternating frames were tinted red and green by a rotating colour wheel, so the projected image was far from stable. Additionally, fast moving subjects would exhibit a colour fringing artifact. In fact, judging from recent reconstructions, the introduction of

[117] There were earlier attempts but they were more experimental and not widely exhibited. For example, see Lee and Turner's earlier additive colour system of 1899. (Enticknap, 2005, 80)
[118] 'Seeing this stuttering colour one hundred years later is a true experience', writes Gian Luca Farinelli, (Lewinsky & McKernan, 2017, 27)

Kinemacolor in the teens, though a high technology achievement of late early cinema, may have represented a step backwards for the visual stability of the moving image.

Conclusion

The brief review in the previous two sections makes clear that projected film was an amalgam of multiple flickers, in which different layers of spatial and temporal flux would compete for an observer's attention. This was, in fact, the opposite of the necessarily pure stimuli created and investigated by flicker researchers, such as T. C. Porter.

An entire ecosystem of flickering, flashing and wobbling elements appealed for the attention of the spectator of early cinema. In most cases, flicker from the projector shutter was the most dominant of these, although as we have seen with *The Corbett–Fitzsimmons Fight*, mechanical instability was not only a competitor but could be closely related. Especially in the discourse of the late nineteenth century, the problem of flicker in film is to some extent unified with other artefacts of film technology. These artifacts competed to add noise to the theoretically pure stimulus of projected light. Naturally, even the film image itself was a part of this noise component.

At one level the history of film technology is the removal of artefact after artefact. At a certain point, it may be that a modest level of artefact becomes more desirable than none at all. This is a principle known especially to digital film restorers but also familiar to the restoration of other classes of object. With the many repeated viewings of a film necessary during its restoration, the removal of one layer of artefact will often 'reveal' a set of other ones which had previously been hiding in plain sight. As the inverse of this principle, where the removal of one artefact only causes attention to be focussed on the remaining ones, in the artefact-rich early cinema environment, it is possible that flicker may have acted as a decoy in order to distract from all the other issues with the image. In other words, shutter flicker may have had a unifying effect on all these diverse artifacts, adding a purer noise into the system to mitigate the effects of more ephemeral or momentary tremors, reducing their visibility and power to startle.

Apart from this material operation, as the purest form of cinema's many vibrations, flicker's conceptual function is also of interest. Flicker is the point at which cinema seems to hinge, to pivot about itself, it is both visible and invisible, real and illusory. It is the key to unlocking the trick which cinema plays on our perceptual mechanism of conjuring movement out of stillness. In short, it seems to be one of the most fundamental principles of one of the most ubiquitous cultural experiences of the last century and yet, within film studies, it has only been intermittently noticed as an object of study. There has been a prevailing but careless assumption that it was an *invariable* component of the means of delivery of an experience which immediately presented so many further challenges for theoretical investigation. By looking again at the numerous contemporary reports of flickering, jumping images and reminding ourselves of the very extensive and diverse mechanical solutions to the presentation of moving images in the early cinema period, we can see that any assumption for flicker seen across the world's cinema screens circa 1900 should rather be for *variability*.

3. Co-ordinates of the Flickerscape

But suddenly a strange flicker passes through the screen and the picture stirs to life.

Maxim Gorky, Last night I was in the Kingdom of Shadows. *Nizhegorodski listok*. 4 July 1896.[119]

Introduction

The experience of flicker in the numerous worldwide sites and varied conditions of early cinema was far from being the uniform phenomenon common to later more rigidly regulated exhibition practice. The neologism 'flickerscape', introduced in this chapter, is intended to convey this inherent variety – of mechanical design and manufacture, of performance style and of location – while also suggesting that flicker in early cinema should be seen within the wider landscape of industrialisation and mechanisation visible in society as a whole.[120] Even within the discrete experience of a trip to an early film show, patrons would have encountered extra-cinematic flicker in street lighting and public transport and, potentially, spectacular artificial lighting in the electric dreamlands of entertainment districts, the amusement parks and travelling fairs in which moving images found an early foothold.[121] To these multiplied sources of flicker in late nineteenth and early twentieth century society, cinema added all manner of variously modulated forms of

[119] Translated in Leyda, (1983, 407-409)

[120] See Charney & Schwartz, (1995) and Pomerance, (2006) for contextualisations of cinema in the experience of modernity.

[121] For example, see the memoir of George Cushing on the spectacular impression made by the electric lighting at the fair in rural Norfolk. (Cushing & Starsmore, 1982, 35-36)

scintillation. In this newly forming institution, society held a flickering mirror up to itself in a process which was both symptomatic of and influential upon what has been termed 'vibratory modernism'.[122]

The combination of a source which made a direct and attenuated appeal to the senses with a visual phenomenon that repelled them arguably made cinema the first situation encountered by human beings in which flicker was a problem.[123] The screen of cinema demanded attention but flicker, image instability and other artifacts could make it an uncomfortable compulsion. Unlike naturally occurring flicker, looking away was not really an option and certainly not the point.

This chapter looks in detail at the parameters and variables of flicker phenomena in early cinema. Although it can be easily measured, to the human observer flicker is relative and subjective. It describes a percept of a phenomenon not a phenomenon. Although we might say, 'the light is flickering', we only know this because our visual system allows us to make this judgement. Under some conditions the rate of flicker might be high enough to elude detection by our senses, and yet it could still appear as flickering to a non-human animal or photoelectric cell. It is as well to hold this fact

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[122] The term was introduced by art historian and critic Linda Dalrymple Henderson in her discussion of cultural trends in scientific and artistic theory surrounding the concept of ether in the late nineteenth and early twentieth century. (Henderson, 2002) The easy mix of occult and scientific theories commonplace at this time, promulgated a so-called 'ether physics' which was eventually challenged by Einstein's theory of relativity. This is one possible cultural context for Hopwood's digression into 'vibrating existence' and 'the tremblings of the boundless ether.' (Hopwood, 1899)

[123] Earlier candidates include the potter's wheel, cited since classical times as a source of flicker. The brain researcher W. Grey Walter, put forward a theory that the evolutionary shift from tree top to forest floor habitation of human ancestors was caused by the apes, with their 'slowly swelling brains', wishing to avoid the flicker experienced in forested environments. (Walter, 1953, 63)

in mind because otherwise what is a subjective impression can appear to be an objective fact. Flicker is a pattern in time that does not exist without an observer and naturally the physiological and psychological make-up of the observer plays a role in the experience of that percept. Because its existence as a subjective phenomenon is a matter of perception, flicker was only a problem in the practical environment of cinema when it was perceptible, even when objectively it continued to exist. This boundary is therefore crucial to the discussion although it transpires that it is the opposite of a line in the sand. It is highly contingent upon many different variables both internal and external to the perceiving subject and is based upon the arbitrary point at which the human visual system ceases to distinguish between the pulses of an intermittently luminous object and accepts it as continuous. In scientific parlance, this is called the point of critical flicker fusion (CFF).[124]

The single term 'flicker' describes only the sensation of intermittence, not the rate of intermittency or its intensity. Its use in a particular context needs to be qualified because it encompasses a wide range of frequencies and amplitudes that can have very different effects on the sensory and perceptual system of the observer. At different frequencies, the experience of flicker is subjectively pleasant, unpleasant,

[124] CFF is used in scientific discourse although the precise constitution of the acronym is variable: 'It generally means critical flicker frequency, but sometimes it means critical fusion frequency or critical flicker fusion threshold.' (Piéron, 1965, note 180). See also Landis, (1954, note 259): 'Critical is used in the physical sense of a transition point of change from one state to another; for example, the physicist speaks of the critical temperature where ice becomes water. Some recent investigators […] have recommended the designation flicker-fusion-frequency (FFF). I prefer CFF since it emphasizes the fact of a critical threshold.'

tolerable and, finally, consciously unreportable. It has an on-off moment but it also has perceivable degrees existing across a range. At the low end of the range flicker can be felt as pleasant and a natural focus of attention. At the high end, distinction needs to be made between visible, and the consciously and unconsciously perceivable given that there is evidence for a physiological response to unreportable flicker.[125]

The first section of this chapter begins with a brief summary of the cultural coordinates of flicker experience in the period before cinema. In freely exchanging modes of industrial activity, scientific research and drawing-room play, mechanical devices were both the incidental, and inspirational, source of flicker and, following on in short order, the specifically designed showcases of flickering visual illusions. This playful, empirical tradition of flicker research translated easily into the mass worldwide 'laboratory' of early cinema, rather more so, in fact, than later laboratory research which utilised highly simplified purely binary flicker stimuli.

Subsequent sections examine in detail the part played by flicker in early cinema exhibition through a flicker-related reading of Maxim Gorky's famous review of a screening of Lumière films in July 1896. A screening which was typical of the first demonstrations of moving image technology and one in which flicker was not just

[125] See Herrmann, (2001) for evidence of electrical activity in the cortex corresponding to high frequency flicker stimulus above the perceivable limit of the CFF.

present as sensed experience but also connoted meaning, working even as a metaphor for the revelation of vibrating existence. Gorky's reporting stands not only for the metaphorical importance of flicker but also provides quite literal evidence of the typical physical conditions of an early film screening. I therefore continue the mapping of the flickerscape by mining his report for the kind of data with which we can re-assemble a sense of the likely impact of flicker in a given situation, in tandem with an informed knowledge of factors affecting flicker perception. The 1896 screening in Nizhny Novgorod is exemplary therefore of one plot on the globe of early cinema, of which the screenings in Colorado or the London Aquarium, mentioned in chapter 3, can be seen as other geographical and temporal data points. While the incompleteness of such data is obvious, I suggest that by continuing the process, a preliminary sketch of the flickerscape can be produced, certainly sufficient with which to better contextualize modern day screenings of early cinema, which usually take place without any such historical referent. One result of this approach is to underline the need to study many more aspects of the *dispositif* than are currently taken into account. For example, although in this thesis the emphasis is placed on select features of projection technology, above all the shutter, the space in which the projection takes place can be seen to be just as significant in creating conditions for flicker experience.

Finally, in the last section, the importance of assessing the quality of flicker is grounded in the direct effect which it can have on the operation of human brainwaves. The impact of flickering light on the electrical activity of the brain is not consciously felt by the perceiving subject but is nevertheless a component of the vibratory *dispositif* of early cinema in which variously visible and invisible vibrations in the world, the machine and in the perception and cognition of the spectator conjoin. Furthermore, the range of frequencies at which this effect is observed is seen to correspond especially to the typical operation of early film technology around 16Hz, in contrast to the later standardised flicker frequencies of 48 or 72Hz employed in sound cinema.

3.1 Spinning discs: flicker phenomena as research and recreation

The eminent 18th Century Newtonian scientist, Pieter van Musschenbroek, was amongst the first in the modern era to use spinning discs to investigate visual phenomena. He arranged differently coloured sectored discs horizontally on spinning tops to investigate phenomena of colour mixture.[126] Later experimenters raised the discs through ninety degrees to better accommodate our vertical posture. Larger versions of this apparatus were created in the form of optical cabinets, a few of which have survived from the eighteenth century which hold larger discs in a decorative housing and would seem designed for drawing room entertainment. Also called Chinese fireworks or *feux pyriques* they would have

[126] See Kuehni, (2010) for a historical review of disc colour mixture including earlier observations by Ptolemy and Ibn al Haythoun made in Hellenic and Fatimid antiquity, respectively. Pieter van Musschenbroek's brother Jan was an instrument maker and lanternist. As Michael Punt has shown in the case of Robert Paul, instrument makers could be key players in the connection of scientific research to popular entertainment. (2000, 72)

produced a pleasant scintillation and gentle flicker effect via means of the interchangeable vertically-held discs and backgrounds. The revolving semi-transparent image-patterns were back-lit by candles which would have themselves been emitting a flickering light. An example in the Eye collection which is regularly demonstrated is thought to have been used in public although it is likely that it was first made for and used in a private setting, effectively a kind of domestic flicker machine.[127] Construction of the discs alone was also suggested as a reasonably edifying pastime for curious youths.[128] A similar effect was created in projection using chromotropic slides made with contra-rotating discs in magic lanterns. By the mid nineteenth century, therefore, people in laboratories, school rooms and drawing rooms were looking intently, curiously and playfully at spinning discs.[129]

However, for much of the newly urban population, labouring in factories, a significant new source of flicker experience would have been involuntary. Mechanical flicker would have replaced the natural flicker of wind-blown foliage, reflections in sunlit streams, or the beating of butterfly wings, a fact which makes the absorption of such subjects into the grey repertoire of the cinematograph all the more poignant. 'Glory be to God for dappled things', wrote Gerard Manley Hopkins in his poem *Pied Beauty* but such naturally occurring spatial flicker had increasingly

[127] Eye catalogue number: APP1593. The illuminant has been modified and is now an incandescent electric lamp.

[128] See for example the chapter on Artificial Fireworks in William Clarke's Boy's Own Book of 1829 where they are collected in the section of the book devoted to conjuring rather than scientific recreations and promoted as a safe alternative to 'real fireworks and Lilliputian artillery'. (Clarke, 1829, 408)

[129] A detailed overview of such philosophical toys can be found in Wade, (2004)

been superseded in public experience by more rigidly metrical temporal flicker of the mechanical technologies invading all walks of life.[130]

With the increasing mechanisation of life, incidental observations such as the spinning cart wheel seen against the picket fence, and described by Roget in 1824 as the palisades illusion, increasingly became a part of everyday existence as industry and transportation harnessed the power of steam to drive its steel wheels and satanic mills.[131] Similar practical experience inspired Michael Faraday's researches into visual illusions and the first report of what became known as the wagon wheel illusion after a visit to Maltby's Lead Mills in Lancashire.[132]

> Being at the magnificent lead mills of Messrs. Maltby, two cog wheels were shewn me moving with such velocity, that if the eye were retained immovable, no distinct appearance of the cogs in either could be observed; but, upon standing in such a position that one wheel appeared behind the other, there was immediately the distinct, though shadowy resemblance of cogs moving slowly in one direction. (Faraday, 1831, 205)

In both Roget and Faraday's observations of revolving wheels an extra element is present which acts as a shutter – the uprights of the fence and the teeth of the cog wheel. Although they resulted in different illusions of bent spokes and stilled or reverse motion respectively they pointed to how the mechanism of human vision could begin to be unpicked by presenting a curious human subject, usually the

[130] The poem was written in 1877 although not published until 1918. Of course, the patterning and camouflaging displayed on the bodies of animals becomes temporal flicker when the animal moves. If the movement is rapid enough it can even result in a 'flicker fusion effect' in which, in the perception of the observer, the pattern can disappear. It is thought that such patterns may have evolved to help prey evade predators. See for example Umeton, Read, & Rowe, (2017)
[131] (Roget, 1825)
[132] Mentioned by Crary, (1988, 20) and Robinson, (2001). Robinson also mentions Faraday's debt to Charles Wheatstone.

scientist themselves, with a rapidly moving stimulus. Both Roget and Faraday constructed models to replicate the illusory phenomena which they had observed (Chanan, 1996, 59). Faraday's apparatus could vary the speed and direction of rotation of different shaped discs in order to correspond to different empirical situations. The Belgian researcher Joseph Plateau, working also in the 1820s had independently made similar observations.[133] The device he created, the anorthoscope, exploited both the palisades and the wagon wheel illusion but went further, reverse engineering the observed illusions by beginning with a distorted image that became readable and apparently motionless once the image and shutter discs were set into motion.

These researches inspired the more popular and still familiar phenakistiscope of Plateau and *disques stroboscopiques* of Simon Stampfer. These philosophical toys, commercially available from 1833, were single slotted discs which incorporated sequential imagery between the slots. Once activated by the hands of the observers they completed the reverse engineering of visual experience by turning still images into moving ones. The shutter like teeth of the cog wheel which had stilled or reversed movement in Faraday's initial observation were now employed to animate stillness. These playful researches are what Hopwood called 'the subject of wheel phenomena' (1899, 229) when discussing the almost simultaneous emergence of the phenakistiscope from the minds of Plateau and Stampfer and were clearly seen

[133] See Robinson (2001) for a thorough account of the joint works of Plateau and Faraday.

as a part of the heritage of living pictures. Indeed, for Laurent Mannoni this heritage of the shutter recurs as the hidden centrepiece secreted within nearly all film projectors and cameras.[134] The phorolyt, Jan Purkinje's adaptation of the phenakistiscope of Plateau and Stampfer, separated out the slits from the picture discs and in so doing created a rotary shutter which more closely resembled those that would appear in the cinematographic technology to come.[135]

To use a thaumatrope or phenakistiscope or phorolyt was to conduct an experiment with oneself as both subject and observer. Purkinje and Plateau were empirical scientists fascinated by documenting subjective phenomena and were famous, or even infamous, for their enthusiastic self-experimentation despite its sometimes-disabling consequences. (Posner, 1969, 108) The happily benign spinning wheels that they popularised and sent out into the world were not only delightful and educational, they posited a new relationship with technology, one in which a device propelled by the subject created an illusion of motion in that same subject. They were portable self-administered moving image experiences with a significant flicker component. It is hardly surprising therefore that some traditionally chronological histories of cinema and moving image technology decide to begin in the early

[134] 'Le disque obturateur mis au point par Faraday, Plateau et Stampfer se retrouvera plus tard, comme une pièce maîtresse, à l'intérieur de tous le projecteurs et caméras cinématographiques.' (Mannoni, 2016, 24)

[135] Anděl & Szczepanik, (2008, 22) claim this separate shutter as a first for their countryman Purkinje, but it could also be a reintroduction of the paired slotted discs already seen in Faraday's wheel and Plateau's anorthoscope.

nineteenth century, such as that of Georges Sadoul with the 1832 of Plateau's phenakistiscope.[136] And as D. B. Thomas, curator of the Science Museum observed,

> it is likely that many of the pioneers obtained information on the design of shutters and the rate of taking and projection of pictures from examining the action of optical toys. (Thomas, 1964, 8)

The spinning discs were also combined with the contemporary projection technology, the magic lantern, with specially made devices designed to be inserted into the slide carriages of the lanterns. Ross's wheel of life, also called projecting phenakistiscope, and Beales' choreutoscope both fall into this category and would have offered a collective experience of apparent movement and flicker for large audiences up to 25 years before the debut of the Cinématographe. They both had shutters operated by hand cranks and the choreutoscope also boasted a Maltese cross-type intermittent movement. Its hand painted images, typically a skeleton on a black background, would have moved jerkily, falling short of life-like movement while the impression of flicker would not have been strong because of the opaque background. By contrast, flicker from the Ross's wheel of life slides with phenakistiscope-type animations painted onto a mica slide would have been much more noticeable because of the transparent background.[137] Eadward Muybridge devised a similar system, the zoopraxiscope, to animate his chronophotographic images and used it in his demonstrations for 15 years from 1880 to 1895. The

[136] Given the rich, phenakistoscopic, tradition of spinning discs in parsing the illusion of motion, it is not surprising that even after the success of 35mm film as image carrier, some inventors' minds – for example, those of Leo Kamm, Theodore Brown, Charles Urban and Henry Joy – were still occupied with the idea of the disc as actual image bearing surface. (Huhtamo, 2013)

[137] See https://www.stephenherbert.co.uk/wheelPROJECTINGpart1.htm for further details and a demonstration video.

machine used large phenakistiscope discs paired with an equally large shutter bearing 8 slits to correspond to the 8 images. Muybridge used the machine in combination with chronophotographic lantern slides and, as Stephen Herbert relates, the slides would have provided an experience of pictorial detail while the zoopraxiscope discs would have contributed the illusion of movement (Herbert, 2018). Even in projection the effect produced by these devices was still far from the immersive potential of the cinema screen. The on-screen image could not be mistaken for reality. As with the hand-held devices, multiple images were presented to the spectator's field of view at one time, although the variable masking incorporated into the zoopraxiscope may have been an attempt to contain the spread, an action which could even have been part of Muybridge's performance. The action not just framing the image but also framing the technique and its illusory potential.

As well as looking at and growing up with optical toys, it is also possible that film pioneers were aware of a device used by nineteenth century physiologists for creating very precise and proportionately variable quantities of light. Called an episcotister, which means something like 'throwing darkness', it was little more than a finely made spinning disc with an adjustable open sector, mounted on a stand.[138]

[138] This particular form of spinning disc apparatus was devised by the physiologist Hermann Aubert for his work on dark adaptation in human vision, published in 1865. See Jülich, (2000, 52) Hermann von Helmholtz mentions that Talbot had used a similar device in 1835 and describes Aubert's version thus: 'The episcotister is composed of two black discs made of brass, which are mounted together, one in front of the other, and in each of which four 45° sectors are cut out. The discs can be adjusted relatively to each other so as to leave four slits open whose angular widths may be anywhere between 0° and 45°. By rotating them rapidly the same appearance and effect can be produced as is

Useful in investigations of scotopic or low light vision, the device was also found in the laboratories of experimental psychologists such as Wundt and Münsterberg. Erwin Ferry used just such a device in his 1892 studies of visual persistence which led to his discovery that '[t]he duration of retinal impression is inversely proportional to the logarithm of the luminosity'[139] (Galifret, 2006, 374). When combined with T C Porter's similar experiments, the findings could be expressed in terms of flicker frequency and became known as the Ferry-Porter law which states that critical flicker fusion is directly proportional to the logarithm of the light intensity.

The projector shutter and the episcotister continued the tradition of isomorphism which has been noted by Jonathan Crary in relation to the phenakistiscope and Faraday's wheels (1988, 20). Sharing more than a physical resemblance, however, these experimental devices contributed to the project of deciphering the workings of human perception, a tool in mankind's study of man. This role was continued by the projector shutters used in the mass experiments carried out by film pioneers and early cinema audiences. Both methods of investigation carried the implication that discoveries could be reverse engineered and adapted to control and create new perceptions and this may be one reason for continued experimentation with shutter systems within the sphere of early cinema past the point that a satisfactory

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obtained by using a piece of grey glass, and the amount by which the light is reduced can be computed easily and exactly.' (von Helmholtz, vol3, 522). My thanks to William Simpson for introducing me to this term.

[139] See Ferry, (1892) for his original text. See also Augustin Charpentier's similar experiments with an episcotister in 1887 as detailed in Galifret.

solution to perceptible flicker was discovered. The projector shutter's roots in this rich experimental history indicate the scope for more creative operations than its role as a 'necessary evil' and simple mask for the pull-down of the projector would suggest. The shutter designs of early cinema carried forward inherent traditions of playful engagement with flickering movement and delicate, even sensual control of light.

3.2. The quickening agent

Like the episcotister, the projector shutter mixes dark and light, black and white. Or rather it cuts them up *fast enough* so that the visual system has no choice but to mix them and fuse them together. Perhaps it is appropriate therefore that the chief impression one receives from the vocabulary of Maxim Gorky's review of the Lumière screening that he witnessed in the summer of 1896 is not of relentless flicker but of overwhelming greyness. In the close to 1000 words of his text, there are no instances of the words 'black' or 'white' or 'black and white'. There are however seventeen occurrences of the word 'grey'.[140] The shutter, probably assisted by a lacklustre lighting source, has shaken up the highlights and shadows of the films, added the darkness of the shutter blade, and cast a grey pall over the representation of the Lumières' *haute bourgeois* existence.

[140] The word 'flicker' is used only once, in contrast to the seventeen instances of 'grey'. There are also seven uses of the word 'shadow' and three expressions of regret at the lack of colour. Gorky also finds the absence of the sounds of life deeply alienating: 'It is not life but its shadow. It is not motion but its soundless spectre.' (Leyda, 1983)

Gorky's text is one of the most familiar in the literary sources of early cinema and certainly has a claim to being 'perhaps the most lyrical and prophetic' of the early reviews (Harding & Popple, 1996, 3). One might also claim that it is the most phenomenological, with the young Gorky trying to work through the mix of feelings aroused by this new experience. In a second, less well-known, review that he wrote in the same period about the same screening, he expresses himself in a similar vein but also emphasises the effect of the experience in terms of 'nervous strain.'[141]

Although Gorky consciously notes only one moment of flicker, I have selected it for this chapter's epigraph because it is, in its own way, momentous. It refers not so much to the flicker of 'the flicks', which would be a part of the cinema experience for the next century and more, but a more rarefied phenomenon generally only available to the audiences of the early cinema period. It is an instance of that section in the repertoire of a showman-projectionist where the demonstration of the new invention begins with the projection of a static frame. Then slowly – over a couple of seconds – the speed is increased to that required for the human visual system to no longer register the consecutively arranged, discrete, frames of the film strip and for the illusion of constancy to occur, more or less at the same moment for each individual audience member.[142] The effect is achieved by virtue of the fact that

[141] This 'thoughtful speculation on the future and real meaning of this novelty' (Leyda, 1983, 20) is published as 'Gorky on the Films, 1896'. (Kline, 1985)

[142] In general, there is relatively little individual difference across human beings as to when this illusion takes flight but certain factors and pathologies can increase sensitivity to flicker and therefore decrease the CFF. Age is probably the most significant variable in the general population. See for example Misiak, (1951)

in most cases the projectionist of early cinema would propel the film through the projector via a hand crank and was therefore in control of the rate of advance of the film. Although the operator could vary the film speed at will, for the most part the aim was to reconstitute lifelike motion, delivering the appearance of a surrogate reality generated by the consensus of audience and operator. By the 1910s accessory electric motors had been attached to many projectors, thereby relieving the operator of much tedious labour but also restricting a key variable of the early cinema experience and one which was crucial to the effect of a film stirring into life.[143]

However, what one might call the standing start technique witnessed by Gorky would have long been culturally obsolete even by the 1900s. It was likely to have been a phenomenon only of the very first cinema shows and would have served as a way – rich in symbolism – of introducing an audience to the new experience.[144] Gorky perceived the projection as a still image which then 'stirs to life'. This quickening of the static photographic image into 'Animated Photography' or 'Living Pictures' is like an early but already symbolic re-enactment of the beginning of cinema itself, a restaging in Russia, six months later, of the *Salon Indien* screening of 28 December 1895. Certainly, many of the films described by Gorky are recognisable as the same as those making up that initial programme and, like that

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[143] Until the need to synchronise the frame rate for talking pictures, electrically driven projectors would have been controlled by rheostats which would themselves have been adjusted by hand.

[144] McKernan characterises this technique as 'the familiar transmuted into the new,' (2006, 37) – a demonstration of the familiar photography, newly animated.

first public screening in Paris, its operators would have known that the majority of the audience were new to the experience.[145] It was a demonstration of technology more than a screening of any particular images. However, as the global cinema audience developed and started going to its second and third shows, the idea that the screen needed to be stirred into life would have slipped away and the showmen, responding to audience feedback, would have been concentrating on strategies to minimise flicker rather than reveal it. Safety concerns would have been another reason that the standing start would have quickly slipped from the early cinema ecosystem: It required a certain degree of skill and careful and precise handling in order to avoid the 'firing' of the nitrate cellulose film, as any time that the film spent motionless in the gate with the lamp burning constituted a significant fire risk.[146]

The showman's bravura of this technique of the standing start is discussed by Tom Gunning as an aspect of an 'aesthetic of astonishment' in which the 'astonishment derives from a magical metamorphosis rather than a seamless reproduction of reality' (Gunning, 1989, 118). Citing the same passage in Gorky as I do, Gunning emphasises the 'impact of the moment of movement' but does not comment on the role of flicker in co-producing and framing the effect. Without this acknowledgment,

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[145] The programme was not however identical. As Martin Loiperdinger has pointed out, the seminal *L' arrivée du train à la Ciotat*, which Gorky describes, was not part of the December 28 1895 screening and there are in fact three different but comparable train arrival films listed in Lumière catalogues. (Loiperdinger, 2004, 102)

[146] This situation is vividly dramatized in Albert E. Smith's memoir as he describes the anxiety of holding the image still in the projector while his partner J. S. Blackton held forth with lengthy perorations before the audience. (Smith & Koury, 1985, 39)

we miss the sense in which flicker itself would have been felt as the quickening agent of these now living pictures. Like striking flints to achieve a spark, it would have functioned as a potent symbol of the fundamental process of cinema. The gradual revelation of movement to a satisfactory approximation of the pace of life would have been accompanied by a gradual increase in flicker frequency from a kind of fast blinking up to the rapid scintillation of approximately 16 cycles a second (to use the older and more descriptive term for the measurement of frequency).

Thus, flicker and movement were intimately bound together. And this would have been sensed by all the spectators present whether the showman explicitly alluded to it or not. Furthermore, in the still images with which they would have been familiar from lantern shows flicker was not present – with the possible exception of flicker in the light source. In the open *dispositif* of early cinema, the spectator would usually be aware of the source of flicker from the projector and its exposed shutter.[147] In some early shows the projector would even be in front of the audience, in most it would be visible with a turn of the head and in any case its rhythmic rattle would also denote its location. With the operator standing ready, hand on crank, flicker and its source were material signs of the new technology of living pictures which represented the ability not just to depict life but to create it. To conjure it out of stillness.

[147] However, not all shutters were exposed and the Cinématographe is probably the best example of an early projector in which the shutter was hidden within the mechanism.

Although the 'standing start' would have been quickly obsolete as part of the showman's technique, a similar effect in which still and moving (flickering) images were seen in close temporal proximity to each other would have continued later into the early cinema period with the practice of switching between films and lantern slides throughout the programme. Many of the early projector outfits incorporated the means for rapid exchange, within seconds, of a film source for a slide source. A typical design such as that developed by Cecil Hepworth for the Warwick Trading Company in the late 1890s would swivel the entire mechanism through 45 degrees in order to line up a second lens matched to the slide source. In performance, use of this technique would have reinforced the association of flicker with movement because it would have been co-presented in a context which also exhibited the flickerless stillness of the photographic lantern slide.

If low frequency flicker was the sign of the emergence of life, then the higher roughly 16Hz flicker maintained by continuous projection and still easily perceptible was the sign of its sustenance. This mechanical flicker was joined in performance by certain parts of the profilmic reality that were engaged in their own regular vibrations within the natural world. As has often been noted, early cinema audiences were apparently fascinated by the kind of subtle naturalistic detail not previously seen in other forms of moving image experience.[148] The gross movement effects

[148] See Neale (1985, 52) for further examples of this tendency in the contemporary reception of early cinema.

provided by optical toys or the slipping slides of the magic lantern had prepared spectators for the Lumières' *Arroseur* spanking the juvenile practical joker but not for the mist of water coming from the garden hose nor how the 'leaves quiver under the spray' (1985, 228), as noted in Gorky's second review based on his experience of the Cinématographe at Aumont's. This effect of unprecedented realism must have made a significant impression on him as elsewhere in his review while discussing a Parisian street scene as well as *Repas de bébé*, his attention is again drawn by the 'fluttering' of the leaves.[149] In this review, he does not use the word flicker, rather he expresses the moment of the quickening thus: 'And suddenly there is a sound somewhere, the picture shivers, you don't believe your own eyes.' (1985, 227)

We need not, however, obsess over the precise use of the word flicker to see that much of Gorky's prose is synonymous with the concept of vibrating existence. The quivering, fluttering signs of life in the photographic record became inextricably combined with the life force implied by the flickering, shivering shutter. 'Before you a life is surging'. (Leyda, 1983) And although Gorky's conclusion that it is not strictly life 'but its shadow' is somewhat damning in terms of its realist ambitions, he is typical of the early cinema spectator caught in the perplexing experience of

[149] It is worth noting that the lively natural settings of their subjects are a distinguishing feature of the Lumières' film making in particular relative to the studio bound films of early competitors such as Edison. This can be theorised as auteuristic evidence of cinematic sensibility and/or technologically determined by the light weight and portable nature of their camera.

astonishing realism combined with obvious artifice.[150] Both Gunning and Tsivian have commented on this paradoxical relation made especially apparent by Gorky's thoughtful reporting and have used it to posit a spectator assaulted by feelings of astonishment and the uncanny.[151] Tsivian writes of the 'mutually contradictory signals (or "commands" to use a computer analogy) coming from the image' (1998, 6). Flicker, greyness and silence are all signals of the artifice but while commentary on Gorky has noted his emphasis on the lack of colour and absence of sound it has overlooked the single mention of flicker. Unlike these lacks, flicker is within itself a contradictory 'command' of cinema that simultaneously connotes artifice and realism because only flicker is bound in with the phenomenal factor of realistic movement and despite its anti-realism maintains a connection with the pulse of life. In short, where monochrome silence seems to refer only to death or the haunting of life, flicker is analogous of the quickening and sustenance of life while at the same time leaving the door ajar on the cinematic illusion.

[150] It is possible that Gorky's unease is effectively picking up on what Noel Burch would call the bourgeois dream 'to exorcise the supreme phantom, to abolish death' (1981, 21) as evidenced in the rather different reviews of the screening of 28th December 1895 in which two Parisian correspondents greet the prospect of immortality more enthusiastically. Burch personalises the struggle for the direction of cinema in binary terms between Dr Frankenstein's headlong plunge into the creation of artificial life and Charles Baudelaire's aversion to 'the ideology of naturalistic representation'.

[151] Gunning sees in Gorky's nuanced response a recognition that 'the film image combined realistic effects with a conscious awareness of artifice' (1989, 118). Tsivian relates this paradox of early film reception to Viktor Shklovsky's concept of *'ostrannenie'* or de-familiarisation. 'The presence of movement made the image look strikingly life-like, while the absence of sound and colour turned it into a haunted frame.' (1998, 6)

3.3 Flicker and apparent motion

This strong association of flicker with movement in the cinematic experience may have laid the groundwork for the long-held misconception that flicker is also the means by which moving images move, in the sense that a theoretical 'persistence of vision' located in the spectator's eye and mind amalgamates the separate image flashes delivered by the projector.[152] The illusion of motion provided by the films of the Lumières is, however, a separate visual phenomenon from the illusion of continuity of vision.[153] Flicker, at a high enough frequency, such as the 48Hz typical of modern cinema projection, does facilitate the appearance of a continuous stimulus but it does not help us conjure movement from the discrete images of the film strip. That role is carried out by the phenomenon of apparent motion, and was only first identified by the Gestalt psychologist, Max Wertheimer, in 1912.[154] Rather more prosaically, in combination with the projector mechanism, flicker helps to hide movement – the vertical movement of the film in the projector gate – and then, once it has achieved a high enough frequency to appear solid to the human visual system, it hides itself. This point, the critical fusion frequency (CFF) would have been

[152] Only since the 1980s and the work of Nichols and Lederman and Joseph and Barbara Anderson has film scholarship gradually released its grip on the persuasive but erroneous notion that the illusion of movement in the cinema was due to the persistence of vision. (Nichols & Lederman, 1980), (B. Anderson & J. Anderson, 1980)

[153] The Andersons express the two issues thus, 'Why is the image continuous, and why does it move? In other words, why do the separate frames appear continuous rather than as the intermittent flashes of light we know them to be? And why do the figures on the screen appear to move about in smooth motion when we know they are in fact still pictures?' (B. Anderson & J. Anderson, 1993) It is of course the continuity of the image or lack thereof with which I am concerned in this thesis.

[154] Also called Stroboscopic or Beta movement. 'This occurs because the brain tends to organize two points that are presented sequentially to different locations on the retina as having moved from one place to the other in the visual field. In the case of small displacements (small distances of movement) the motion detectors in the visual system are stimulated in equivalent ways by beta and by real movement. When large displacements are involved, motion between the two more distant points is inferred.' (Brooks, 1984, 107)

fully achieved by very few performances in the early cinema period. The illusion of apparent motion requires a less frequent (10-12Hz) percept than flicker fusion and so, at typical levels of 16Hz, a projection such as that witnessed by Gorky would provide a convincing representation of jerk-free motion combined with a noticeable flicker.

The historical period of early cinema predates any kind of widespread understanding of the separation of these two perceptual effects. Indeed, the speed of vision is still a contested area in modern vision research which proposes the human visual system as a complex interrelation of different perceptual components operating at different speeds.[155] Although psychologist and film theorist, Hugo Münsterberg is now credited with recognising the complexity of the situation in 1916, his book, *The Photoplay: A Psychological Study*, was overlooked at the time and the 'myth of persistence of vision', which had already been created by the discourse around optical toys, was simply grafted on to the reception of cinema and

[155] See Holcombe, (2009) for a discussion of the differing 'timescales on which the machinery of perception operates'. It includes this lengthy but instructive description of the passage of a visual signal through the HVS:

> 'After hitting the retina, visual signals rocket towards cortex and on the way only changes on the order of a few milliseconds are lost, perhaps due to membrane fluctuations and temporal summation of signals at geniculate and geniculo-cortical synapses. Shortly after reaching cortex, specialized motion detectors and edge detectors cross correlate the incoming signals, outputting representations of certain events at narrow timescales. These specialized, high temporal resolution motion detectors and edge detectors are replicated across the visual field. But with a high cost in cortical territory to be paid for having these special purpose mechanisms, evolution has provided for only a select set. Visual signals continue past the secondary visual cortices and move towards visual cognition, but then hit slow going. Visual cognition can make nearly any judgment about its inputs, but these computations are so slow that information at narrow timescales cannot be accessed if not already explicitly represented by the low level specialized detectors. Making matters worse is that cognition is also limited in resources and only able to process one or a few objects at a time.'

not seriously challenged in film scholarship until the 1970s.[156] The proselytisers of this important revision to film studies have not separately considered the conditions of reception in early cinema and have not recognised that one reason for this misconception may be that in the early cinema period the artefact of the still visible flicker was the obvious, intuitive, candidate for explaining the illusion of movement which so distinguished the new experience and was generally speaking fluid and continuous; a remarkable novelty but lacking its own material sign.

It is worth noting that in machines such as the Lumières' Cinematograph with single blade shutters the frame rate or rate of movement and the flicker rate were not just mechanically connected but bound to the same frequency. With the first appearance of three-blade shutters around 1903, this intimate connection between flicker and movement was teased apart but, as I will show in chapter 5, only gradually because adoption of three-bladed shutters was by no means universal. From 1903, therefore, it was possible, though probably still not common, to see a 16fps film projected with 48Hz flicker, in other words the same degree of apparent movement coupled with three times the flicker frequency, high enough to achieve fusion in most subjects. This arrangement, with its division of frame rate and flicker frequency, was much better suited to the longer-term engagement of the human visual system.

[156] The notable work of Münsterberg, interdisciplinary *avant la lettre*, was rediscovered at the same time. *The Photoplay* was re-issued by Dover press in 1970. (Münsterberg, 1970)

Although flicker does not contribute to the on-screen movement of the train or even the fluttering leaves, it is nevertheless clear that the experience of flicker and movement is culturally and imaginatively tightly imbricated especially in the earliest forms of cinema in which movement was the vivid shock of the new and critical flicker fusion was approached but rarely achieved. These are the registers of flicker experienced by Gorky, one which he directly mentions and another which we can hypothesise based on known facts about the production of Lumière films and the design of early Lumière projectors. When the still image started to move the 'strange flicker' would have been of very low frequency such as 2-3Hz but would have quickly increased to 16Hz at which point the projectionist would have maintained a more or less constant speed albeit with modest variation such as +/-1Hz. This equates to a nominal 16fps on a machine using a single shutter blade of about 120-degree sector.[157] Somewhere en route to 16Hz flicker the jerkiness of movement would have resolved so that the viewer who started out with an experience of flicker and jerky motion would have been left only with the flicker, as though the fluid motion had been born from the struggle of the flicker.

[157] I am basing this value of 16Hz on the known specification of the Lumière projector as seen in surviving machines and patents (Lumière & Lumière, 1895). As usual, precise shutter specifications are not easily obtained and in the case of the Cinématographe the data are complicated by its dual function as camera and projector, with potentially different shutters for each role. Loiperdinger states the Cinématographe was equipped with a two-bladed shutter. (2004,96). I would disagree based on primary evidence; of the single blade mentioned in the 1895 patent and also on the continued use of a single blade in their improved model as outlined in the 1896 patent. (Lumière & Lumière, 1897)

3.4 Flicker and luminance – the contribution of T.C. Porter

Data such as the flicker frequency of any given device begins to describe something of the strictly flickering component of the artefact-filled experience of early cinema. It is not enough, however, to speak of flicker simply in terms of frequency. Sensitivity to flicker and therefore the value of the CFF depends on the intensity of the light, also expressed as luminance, as well as the frequency with which it is interrupted.[158] These two factors together describe the most fundamental relationship of the phenomenon of flicker and its disappearance at the limen of the CFF.[159] Since the turn of the 20th century, this has been expressed by the terms of the Ferry-Porter law, named after separately working researchers, Erwin Ferry and Thomas Cunningham Porter whose conclusions were published ten years apart (1892 and 1902, respectively) and only subsequently joined together in scientific law. The reason for this split attribution is that Ferry noted the importance of luminosity only in terms of visual persistence and it was left to Porter to express its relation to frequency.(Galifret, 2006, 374) As detailed in chapter 2, Porter was an interested and thoroughly engaged spectator of the 'kinematoscope', commenting on the 1897 screening of *The Corbett Fitzsimmons Fight* that, '[t]he flicker was unpleasant throughout, which means that somehow or other more pictures should be thrown on the screen per second' (1899, 193), or in other words, that the flicker

[158] Light intensity and luminance are also more or less synonymous with brightness. In terms of a waveform signal, this value, measured in foot or meter candles, makes up the amplitude and its variation over time, the frequency.

[159] See Landis (1954) and Piéron (1965) for extensive reviews of the literature on the parameters and determinants of flicker sensitivity and flicker fusion.

frequency should be raised. Familiar, at the very least, with performances of the Veriscope and Biograph, it seems likely that Porter was a regular visitor to the various forms of early cinema and it is fascinating that the flicker researches that made his name and which were published in attenuated fashion in three papers of 1898, 1902 and 1912 coincide precisely with the development of cinema as a mass cultural practice. The psychophysiologist, Yves Galifret, goes as far as to suggest that the arrival of the practical example of cinema helped to straighten out the scientific theory.[160]

> The transition from duration of the persistence to frequency was not motivated by theory only, because, with the appearance of the 'cinematography', the problem of the choice of the projection frequency was becoming important from a practical point of view. (Galifret, 2006, 375)

Porter's 1902 paper is key to Galifret's 'pressure of practice' thesis because it established 'the logarithmic relation between fusion frequency and the intensity of the stimulation' (2006, 369) that precisely described the conditions faced by early cinema's apparatus designers as they experimented with different forms of shutter. As Galifret points out, Porter even mentions the practical example of the cinematograph in his paper delivered before the Royal Society, stating that although his first wish was 'to throw light upon the process of vision' his results can also be used to ascertain,

> the number of pictures which must be projected on a screen per second in order that there may be no trace of flicker; the illumination of the brightest part of the brightest view, and that of the darkest part of the darkest view being known ; and a rough estimate from observations of the brightnesses of

[160] Ibid, Galifret's paper, written when he was 86, is a remarkable review of 200 years' research into visual persistence.

> the pictures as usually projected by cinematographs on a screen would point to as many as 50 per second being necessary where the arc light is used for projection, though half this number would probably be sufficient to prevent the flicker from being distressing. This assumes that the photographs are "in register" on the screen. (Porter, 1902, 321)

Besides the reference in the above passage and the broad temporal contiguity, Galifret does not offer any further direct evidence of a link between cinema and flicker research, so it is gratifying to be able to supply the additional evidence of Porter's analytical mind being present at multiple screenings of early cinema, as gleaned from his book *Impressions of America* and quoted in chapter 2. Taken together, Porter's two statements are remarkably well aligned and despite their different publishing contexts effectively follow on, one from the other, as parts of the same research project. In 1897, he knew that 'somehow or other' the Veriscope needed more frames per second to reduce the flicker. By 1902, Porter was able to quantify the frame rate required to eliminate flicker, giving the still widely accepted figure of 50 per second. In the interim, his laboratory researches had evidently been supplemented by observations conducted at cinematograph venues where he had acquired a range of experience of screen 'brightnesses' and lighting technologies – the arc light being the most popular and powerful choice for large scale shows. Even his proviso that the frames should have good registration clearly derives from his direct experience of cinema and may well be due to a recollection of the over-animated Veriscope performance that he saw in Colorado.

It is also clear that Porter was part of a wider community that helped return the results of his research to film pioneers. He was, for example, a member of the Royal Photographic Society and present at the reading of a paper in 1907 about duplex projection in which he referred to his Royal Society papers on flicker. (Haines, 1907, 112) In contrast to Ferry, Porter had taken the crucial step of tabulating his results in a graph and a modified version of his 1912 data became the standard visualisation of the relationship of flicker frequency and luminance, quickly entering into the discourse in the technical literature of cinema. Just two years later, for example, technical authors Simon and Henry Gage published Porter's graph in their handbook. The data was plotted alongside that from their own 'rough observations', taken during a repeat of his experiment.[161]

As both a scientific researcher and a cinema-goer, Porter shows a degree of familiarity of the practical 'lab' of early cinema which is lacking in subsequent scientific flicker research, where experimental conditions become more essentialist and specialised and lab conditions and cinema conditions diverge. The differing nature of the stimulus in lab versus cinema conditions is an issue for studies which concern themselves with the effects of flicker rather than its simple visibility: It is enough for Porter to take the value of the 'brightest part of the brightest view' in order to find the maximum fps required for the elimination of flicker. It is not

[161] Their book *Optic Projection* was intended to convey the 'underlying principles' of the 'art' of lantern and motion picture projection to a broad audience. (Gage & Gage, 1914, 424)

enough however to determine in detail the cognitive effect on a spectator of regarding the complex, constantly changing field of image data in which some parts will appear to be flickering and others not. Although concentrating his research on the relation of frequency and luminance to the flicker fusion threshold, Porter understood that flicker operates over a range, commenting that while 50fps would be necessary for 'no trace' of flicker, perhaps half that amount would be sufficient to avoid 'distressing flicker'. A frequency of 25Hz would still be a tall order for most projectors operating in 1902, although Porter's preferred show using Biograph machines would have been operating somewhere between 25 and 50Hz. In fact, in common with the laborious and expensive high fidelity of the Biograph, Porter was still assuming that the desirable increase in frequency could only be obtained by a higher frame rate, effectively thinking in terms of pictures per second, not pulses per second. In chapter 5, I will show how almost concurrently, a formalisation of the practical experience gained in the proving ground of daily projection practice would implement Porter's suggestion of 50Hz, not by adding extra picture frames but by repeating the projection of the existing frame.

Archaeology of illuminants

Given the importance of luminance in qualifying flicker phenomena, greater attention needs to be given to our understanding of historical changes in projection lighting technologies. In fact, a similar archaeological work for historical illuminants is required as that which this thesis proposes for projection apparatus. The power of a light source as well as the film print density and contrast have a significant effect on parameters of flicker perception, as noted, for example, by Herbert Maclean in 1900.

> A good deal of the flicker sometimes met with is due to (1) The exhibition of films lacking in half-tone, and having glaring expanses of white sky, water, etc.; (2) the employment of an illuminant which is too brilliant.
> (Maclean, 1900, 113)

In practice, dull images were likely to be more of a problem. The German pioneer, Guido Seeber, recalled one of his first experiences of film projection given by a showman named Reichenbach around the year 1896. The images from a limelight lantern positioned too far from the screen, with a short focal length lens and a greedy shutter were very dim.[162] Such an accumulation of negative factors indicates the challenging conditions of early film exhibition and demonstrates the need to hold in balance bright flickering images on the one hand and dim dull ones on the other. Limelight or acetylene gas were used where electricity was unavailable but they struggled to match the intensity of the electric arc lamp. Limelight was also called Oxy-hydrogen after the gas mixture used to create the flame used to heat the piece of lime which was the light source. The gas could be handled in various different ways such that the third, fourth and fifth options in the citation below all refer to limelight.

> The various powers obtained from the different sources of light according to photometric tests are:

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[162] From Seeber, G. *Der Seeberograph und das Seeberphon*, see Seeber, (1979, 35) 'Die Bilder waren sehr dunkel, denn einmal war die Helligkeit des Kolklichtes gering, dann nahm der Verschluss sehr viel Licht weg, und ausserdem war durch die grosse Entfernung von 15 Metern von der Galerie zur Bühne in der Aufprojektion mangels anderer Optik das Bild viel zu gross.'

4-wick Oil Lamp	80 to 100 c.p.
Acetylene Generators	100 to 250 c.p.
Oxygen with ordinary house gas used with blowthrough jet	300 to 500 c.p.
Oxygen gas compressed in cylinders and used for mixing jet	1,000 to 1,500 c.p.
Oxygen with an independent Ether Saturator of good capacity, and used with a high-power mixing jet	1,000 to 2,000 c.p.
The electric Arc light from	1,000 c.p upwards.

(*Walturdaw Bioscope Specialities*, n.d.)

While it is difficult to imagine the effect of now obsolete lighting systems, this typical contemporary text with measurements of light intensity in candle power (c.p.) is instructive as to the relative power of lighting systems in use in the early cinema period.[163]

3.5 Further flicker factors

A full assessment of the parameters of Gorky's experience in terms of flicker and its likely perceptual impact would therefore require additional data, the most significant of which would be a measure of the intensity of the illumination which would help to indicate the more relative value of perceived brightness. This information is both more complex and less easily discovered in the historical record because factors determining the relative brightness of the image on screen are far more numerous than those responsible for its rate of intermittence. Influential factors include the specification of the light source; the design of the shutter; the density of the film material; the image content; the material of the screen and its

[163] This text appears identically in both CUTC and Walturdaw catalogues.

size and placement in the spectator's field of view; and the relative brightness of the space into which the film is projected. Further evidence gleaned from Gorky's text is useful in this regard but can hardly be considered as definitive.

> A beam of electric light is projected on a large screen, mounted in a dark room. And a photograph appears on the cloth screen, about two and a half yards high [sic] and a yard and a half high […] Your eyes see a plain piece of white cloth in a wide black frame. (1985, 228)

In the example of the screening of Lumière films witnessed by Gorky, we therefore know that the more powerful electric arc light was used, in contrast to alternatives such as limelight or acetylene gas. Although it may be hardly surprising that the screening took place 'in a dark room', given our retrospective immersion in so many black boxes, Gorky evidently found it worth mentioning as one of the conditions of the Cinématographe's novel *dispositif*.

In fact, environmental light levels are a highly significant variable in flicker perception and while darkness could be easily arranged in most venues of early cinema it is worth considering the issue of reflectance: The one interior light that could not be extinguished was that in the projector itself. Its light, reflected from the screen, fell not only on the retinas of the spectators but into the room itself. Darkly painted matt walls of modern cinemas absorb most of this stray light but the interior of a travelling cinematograph show tent would have been another matter. The black surround mentioned by Gorky would have helped to provide a stable border to the image, effectively a cushion for mechanical instability in the image which would have been highlighted if the edge of the image had been allowed to appear on the white cloth of the screen. The border would also have absorbed the light at the edges of the image but beyond this black frame reflected flickering light would still faintly illuminate the interior space. This is significant in terms of perceptual impact because if areas surrounding the screen but within the spectator's visual field are lit they will reduce the subjective experience of on-screen flicker and lower the value of CFF. Of course, this reflected light is itself still a source of flicker at the same frequency as the on-screen light but with reduced brightness.

The emphasis which I have previously placed on the surroundings of the moving image experience, using Barthes' meditation is therefore not coincidental to the case of flicker. Experience of flicker is fundamentally a relative phenomenon and thus the nature of the surroundings is significant already at an immediate perceptual level, irrespective of any affective contribution of the humility or grandiosity of the architecture. A viewer with Barthes' dual awareness or, perhaps more appropriately to the early cinema period, a spectator with Tsivian's medium sensitivity, could therefore have found the twin foci of their attention more equally occupied.

One can therefore postulate that experience of flicker in early cinema would have been associated with the wider experience of being in a theatre and not just watching a film, even though the less extreme quality of environmental flicker would have usually escaped reporting. It would have been one of a number of factors which subtly drew attention to the means of production of the illusion while in the same instant the irresistibly convincing illusion itself took centre stage.

Ocular Physiology

Gorky informs us too about the size of the projected image. This information is useful because it tells us how widely dispersed the light from the arc was, which, in turn, has an effect on the brightness of the image; the smaller the image the brighter because the same amount of light energy is concentrated in a smaller area. However, the size of the image and its placement within the spectator's field of view also has an effect on apparent flicker because sensitivity varies across the cells of the retina. Variations in retinal sensitivity are most profound at the centre and the edges, that is in foveal and peripheral vision, respectively. They are the inverse of the resolving power of these areas; foveal vision gives the finest detail and the lowest CFF and peripheral vision the least detail and the highest CFF, with obvious ecological benefits. In laboratory studies of flicker 'the area (visual angle subtended on the retina) of the test patch of intermittent illumination,' (Landis, 1954, 283) is the next most important determinant of CFF after luminance.

> Not only is the size of the retinal area a determinant, but its position on the retina, its shape whether it is discrete or composed of several component parts, all enter into the areal effect. (Landis, 1954, 265)

In the practical example of cinema these parameters of human vision dictate the forward-facing arrangement of spectators but also mean that flicker experience can vary according to seating position, a fact acknowledged by T.C. Porter's comment on the Colorado Veriscope screening that he found a seat 'perhaps rather too near the screen'. These fundamentals of human vision also indicate how stray flickering light in the screening space could potentially become visible to the peripheral vision of the spectator.

Regularity of cycle

If flicker has a highly constant frequency it will be less visible than if there are fluctuations in the frequency. The human visual system averages the visual information it receives over a period of 20ms (1/50 sec) or more. (Holcombe, 2009, 217) This averaging is key to rendering the 48Hz flicker of classical cinema invisible but if there are sufficiently powerful anomalies within that 20ms period the average will be distorted. For example, in this way a single brief flash even of 5ms will still be perceptible where a regular series of 5ms flashes, effectively 200Hz flicker, would not. This in part explains the visibility of dust and blotches that appear only on single frames of film. In early cinema, this fact also impacted both the situation of hand cranked projection and the design of shutters in which multiple blades of differing sectors were used. In both cases the consequent irregularity of the flicker increased its visibility.[164] Projector designers were tempted into compromises between coverage of the picture shift and loss of light from large second and third blades equal in size to the cover blade. They often slimmed down the anti-flicker

[164] Both Proszynski (1913) and Porter, (1912) note this effect.

blades in order to increase light output. 'This, however, destroys the regularity of the alternations of light and dark, and is at best a makeshift.' (Foster, 1915, 235).[165]

Duration

Of course, flicker didn't arrive in nineteenth century experience at the same time as Lumière's train in the station. Mechanisation and electrification had already introduced a host of artificial flickering stimuli in addition to those provided by the natural world. However, streetlights may flicker but they do not generally require sustained attention.[166]

Existing visual technologies such as phenakistiscopes and zoetropes or the earlier optical cabinets also had a flicker component but they were designed for short periods of use and were, in any case, within the control of the spectator. Comparable versions of these earlier handheld technologies sprang up around the new cinematographic devices, such that a Biograph, Lumière or Paul film could be re-experienced through, respectively, a Mutoscope, Kinora or Filoscope. Via these hand-controlled devices a short burst of action was delivered for a matter of seconds usually under ambient lighting conditions and through the direct agency of the spectator who could therefore self-administer the degree of flicker experienced.

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[165] In the case of a standard two blade shutter operating at 48Hz, 'The threshold below which flicker is seen when the time of opening is not equal to the time of closure rises to approximately 60 interruptions per second.' (Wheeler, 1969, 293)

[166] Wolfgang Schivelbusch suggests that the mixed streetlighting of the 1880s caused a taxing physical switch between the eye's rods and cones, its mechanism for dark and light adaptation, due to variations between the power of the dim flickering of gaslight and brighter, steadier electric carbon arc lighting. (1995, 118)

Within this class of device, flicker could even be celebrated. An Austrian device, one of a number operating on the principle of the Kinora, even went as far as to name itself – and therefore presumably with pride and not disparagingly – 'Flickergraph'.[167]

Such moving image experience was naturally very different from the marathon perceptual endurance test of the Veriscope. In general, though, most films screened in the early cinema period would have been of much shorter length and there would have been plenty of gaps in the programme to look away and refresh one's vision. Nevertheless, even a film of one minute's length represented an increase for most people on the few seconds of time which they might otherwise have spent regarding flickering light sources.

Strategies for reducing and controlling flicker are therefore undeniably linked to changing trends in film form towards longer productions and longer programmes. Despite the example of the Veriscope, it is hard to imagine later developments in extended narrative and even feature film occurring with late 1890s projection technology. However, the precise degree of responsibility that technological change can claim remains unquantifiable and there are competing arguments for

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[167] A cheaply made homonymous device of otherwise unrelated design and manufacture was available in the UK for the toy market. For 'Flickergraph' as an Australian slang term for film projector, see Bottomore, (2012, 460)

such significant structural change in the film business. Charting the rise of Vitagraph studios in the nickelodeon boom, Charles Musser writes

> It would be a mistake to simply see the nickelodeon form of exhibition as a result of improved technology - the reduction of flicker. Rather it was made possible by the production of an increasing number of longer films which could be used interchangeably by theatres. (1983, 40)

It could be better said that reduced flicker and jitter in projection made sustained attention to longer films a more attractive proposition, certainly encouraging increases in length and quantity of films, but hand in hand with changing business practices.

Multi-sensory Flicker

The overwhelming sense of flicker as a purely visual phenomenon should not divert attention from the effect of intermittent stimuli received by other senses, especially when received in conjunction with visual flicker. In the case of cinema, auditory flicker from the rhythmic mechanical sounds of the projector was known anecdotally to exacerbate the effect of visual flicker, although as Hopwood says, it was easily overlooked.

> It is not sufficiently recognised how large a degree of sympathy exists in many organisations between one sense and another. There is little doubt but that a continual rattle impinging on the ear tends to intensify irritation caused to the eye by flicker on the screen. (1899, 207)

Logically therefore, the enclosure of the projector, which gradually became more common in the middle of the early cinema period, would not only have removed the noise of the machine from the audience's experience but reduced the apparent visual flicker as well. It is a commonplace that musical accompaniment to film was introduced to mask the sound of the projector but in so modifying the soundscape in the screening space, it too would have offered a distraction at a sensory level from visual flicker.

Hopwood's anecdotal findings are supported by work carried out in the 1930s by the psychologist, Paul Schiller. Using a spinning disc apparatus to create visual flicker stimuli, he then exposed his subjects to a loud 'dissonant sound with rapid pulsations.'

> The disc which showed a slight trembling before seems suddenly to flicker wildly and roughly as the sound appears, and reverts to a weak trembling only after the sound has ceased. (Schiller, 1935, 465)

Contrasting this with a condition which used smooth sound, 'such as a perfect fifth', he found that for one observer with a CFF of 24Hz without sound, the value decreased to 20Hz when visual flicker was accompanied by the smooth sound and increased to 27.5Hz when accompanied by the dissonant one.[168]

Among the many reactions to the mechanical sounds of the cinematograph as 'the cacophonous chorus of modernity itself' (1998, 119) that Yuri Tsivian has unearthed, none make the link with visual flicker. He does however find that 'the noise of the film projector was associated with the noise of time,' namely the ticking of a clock.

[168] Schiller also found that the sense of touch, explored through smooth and rough sand papers, was similarly co-ordinated to produce a decrease and increase in apparent visual flicker, although of course this finding has less bearing on cinema experience.

Using citations from Vertov to Meyerhold, he shows how mechanical noise served a metronome like function in both the cranking of the camera for film actors, and the cranking of the projector for cinema audiences. (1998, 119-121) This view of the projector as a ticking clock, sounding out its auditory flicker is also relevant for the study of purely visual flicker in cinema. If the intermittent sound of the projector makes the audience aware of time, we can therefore postulate a similar effect for visual flicker and a strengthening of the effect of both when experienced in unison, as would have been common in early film presentations.

3.6 Pleasant and unpleasant flicker

The large number of variables affecting flicker phenomena outlined in the previous sections inevitably indicate widely varied experiences of flicker received in early cinema at least until the imperative toward the institutionalization of cinema gradually tamed many of them. By contrast, the emphasis in contemporary manuals and later historical accounts on overcoming the 'problem' of flicker has led to an assumption of early cinema experience as being *uniformly* plagued by unpleasant flicker. Typical of such attitudes is the recollection of Albert Smith, the Anglo-American pioneer of Vitagraph.

> The flicker almost killed motion pictures. It irritated and tired the eyes; and caused many patrons, particularly the older, to forego the movie houses altogether. (Smith & Koury, 1985, 35)

Of course, there were many other reasons why the elderly may have chosen to avoid the often rather crude early 'movie houses'. Wholly accepting the monotonous negative discourse around flicker risks masking other potential reactions. Acknowledging flicker as a range of experience varying especially in luminance and frequency is important because subjective reaction to flicker from 0-50hz and under varied conditions of ambient lighting is very changeable. As Porter mentioned, 25hz (and higher) would probably not be 'distressing'. The most painful flicker is around 8-10Hz and frequencies lower than that can be found to be relatively attractive.

Pleasant flicker is well known to us from such situations as candlelight reflected in gilt-framed mirrors or a bounce light cast by sunshine reflecting off water. However, these conditions of modulated light exhibit low flicker frequency and soft contrast.[169] When the light is collimated – that is gathered into a narrow beam by the lens - and the frequency increased, as in the case of motion picture projection, the flicker typically becomes irritating until, as the frequency is further increased it will gradually become barely perceptible and then apparently solid, dying away finally in the brightest parts of the image. Therefore, not all flicker, even if it was noticeable, was objectionable and there is at least the possibility that it may have been actively welcomed. This has hardly been acknowledged in studies of early cinema although explicit engagement with flicker has been a feature of the filmmaking avant-gardes of both the 1920s and 1960s.

[169] These natural flicker effects have been replicated in various automated devices which also employ shutters such as synthetic-coal fires or aquarium tanks.

Exceptionally, Yuri Tsivian has compiled evidence of a flickerphile response in the early cinema period. He discusses the attraction to the unstable projected image of the cinematograph; its 'tremor, flickering, blinking, vibration', by members of the contemporary cultural community and notes Christoph Asendorf's observation that around 1910 the theme of vibration was often present in aesthetic debate.[170]

> Oscillation was a significant element in the 'new sensibility' cultivated in fin de siècle literature and art. It was connected – insists Asendorf - with the cultural discovery of such scientific concepts as the behaviour of nervous systems, electricity and the undulatory nature of energy. (Tsivian, 1998, 108)

Tsivian traces examples of this tendency in decadent literature, Art Nouveau design, Post-Impressionist painting, the theatre of Stanislavsky, the theosophy of W.C. Leadbeater and Symbolist poetry. He concludes that for such creative souls, a visit to the cinema 'was like feeling the pulse of modernity itself.' (1998, 109) Within her art historical writing, Linda Dalrymple Henderson coined the term 'vibratory modernism' to address comparable similarities in works by Boccioni and Kupka.[171]

An alternative manifestation of this tendency in the reception of cinema was to be found in parody acts presented on the Vaudeville stage. It was what Terry Ramsaye identified as 'a testimonial of recognition' for the upstart technology while describing a Weber and Fields sketch at the Alhambra Theatre in New York.

> This act depended for its humor on a parodying of the faults of the projector. A pair of dancing girls appeared in a burlesque of the performances of Annabelle, performed before a white sheet. They were illuminated by spot

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[170] Tsivian cites page 154 of Asendorf's German language book, Asendorf, C. (1989). *Ströme und Strahlen: Das langsame Verschwinden der Materie um 1900*. Giessen: Anabas.
[171] She finds in particular a 'new conception of artistic creation as the reception and emission of waves' (2002, 142) in a 1923 woodcut by Kupka entitled *Fantasie Physiologique*.

> lights so manipulated as to give a grotesque exaggeration of the pulsations of the screen picture. (Ramsaye, 1926, 267)

Apparently, Weber and Fields also offered an alternative version of the sketch featuring, fittingly enough, a burlesque of the Corbett-Fitzsimmons Fight (Streible, 2008, 58). Similarly, Rosalind Krauss has discerned an echo of stuttering film technology in the 'stop-and-go flicker' and 'jerkiness' of the mannerisms of Charlie Chaplin's iconic little tramp character.[172]

Clearly then, parts of the vast flickery media landscape of early moving image technologies – the phrase also includes optical toys such as described in the previous section – contain a mode of reception in which flicker was part of the attraction and playfully engaged with. There was more to be gained from the 'living pictures' than the experience of lifelike movement. There was the chance to measure the pulse of life itself. Although simultaneously recognizable to the senses as artificial life, unlike the other artifacts of the artifice such as greyness and silence, the sensed intermittence of visual and auditory flicker injected life in to those shadows.

It is perhaps from a similar cultural perspective that the Czech critic, Vaclav Tille, wrote about the 'new visual medium' of cinema's shadow world in 1908.

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[172] 'This hiccup, this jerkiness, this twitch, would enter the projection of early films, from nickelodeons to silents, finally to be internalized in Chaplin's very walk, as hitching up his pants and bouncing his cane he imitated the tremor that constantly palsied the visual space of primitive cinema, everyone seeming to march to the sound of an invisible drummer.' (Krauss, 1993, 204)

> In those silent, nimbly and playfully flickering swarms of shadows there is something astonishing and alluring, something that so vividly evokes in the soul the impression of our own dreams, mysterious and unimaginable images that flash on and off inside our consciousness. (Anděl & Szczepanik, 2008, 90)

Tille's characterization of cinema's shadows came not from Gorky but from what he saw as its precursor, the 'ancient visual medium of the Oriental dramatic arts' (2008, 89). His emphasis on flicker in both media is notable but especially so 'the flickering, dappled pictures of various bioscopes and cinematographs,' (2008, 71) because it grants us a glimpse of a much less familiar response to flicker in early film, one which is positive and playful. It substitutes ideas of flicker as irritating, dangerous or just plain tolerable with the notion that it can be actively and positively 'astonishing and alluring'. What's more, Tille's reference to consciousness suggests that he has divined something of the potential of film-based flicker to cut through directly to the operation of our nervous system. In other words, it is not just the presentation of attractive and astonishing images to our consciousness that is significant but their delivery through a flickering medium. It is potentially instructive, therefore, to put this cultural analysis into dialogue with scientific research which offers evidence of a direct connection between a flickering stimulus and brain activity, that of brainwave entrainment.

3.7 Flicker and brainwaves

This form of brain behaviour, was first reported by Edgar Adrian and Bryan Matthews in the 1930s. It followed on from initial research into the electrical activity of the brain and its recording (electroencephalography or EEG) which had been conducted by Hans Berger in the 1920s. (Berger, 1929) Berger had found a 10Hz resting state rhythm in subjects in a relaxed wakeful state but which disappeared when their attention was engaged. Adrian and Matthews investigated this '10 a second', 'alpha' or, at that time, so named 'Berger rhythm' which would be abolished by visual activity such as looking at a simple pattern or indeed any feature in an otherwise blank visual field. As part of their investigation of the mechanism of the 'Berger rhythm' they employed flicker stimuli to see how it could be manipulated in controlled conditions, reasoning that 'if a group of cells tends to beat spontaneously it should be possible to induce a beat at a higher rate by rhythmic stimulation.' (Adrian & Matthews, 1934, 377) They created a source of flicker using an open sectored disk, or episcotister, lit from behind by a headlight bulb and presented it to subjects, whose faces were enclosed in an opal glass bowl, with eyes open regarding the diffuse flickering light. With most of the visual field thus exposed to flicker, they then recorded EEG signals from the rear of their subjects' scalps. The signals corresponded to traces of electrical activity in the occipital region of the cortex, the area responsible for visual processing. Although there was marked variation across individuals they found that at frequencies up to 25Hz, the limit of their apparatus, brain waves could be seen to shift from the alpha band and match the frequency of the flicker source. Continuous flicker was necessary to achieve the effect. Single changes in illumination did not leave a trace on the EEG record, showing that the occipital cortex was only responsive to changes in frequency of flicker and not light intensity. They further remarked that,

> To obtain this result the intensity of the light has to be carefully adjusted. If it is too dim the sensation of flicker soon dies away and the rhythm reverts to 10 a second. If it is too bright the field may become filled with coloured patterns, the sensation is extremely unpleasant and no regular waves are obtained. But it is usually possible to find an intensity which will at the worst give occasional patches of the flicker rhythm; more often the rhythm is clearly marked when the eyes are first opened and becomes intermittent after a time, but is never absent for more than a second or two. (1934, 378)

Adrian and Matthews here describe the not too dim and not too bright conditions that we can recognize from cinema experience and show the ability of 'just right' flicker to shift resting state brainwaves - the 10 a second, 'alpha' – to the frequency of the flicker source. Ordinary visual activity will also disrupt the resting state rhythm but in less regular fashion. They showed that flicker caused a positive interruption to the negative cerebral activity of the alpha wave, which was the sign of cortex with nothing to do and that once a response to flicker was induced it could 'resist disturbing influences which would upset the spontaneous beat' (1934, 381). They acknowledged that such flicker phenomena 'cannot often occur normally' (1934, 383) but did not consider the readily available source of flicker in the contemporary cinema experience. However, it should be noted that even in such lab conditions of all-encompassing flicker there is a volatility to achieving a synchronous response. When one considers the vastly more complex conditions and variously flickering visual field presented by cinema screenings, it is clear that results are unlikely to be so consistent. Adrian and Matthews also noted that their subjects were not conscious of any change in sensation when the synchronization occurred, indicating a territory beyond conscious awareness of the human response to vibrating existence.

The study of the EEG became a valuable neurological tool and researchers found other ways of activating the EEG in addition to the flicker technique that became known as photic stimulation or photic driving. In the early 1950s, Henri Gastaut, who had previously worked in W. Grey Walter's laboratory using a powerful stroboscope to administer flicker in place of the usual episcotister, decided to take a step away from lab apparatus and try a novel approach. In an unprecedented and indeed hardly repeated series of experiments he employed not an episcotister or a stroboscope but actual film projection as the stimulus, 'considering the changes in the EEG patterns corresponding to transient psychical states, and also the considerable influence of cinematographic projection on the psychical state of spectators.' (1954, 433) His 1954 paper describes experiments in which subjects viewed a control reel made up of 10 different newsreel items, also including two blank sections and followed by a session of eyes-closed stroboscopy applied through the range 1-24Hz with a photic stimulator. By including film projection in his method, he aimed to achieve greater ecological validity, studying

> the bioelectrical cerebral modifications in conditions as close as possible to those of life itself, i.e., with the eyes opened in front of diverse and changing situations. (1954, 433)

Of course, these conditions were not life itself but a cinematic representation of it. In fact, the film presentation was seen as a surrogate reality not a unique visual stimulus in its own right, a disregard for medium specificity in common with many neurocinematic experiments of the present day. Gastaut's main observations relate to already intriguing changes in brain patterns between different sequences in the films shown,

> In contrary to the resting records taken with the eyes closed, which on the whole are rather stable, records taken during the projection of a neutral film show, except in cases where desynchronization is persistent, a continuous transformation of cerebral activity, one may say a constant adaptation to a moving situation. (1954, 439)

These findings are perhaps as one might expect given the richness of the visual stimulus. However, his paper also provides helpful evidence from the photic stimulator of 'occipital "driving"'. As well as the sequence of news items, subjects were exposed to photic stimulation at all frequencies between 1 and 24Hz. Gastaut found that 'characteristic occipital driving occurs only for stimulus frequencies below 15 flashes/sec.' (1954, 435) While Gastaut himself felt that this precluded direct influence from the 'frequency of movie images' which he stated, probably erroneously, as 24Hz (1954, 442), clearly, when considering the flicker frequency of projections in the early cinema period, a rate of 15Hz or lower is entirely plausible. EEG research into brainwaves has uniquely occurred in the period of the classical cinema *dispositif* and where resemblance to cinematographic media have been noted it has often been assumed to be operating at the iconic 24 frames per second. Acknowledgement of the doubling and trebling of flicker frequency with multiple blade shutters is rare; and of the non-standard and lower frame rates of early cinema even more so.

For example, a recent psychophysical investigation of the speed of visual perception, based not on EEG but on analysis of responses to the wagon wheel illusion found that, 'the sampling rate used in processing motion is about 16Hz.' The authors commented that

> cinema films may achieve their realism by using a frame rate – 24Hz – close to the native sampling rate used by the visual system (note that cinema superimposes additional whole field flicker onto the display). (Simpson, Shahani, & Manahilov, 2005, 25)

As with Gastaut, the import of these results would benefit from an understanding of the distinct specifications of early cinema in which the rough standard of 16fps and a single blade shutter can be seen to be in greater sympathy with human visual processing and cognition than later sound cinema, usually operating at the much higher frequencies of 48 or 72Hz. Both the potential synchronization or nudging of brainwaves by the flicker rate and the similarity to the visual system's 'native sampling rate' are implicated in this way.

The question remains whether flicker, when embedded in the already complex stimulus of a motion picture as opposed to the simpler stimulus of a laboratory study, is still a powerful enough phenomenon to influence brainwaves. In order to address this question and with the assistance of colleagues in neuroscience, I conducted an EEG study of the occipital lobes of subjects watching short samples of early cinema content.[173] Two conditions were presented, one in which the

[173] My thanks to Stephen Hall and Edward Rhodes of Plymouth University for their invaluable support and assistance with this study. The planning of the study is discussed in Edmonds, (2016). A

content was delivered by a hand cranked 35mm projector operating roughly at 16Hz, and the second in which it was presented by a typical modern high definition video projector which had a flicker signature of 120Hz due to its use of a colour wheel. As expected, the results showed cerebral activity across all participants in the register of the operation of the film projector but not the video projector. In one out of the 11 participants in the film condition there was a good match for the visual EEG and light sensor data with consistent pairing across film clips around 15-16Hz. While far from conclusive, the results at least showed that such flicker sympathy in film experience is more than a theoretical possibility.

Conclusion

Early cinema with its non-standard technology and variable frame rates under the control of the operator represented a continuous negotiation of the parameters of flicker, as it flashed 'on and off inside our consciousness.' (Anděl & Szczepanik, 2008, 90) To harness the flow of the 'vibrating existence', to manipulate and control it, to ride its waves, would have become part of the contested 'art' of the operator.[174] This role would have been shaped not just by considerations such as adherence to lifelike movement, and respect for the emotional content of scenes, but less consciously considered input responding to the direct stimulus of the

secondary project to re-contextualise the EEG data in a live theatrical screening of early cinema is discussed in Edmonds & Lewin, (2017). Both texts are included in the appendices of this volume.

[174] I am proposing an extension of the acknowledged role of operator in selecting a speed for projection which was artistically right even if not the same as had been used to photograph the film. See Barnard, (2002, 59). As Barnard shows the recognition of this 'art' was always threatened by the lowly status of the job of cinematograph operator.

flickering image. The operator's synthesis of these factors and developing skill at 'playing' their public would have been supplemented by the audience's own agency in self-administering the extent of flicker experience through the means open to them; selection of seating position, bodily shifting, and even the use of homemade viewing aids. There was a fine line (and an individually variable one) to draw between pleasurable flicker and alienating flicker but there remained a gap for exploitation in the right circumstances.

The multifarious inventors of cinema had stumbled upon a system that combined compulsion and repulsion. Logically enough, if there was repulsion there must also have been attraction and the possibility that certain combinations of pictorial content, mechanical technology and human moderated tempo could produce one or other response via the perceptual mechanisms of the audience, or indeed a more neutral state, must be acknowledged as a fundamental dimension of the experience of early cinema. In this form of cinema, the attractions were also the repulsions and indeed the attractions of the 'cinema of attractions', rooted in Eisenstein's notion of attraction as dangerously thrilling, already point, albeit more explicitly, to the internal tussle between the push and pull of variable flicker rates and intensities which may actually have tied spectators to a rollercoaster of attraction and repulsion.

Scientific discoveries throughout the nineteenth century, which revealed that behind what seemed to be seamless existence lay quivering pulsing patterns beyond the discernment of our senses, began to cross over into the consciousness of a wider public. Nothing was stable, everything was in flux. Against this cultural backdrop, cinema appeared as a new technology which claimed to perpetuate a likeness of the apparently seamless existence but which exhibited perceptible vibrations of its own. The fits and starts of the cinematograph made the hidden tremors of the world manifest and provided an analogy too apposite to escape the attention of such educated forward thinkers of the age, as assembled by Yuri Tsivian. Whether accorded this genial reception or the more familiar negative reaction, flicker was a key feature of the experience of modern life and as such should be integrated into our understanding of early cinema and its continuing performance.

4. Nuts and Bolts, Cogs and Cognition

Figure 2. Participants in the 'Bioscope – Object as text' workshop, Plymouth University, 29-30 March 2017

Introduction

This chapter continues the propositions of the introductory chapter by considering the technology of early cinema as a research resource in itself. It adds the physical remains of technology to the roster of available 'texts' and subjects it to a close reading in the light of our knowledge of human perception and cognition as discussed in chapter 3. In contrast to the case of the Veriscope examined in chapter 2, the Bioscope, which made use of the common 35mm film gauge, was a popular and widely diffused device that was manufactured in significant numbers, with multiple examples surviving to this day. However, whereas the Veriscope has left a rich paper trail of audience responses, reaction to performances involving the Bioscope has no such directly attributable first-hand commentary. It therefore makes a suitable case for the experimental recovery of its impression on audiences through the examination of the resource of surviving mechanisms.

The textual analysis of the 'nuts and bolts' of the Bioscope is carried out by means of both a material examination and a hands-on activation of a model made around 1900 and coincidentally very similar to the projector illustrated in figure 1. of the introductory chapter. The evidence thus acquired is then combined with an interpreted ordering of the existing information available in the contemporary written and illustrated discourse in order to place the machine in the wider context of its manufacture and development over time. This combined archaeological and philological research, shows how it is possible to look at early film technology and discern the traces of cognitive processes within the layers of a single object as well as series production, reverse engineering the design process and creative cognition that were involved in its creation. This tactic discloses a particular focus by the creators of the Bioscope on the operation of the shutter. While the design of the transport mechanism and intermittent movement remains more or less unaltered, the addition of a shutter to the initial design was followed by many changes to its location and form in what may be seen as continued efforts to gain control over the perceptual experience.

4.1 En route to an archaeology of audiovisual perception

Ideally this chapter would begin not with a photograph of the remains of Bioscope projector no. 537 but with the object itself because the sensual fact of the archival object is fundamental to the method which I wish to promote. That said, the photograph does include the presence of participants clearly engaged in a hands-on examination of the device. The photograph was taken during a workshop which had as its aim the investigation of a film technology object, as typically found in archival collections, and its return to operational condition. The intention was to combine a fairly literal archaeological analysis with a version of what has been termed Experimental Media Archaeology (Fickers & van den Oever, 2014). First assessing the material presence of the object and interpreting the signs it may carry about its history and use, before subsequently carrying out a careful recommissioning. The aim was to carry out an activation not a restoration. To leave its material state unaltered, so far as possible, but to enable it to re-establish its connections to human agency. To reconnect the flow of its feedback loop, broken by the inactivity and institutionalisation typical of many devices in museum stores.

In a blog post entitled 'Ah, the Nuts and Bolts', Charles 'Buckey' Grimm, engineer and film historian, perceives a new focus on the study of film apparatus within film archives.[175]

> When archives first broached the idea of film preservation, for the most part film itself was the object of our affection. It wasn't until much later that we realized the importance of this cinemachinery in the industry. (Grimm, 2007)

It is true that once film archives became established in the 1930s their focus was very much on film preservation, although the collecting of apparatus as a separate practice by a select few institutions and individuals pre-dated the first film collections.[176] As we have seen in the introduction, any apparatus collecting that did occur under the aegis of film archives was often incidental and uncoordinated. In contrast to Grimm's post, I do not personally think that the importance of this 'cinemachinery' has ever been fully realised within either archive or museum functions of FHIs and indeed it will not have been until its inter-dependance on the

[175] In the title of his blog entry and his reference to 'affection' and 'cinemachinery' – the mellifluous slogan of the Bell and Howell company – Grimm is probably alluding to the innate sensory appeal of the materiality of technical objects, at least for a certain type of individual. However, it is actually necessary to overcome this superficial appeal with its aesthetic bias in order to engage with the object as a piece of living evidence of the experience of cinema.

[176] The British national cinematography collection now at the NSMM began with a donation of equipment by Robert Paul in 1913. In 1922 it was joined by the loan of the Will Day collection which was put on display in South Kensington. (Latsis, 2016, 25)

film text and on the 'human actors' (Campanini, 2016, 254) has been truly integrated into its analysis. That is, until we can demonstrate the influence of 'the nuts and bolts' on our experience of cinema. The following two sections take up this challenge, looking in detail at the Bioscope, one of the most popular makes of projector in the UK in the early cinema period, and exemplary of the connections that can be made between film technology and spectator experience.

The intention is to seek out a cognitive trace of early cinema spectatorship in its physical remains and to recover something of the hypothesised heuristic approach of the massed inventors of cinema, the pioneers of film technology, film making and film reception. In fact, the 1899 and 1900 Warwick Trading Company (WTC) catalogues acknowledge the input of the wider community of Bioscope exhibitors and operators in its development.

> WE DO NOT STOP HERE but are adding to the BIOSCOPE such improvements and devices as may be found practicable after much experimenting from time to time. Many suggestions have been made by scores of experienced BIOSCOPE exhibitors and Operators (who all have ideas of their own) and whenever these are found practicable they are embodied in the machine, with the result that the BIOSCOPE is always Up-to-Date. (Warwick Trading Company, 1899)

The rapid cycle of production and evaluation and the easy assimilation of suggested improvements represented, according to the catalogue, 'a case of "Survival of the

Fittest".'[177] Considering that in his memoirs Urban also credited the stamina of the public for '"wading through" this early period of jumpy pictures with flicker on the screen and other crudities of this industry "in its infancy",' (Urban, 1999, 34) this approach to projector design becomes quite literally crowd-sourced. By carrying out an activation of the object in a workshop setting with multiple participants, as detailed in the next section, we can to some extent arrive at the inverse of the heuristic process which created it.

4.2 Material investigation and activation

In order to afford myself an example of the closest access possible to early cinema technology, I acquired, at auction in 2015, a reasonably complete Bioscope projector mechanism and an apparently operational Butcher's Empire Home Cinematograph Model A. It seemed to me necessary to have personal access to typical examples of early cinema technology given my ambition to research the role of technology in the experience of early cinema. This close access has enabled insights that would not have been available during a typical visit to a museum storage facility, however it has indicated how such visits might be improved or augmented by catering for workshop-style investigations, such as described in this section. The completeness of the Home Cinematograph made it a good candidate for use in running a comparative experiment on the experience of early cinema,

[177] In citing this phrase from popular biology Urban and the WTC, apply a biological metaphor to a mechanical device. The phrase was first coined by Herbert Spencer in 1864 and used by Darwin in the fifth edition of *On the Origin of Species* in 1868.

where it represented the 'original' condition in contrast to a modern digital video projector.[178] The less functional state of the Bioscope lent itself to a more limited activation: the detailed assessment of the object itself as evidence of early cinema practices. It is that process which I will discuss in this chapter.

When acquired, the Bioscope was partially disassembled and only semi-operational. In addition, although notionally complete, it was obvious that the lantern and base had been constructed at a much later date, probably in an effort to make a working machine. There is nothing unusual in a century old example of film technology presenting in this way. Even considering that the portion of it which was datable to the period of early cinema consisted only of the mechanism and spool arms, it was still more complete than many other examples, whether found in auction rooms or in museum collections. In fact, the degree to which the film projector in general is a kluge or collage of existing technologies is evident in the semi-dissolved state in which they usually survive, missing crank handles, spool arms, lenses, lamp houses, semi-superfluous rollers, and indeed, nuts and bolts.[179] Like the material of film itself, which over time stickily reverts to its molecular ingredients, projectors are often found in a disbound state, with only the central part of the mechanism, that which is most easily placed on a shelf, surviving into the present day. Analysis of the

[178] See appendix 2.
[179] See (Punt, 2003) for his description of early cinema as an exhibited kluge, 'an entertainment which began as a short term technological spectacle of a kluge of existing hardware.'

object must therefore consider its passage through time and apply a critical evaluation of its likely lacunae and excrescences.

In the case of the Bioscope, enough was present to consider aiming to return it to operational condition, initial examination suggesting that the mechanism would likely run again if the badly worn bevel gear on the shutter shaft could be replaced. This gear was made of a red-brown fibre material that may have been chosen to be a weak link in the mechanism, preventing damage to the entire drive train in the event of a jam, or possibly to reduce gear noise. Over time, its teeth had worn down to the 'gums' and it was no longer capable of transmitting drive. Parts wholly missing from the Bioscope included the shutter blade, the swivel base, the auxiliary lantern lens holder and, in common with every other known surviving Bioscope, the pneumatic light cut-off, a safety device which must have been decidedly unpopular.[180] Additional parts included an extra-long main drive shaft held at one end by a reinforcing bracket and equipped at the other end with a crude but ancient looking bicycle sprocket, transmitting chain drive down to another sprocket on the lower spool arm. Apart from the crude sprocket, the high quality and surface patina of this assembly gave the impression of being an early modification, perhaps even carried out by the factory, as the attachment of the bracket had entailed

[180] The difficulties experienced by Nikolaus Wostry with a similar device during his 2017 Il Cinema Ritrovato demonstration of a Wrench projector would seem to corroborate this view – see chapter 2. See also *The Modern Bioscope Operator*, (1911, 64) for a discussion of the device, 'The automatic cut-off may be said to be the most delicate part of the machine, and is in consequence very liable to derangement.'

machining of the main casting and had been carried out to a fine standard. It is likely a one-off example of changes to the initially light weight and modestly dimensioned projection devices that were introduced to cope with the audience's developing appetite for longer film shows.

As might be expected in a machine assembled around 1900, a certain amount of play was noted in the mechanism and in some gears more than others. The gears and sprockets were mounted on the shafts with drift pins, some of which appeared never to have been disturbed, while others had been removed and coarsely replaced.

Cleaning revealed subtle distinctions within the layers of the object itself. While presenting initially as an all over antique brown colour, careful cleaning began to distinguish between different finishes and materials. Brass sprockets and Vulcanite rollers took on individual character. The main body was revealed to have a smart livery of green enamel and gold lining, with the cast-in BIOSCOPE name also picked out in gold. Such attention to making an aesthetically pleasing object indicates that alongside its mechanical performance display was also a function and is thus a reminder, if it were needed, of the open *dispositif* of early cinema exhibition.[181]

Cleaning of some parts was facilitated by disassembly. This process also revealed actual alphanumeric texts within the 'text' of the object. While degreasing the dismantled brass beater and vulcanite roller, the number 37 was found stamped on one face of the beater. Similarly obscured when fully assembled, another number 37 was found stamped on to the rear of the lens holder plate. These numbers obviously corresponded to the visible serial number 537 stamped into the steel main body casting. They would have been used to distinguish between components during assembly in the workshop, the sufficiency of double-digit identification suggesting that production was therefore modest.

The close attention necessary for delicate cleaning also revealed details which observation might otherwise have glossed over. A particularly curious feature was the way in which the mounting for the shutter had been integrated into the main body casting. The two castings had been professionally joined together, seemingly at the point of initial manufacture, rather than at a later date, as at first glance and with the covering of original green paint smoothing out the joins, it appeared to be

[181] In this regard it is interesting to note the comments of Gage who declares a tension between the display of the apparatus and the display of the image particularly in regard to nickel and brass finishes on optical apparatus and advocates for dull black finishes (Gage & Gage, 1914, 7)

one casting. However, somewhat infelicitously, in machining an edge for the two castings to join together, the first stroke of the B of the cast-in BIOSCOPE lettering had been sliced off, leaving it reading 3IOSCOPE. Subjectively datable to early in its life, through a sensitive reading of its material condition, this contradictory combination of evidence of high level work and lack of foresight, or, at least, changed objectives, created an excitingly ambiguous moment while 'reading' the 'text' of the object.

Similarly, the large number of extraneous holes in the main body casting pointed to further anomalies and textual layers. Although easy to disregard on first inspection, being an absence rather than a presence, they were nevertheless incontrovertible evidence of interventions in the object's long existence. They indicated not only changes in the use of the object but also in its operators' intentions. Without reference to other sources they remained mystifying facts but once cross referenced with the illustrated discourse, specifically the 1899 and 1900 WTC catalogues, both the modifications to the casting and the supernumerary cavities could be accounted for. One pair of holes were placed in the exact position to betray the past presence of the pneumatic light cut-off, the ancillary device already mentioned that is only known from catalogue descriptions and illustrations. Another two pairs of holes drilled and tapped into the main casting near the upper sprocket corresponded exactly to the position of the shutter assembly bracket seen on the earlier versions of the projector in the catalogues. These models known as C, D and E were joined in the 1900 catalogue by a 'stop press' description of a new Model F, too recently evolved to be illustrated. However, the description of changes to the gearing and shutter position perfectly described the specification of no. 537. I will address the motivation for these changes in the following section. For now, it is enough to conclude the material examination of the projector by noting the satisfying concordance of two pieces of initially puzzling evidence present in one machine. Observation of the semi-provisional installation of the shutter assembly on no. 537, and the presence of what could be identified as fixing points for an early style shutter, unite to establish a narrative of the adaptation of an existing machine early in its life. In fact, the catalogues provide confirmation not only of these design changes but also that they were retrospectively available, modification of Model E to F, for example, being offered for £6 0s 0d.

In summary therefore, the full identification of no. 537 as a Bioscope Model F that had started life as a Model E required the discovery of copies of the 1899 and 1900 WTC catalogues.[182] They provided the solution to the anomalous evidence of the apparatus but the anomalies themselves provided the impetus to investigate in the first place, and to seek out further contextual information.

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[182] Copies of these catalogues were provided by Toni Booth, Associate Curator of Cinematography at the NSMM, to whom I am especially grateful. They were invaluable in solving the puzzle of no. 537's identity. The only copies known to me, they also happened to be Charles Urban's personal leather-bound editions.

The second aim of the workshop was to return the Bioscope to working condition and this required the restoration of drive to the shutter shaft. A direct replacement part was unsurprisingly not available, but an engineer was able to make a replica bevel gear in brass. The gear was fitted and brought into use during the workshop. Interestingly, if its drift pin was hammered home the mechanism tended to lock. However, with it fitted loosely, it ran well and the mechanism flowed into life. With the projector threaded with scrap film, workshop member, Stephen Herbert, proceeded to give the mechanism a full speed run, turning the crank at the rate of two turns per second.[183] He commented that he could feel the wear in the gears but that the beater movement had very good balance, adding, 'they remember what they're meant to do.'

The affordance of the crank handle was irresistible and once turned, setting the cogs and shafts in motion, provided an immediate demonstration of the relation of each component to the other, the drive and feed sprockets, the beater or 'dog' intermittent and the shutter all rotating in unison. It was also noted that the noise of the beater hitting the film was very emphatic and louder relative to the sound of the grinding of the gears.[184] It was fascinating how much more substantial a connection the immediate experience of an object provided than, for example, and at the other

[183] This was standard practice for camera and projector operators and equated to 8 frames per turn or 16 frames per second.

[184] Yuri Tsivian records a comment of Alexander Khanzhonkov who compared the noise of an Urban projector to a 'creaky farm cart'. (1998, 118) This is likely to have been due to the state of maintenance of a particular example rather than being exemplary of the inherent quality of the Bioscope.

end of the scale, that indistinct much photocopied image of the Nöggerath outfit. Although these components, with the exception of the shutter, are visible in the photo, they do not distinguish themselves from the mass of technology, unless specifically sought out. Equally, even a high-quality photograph or the sight of the object in a museum case may not distinguish itself to the intelligence of an untrained observer who must have prior experience of an object if it is to be allowed to 'speak'. In contrast, however, the physical interaction of an activation is enough in itself to establish a link between the machine and the modern-day workshop participant. Aside from attracting the interest of a much wider group of individuals, this process also affords a means of access to past experience via a triangulation of the modern-day crank-turner, the machine and the machine's first users. The hands-on examination and operation of the projector is a link with the likes of Hepworth operating the machine in the late 1890s and the process of working out how to restore it to operability is the reverse or reciprocal of the process of creation enacted by its first developers.

This was a limited activation going only so far as to return the mechanism into operating condition and not the whole projector. An initial exploration of adapting the lamphouse to LED light source was carried out, but this would have to be further developed and a new shutter fabricated in order for a film to be successfully shown. Although, within the resources of the workshop, we had not achieved a full creation of a cinema experience, this brief resuscitation and hands-on examination of an apparatus of early cinema had not only re-established a link with its earliest exponents but also sharpened the senses and set the questions for the next phase of the investigation: the comparison of different models using both written and illustrated contemporary description and photographic evidence of other surviving mechanisms. It provided training to be better able to interpret the evidence provided by the catalogues, to which access is less privileged. It also sharpened the senses to the significance of differences seen between one mechanism and another. In that sense, one type of enquiry is a preparation for the other and the potential of either limited if not carried out in combination.

4.3 A philology of Bioscopes

Both before and after the investigation described in the previous section, research into the written and illustrated discourse, as well as other surviving models, provided valuable contextual detail. The scattered nature of sources in fact makes this still a work in progress. Promotional material and instruction manuals indicated dating of circa 1900 for the Bioscope and 1920 for the Home Cinematograph. Seeking the existence of comparable models using internet-based research revealed that while the Home Cinematograph, though uncommon, was far from unique, the Bioscope differed from all other surviving models which could be discovered in both private and public collections. What's more, each of the eventual

24 examples that were assembled for the dataset of the philology differed in at least some details, one from the other. See table no.1[185]

Even assuming that some differences could be attributed to the wear and tear of hard, long lives of use, repair, neglect and, in some cases, restoration, there were sufficient variations in fundamental design to be intriguing. The pictorial record of handbooks, sales literature and photographs corroborated many of the changes introduced over the period which the surviving corpus represents, roughly 1897–1910. However, not all changes were evidenced in the surviving mechanisms and the fact that no two machines were identical suggested a high level of improvised activity at the stages of design and manufacturing. In contrast to later mass production of machines such as the Home Cinematograph, the variety within the

[185] This listing is a work in progress and should not be seen as a complete record of surviving Bioscopes. I have only included examples where sufficient is known to be useful and photographs have been available. Interpreting this information with reference to surviving catalogues, I establish a suggested chronology to which both the evolving features of the design and known serial numbers conform, although the naming conventions are seen to fluctuate. The one exception to this is no. 802, which would seem to be a Robert Paul marketed Model K that could plausibly have utilised a different numbering series, that of Paul's own products. The earliest examples do not have serial numbers but those that do are all placed in the same position on a boss to the upper right of the gear-train side of the chassis casting. The unstable naming of the device, which paradoxically forms an indivisible part of the heft of the main casting, indicates some hiatus around the ownership of the design and the control of manufacturing and sales which is corroborated by existing research into the fraught business relationship of Charles Urban and the Warwick Trading company (See Brown 1998). Although confusing to the modern eye, it would not have been difficult to make small batches of castings with different lettering. White metal lettering would have been applied to the wooden pattern and was supplied direct to industry. See, for example, (H. W. Knight & Son, 1927). In compiling the list, I have only given a place to those devices which are connected to companies controlled by Charles Urban. For example, after the split with Urban in 1903 Warwick continued to produce Bioscopes to a slightly different design, possibly under the manufacture of Robert Royou Beard. These and many others, adopting various forms of the un-copyrighted Bioscope name, can be seen to form branches of a wider Bioscope genealogy which I do not explore in the present philology. This wider context has to some extent frustrated previous attempts to summarise production, notably by Barnes (2002) and Gardiakos (2011). This present list aims to build on their researches, to which it is indebted. John Barnes' unpublished draft report was made available to me by Stephen Herbert, to whom I register my thanks. Gardiakos' researches are privately published online. My thanks also to Nick Hiley and Chris Bird for contributing to my search for surviving Bioscope mechanisms.

cat no.	ser. no	cast-in name	location	model
1			Museum Victoria	C
2			S. Gardiakos	C
3			David Hatton	E
4			CF	E
5		Bioscope	Christies 1996	E
6	502	Bioscope	anon NL	F
7	537	Bioscope	GE	F
8	802	Bioscope	François Lemai	K
9	904	Warwick Bioscope	Museu del Cinema	H
10	910	Urban Bioscope	Tekniska Museet	H
11	917	Urban Bioscope	Christies 2006	H
12		Bioscope	Norsk Teknisk Museum	H
13		Bioscope	NSMM	H
14	940	Warwick Bioscope	anon UK	H
15	984	Urban Bioscope	Antiq-Photo 2019	H
16	1051	Urban Bioscope	Christies 2003	H
17	1061	Urban Bioscope	Cinegraphica	H
18	1142	Urban Bioscope	S. Gardiakos	H
19	1185	Urban Bioscope	anon UK	H
20	1295	Bioscope	Nick Hiley	H
21	1331	Urban Bioscope	MOTAT	H
22	1351	Urban Bioscope	GE	K
23	1369	Urban Bioscope	NSMM	H
24	1550	Urban Bioscope	anon AUS	K

table no. 1 Surviving Bioscope projection mechanisms

existing Bioscopes seemed to indicate a low volume boutique operation that could adapt swiftly to change. This intimation seemed somewhat counter to the status of the Bioscope as the most successful projector of the period in Britain, although both propositions are not necessarily mutually exclusive.[186] In fact, as will become clear,

[186] John Barnes records its advent in 1897, writing that 'it was to have quite a phenomenal success perhaps more so than any other machine for the next decade'. (Barnes, 1996, 155) and McKernan notes that, due particularly to its use by fairground showmen, the Bioscope's influence was such that its 'name became a generic term for cinema before there were such things as cinemas' (McKernan, 2014, 22). In terms of numbers produced the 1907 CUTC catalogue states, "2000 Urban Bioscopes

its widespread success can be put down to the solid initial design attracting modifications from a wide variety of individual collaborators. As such the surviving mechanisms become a record of a surprisingly large network of distributed cognition.

The historical record of the Bioscope begins in February 1897 when Charles Urban in New York paid Walter Isaacs for his work on building the prototype. (Brown, 1998, 23) Urban claimed to be the inventor of the Bioscope and it is his name that is most frequently attached to the long line of iterations which he would be responsible for selling under various trading identities for the following decade and more. However, it is more accurate to conceive of Urban as a collector and sponsor of engineering talent, who possessed enough intuitive grasp of the issues – acquired through practical experience as an operator - to commission and collaborate with engineers.[187] Urban's patronage of Isaacs, the first of these collaborators, lasted only for the initial batch of 50 projectors but, using the Bioscope as his calling card, Urban joined the New York office of Film Agents Maguire and Baucus, partly on the strength of the new machine, before taking over

also in use in every land" It may be taken as a given that Charles Urban, assuredly one of the era's greatest salesmen, would not have under reported the numbers sold. Production totals were regularly reported in Urban's catalogues: 400 in 1899, 600 in 1900, 1100 in 1905/6. The leap to 2000 in 1907 does not ring true, considering both the 1905/6 figure and the serial numbers of surviving models.

[187] see (Barnes, 1997, 94) for a report of Urban operating the Bioscope for a half hour benefit show at the Croydon Camera Club. Urban had also gained hands-on knowledge of the mechanisms of the latest media technologies through his management in the US of a phonograph business and Kinetoscope parlour. McKernan states that the phonograph was particularly sensitive device and that Urban was one of the few to make a profit with them because of his ability to keep them well maintained on behalf of his clients. (McKernan, 2001) One wonders, in fact whether because of his obvious talents as a salesman, his technical know-how has been underestimated. In the same article, McKernan provides a list of collaborators, and also describes Alfred Darling as Urban's regular engineer. However, Darling worked on producing the Bioscope camera rather than the projector.

as managing director of their London office in August 1897 and sending at least some of the Isaacs-made projectors across the Atlantic ahead of him. The design of this first version of the Bioscope would appear to be derived from Georges Demeny's 1893 patent for a camera because it shared, at its heart, the 'came battante', the means of intermittent movement known also as a 'beater' or 'dog'.[188] Although the patent didn't envisage its use in a projector, Demeny's precedent was acknowledged by projector makers, especially Urban and Gaumont who became official licensees of the patent at a later date. Demeny's patent describes the simple but effective action of the beater movement which would remain a consistent feature of the Bioscope until the mid-teens when the more sophisticated design of the Maltese cross took over the professional market.

> The bobbin D1 which takes the film after it has received the exposure instead of being coaxial with the shaft d on which it turns is fixed on a pin E1 extending eccentrically from this shaft, so that when the shaft d is turned with regularity the film winds round the bobbin D1 with a variable speed which becomes nil at a certain point. It is exactly at this moment of stoppage of the film that the opening f of the shutter disc B comes opposite and passes the film. (Demeny, 1894)

Fundamentally enough, Demeny's camera synchronises the stoppage of the film with the opening of the shutter. Remarkably however, the first Isaacs-made

[188] It is also possible that Edison's Vitascope which also had a beater movement, and with which Urban had toured Michigan in 1896, was the inspiration, although Brown, (1998) thinks this is unlikely due to Edison's propensity for 'pursuing infringers of his products'. I am inclined to believe that the design of which he had personal experience would have been the most influential. These two potential sources for the initial Bioscope design certainly seem preferable to Charles Musser's assertion that, 'Charles Urban who had had a phonograph parlour in Detroit and later toured the Midwest with a projector, had Walter Isaacs manufacture a modified Lumière cinematographe and then sold it as a bioscope.' (Musser, 1994, 168)

Bioscopes did not reciprocate this arrangement, doing without a shutter entirely. At this early moment in film exhibition there was still debate as to whether the flicker introduced by the shutter was preferable to the ghosting produced by an exposed-to-view pull-down. The claim for this first iteration of the Bioscope was that the speed of its pull-down, taking place eight times as fast as the period of rest, was sufficient to overcome the ghost or rain effect. To our modern sensibility this may seem like arrant nonsense, and yet this trace of a negotiation between two undesirable effects illuminates a fascinating moment in the evolution of projection technology as it was in the flux of live development with its 'human actors'. For some months in 1897 it was a reasonable proposition to build a projector without a shutter and even advertise it as a feature of the design. Amongst the '20 essential features' of the 1897 Bioscope, two were characterised thus.

> Clearness – Flicker entirely eliminated. No strain to the eyes of an audience.
> […]
> No Flicker – The shutter is entirely dispensed with, consequently 25 per cent. more light on screen. (Bioscope advert, 23 September 1897)

It is as though at this moment the constancy of luminance might have won out against the constancy of movement. However, what one can hypothesise as the combined feedback of customers, audiences, and the Bioscope's own makers took cinema in a different direction, one which uneasily embraced the 'necessary evil' of the shutter and the flickering image it produced as the least worse option. One of the intelligences exposed to this first model Bioscope was young British film pioneer, Cecil Hepworth. He was an early adopter of the Bioscope but had no truck with the absence of a shutter.

> Charles Urban had just come over from America bringing with him a new projector mechanism called the 'Bioscope,' which was of good and substantial design. It was reputed to be flickerless, which it was—because it had no shutter! But a shutter is absolutely necessary in order to cover the momentary change from one 'frame' to the next. […] without any shutter at all the 'rain' on the screen is far worse than any flicker—the whole idea was a bad mistake. I bought one of these otherwise excellent mechanisms, fitted it with a shutter, a 'gate' which did not scratch the films, and a 'take-up' to rewind them as they came from the machine, instead of letting them fall into a basket or on to the floor, which was the very reprehensible custom of the time. Then I adapted the machine to my change-over device and I had a good and reliable apparatus. (Hepworth, 1951, 32-33)

Hepworth's improvements were so thorough that Urban ordered more conversions from him and then offered him a job at Maguire and Baucus. None of the original shutter-less Bioscopes are known to exist, suggesting that nearly all would have been converted to include shutters and that, like Hepworth, early audiences had a decided preference for 'flickerscopes'[189] rather than rain or ghost machines. The earliest surviving Bioscopes (numbered 1-5 in the list) share a design of shutter assembly which betrays its origin as an afterthought, with the drive shaft and its support attached to the main casting with screws. Of the five surviving mechanisms with this earliest type of shutter assembly, two have a body casting that has an L shaped base and three a presumably later ⊥ shape. While Soterios Gardiakos (2002) thinks that the L shaped base indicates manufacture by Isaacs in the US, illustrations

[189] The phrase is taken from a Paul catalogue: 'What a Great Mechanician thinks of the Animatograph." I thoroughly tested and examined your new machine and I consider it the best on the market. It is infinitely better than the 'Flickerscopes ' now in general use." (Signed) J. N. MASKELYNE.'

in the 1899 Warwick Trading Company catalogue depict the Model C Bioscope as still having this early type base, along with the 'afterthought' shutter assembly and an adjustable four-bladed shutter. Also mentioned, but not illustrated, in the 1899 catalogue is a Model D which incorporated a revised lens mount and masking device that prevented the projected image moving up and down on the screen when the racking was adjusted. There are no known references to Model A or B Bioscope projectors, although the designation, '97 or '98 is sometimes used to distinguish those made before the Model C specification.[190] By the publication of the 1900 catalogue a more extensively revised Model E had been added to Warwick's offering. It featured a pneumatic anti-firing device driven from a flywheel added to the beater shaft, a hump in the film gate to prevent buckling and a different, though still four-bladed, shutter. It had also undergone a change of livery, from black to green enamel.

The earliest surviving models which all carry the initial shutter are thus a spread of Models C, D and E. At some point, after the first four were made, the word BIOSCOPE was added to the casting, as seen on the fifth known example. It was at this point that a photograph of the Prestwich works would have been taken.[191] Given that Bioscope production was now taking place in Tottenham, the influence

[190] Model A and B designations were however used for Bioscope cameras and so WTC may have started projector model names at C to avoid confusion with their camera range.
[191] Two photographs of the works appear in the 1900 WTC catalogue showing machining of the steel castings and assembly of the mechanism. The photographs appear unchanged again in the 1903 CUTC catalogue. See Barnes, (1997, 92).

of J. A. Prestwich on design aspects must also be considered so that authorship of these early Bioscopes is already distributed amongst Isaacs-Urban-Hepworth-Prestwich. However, the greater influence may rather have been on Prestwich's own machines which adopted many of the utilities advanced by Hepworth as well as emerging from their attractive but impractical mahogany enclosures. Indeed, the multiple changes to the Bioscope introduced by showman-pioneer Hepworth were obviously rooted in its practical use. For example, his idea of a swivel base which facilitated rapid change over between film and lantern slides; from moving to still images, and vice versa, was adopted by nearly all other projector manufacturers. The extensive changes referred to by Hepworth in his autobiography seem to map exactly the specification of the Model C as outlined in the 1899 catalogue.[192] The changes are also enumerated by Hopwood, who may have been using the same source, in his 1899 summary of 'this season's Bioscope'. No credit is given to Hepworth in either source. The description of the shutter itself is most interesting.

> an adjustable shutter is provided, shaped as a four-armed cross with narrow blades, each of which acts as a shutter. These arms are so narrow, and the shutter is so exactly placed at the most condensed portion of the beam of light, that it fully effects its purpose without giving rise to perceptible flicker. (Hopwood, 1899, 133-4)

This type of Model C shutter also corresponds exactly to that of the extant Bioscope in the Museum Victoria. This should be considered as an exceptional survivor, as no component is more vulnerable to damage and exchange than the shutter which was

[192] See four views in the 1899 WTC catalogue as well as an alternative view in the Butcher's catalogue of 1900. (*Butcher's Catalogue of Lanterns 1900*, 1994)

of necessarily lightweight construction, often fixed in an exposed position and even designed for quick replacement. The only other known Model C Bioscope has a roughly made replica shutter and a majority of mechanisms are found with either none at all or later made replacements.

I will look more closely at aspects of shutter design in the following chapter. For the moment, however, I wish to note that the specification of the shutter is of course fundamental to the perceptual effect it creates and seeking out evidence of the conditions of the initial reception of moving images therefore requires close attention to original shutters. In comparison to later simplified designs, that originally fitted to the Model C is noteworthy for both its number of blades and their variable width. The variability implies awareness of the conditions of projection and speaks to the need to give extra controls to the operator in negotiating the evils of flicker, ghosting and dimness. It shows that debate over shutter design was well underway but as yet unresolved.

In his 1897 book, which must slightly predate his modifications to the Bioscope, Hepworth describes a number of experiments with shutter design which led him to conclude that 'different forms of shutter are suitable for different classes of picture' (1897, 54). It is significant that the empirical observations of owner-operators such as Hepworth had noted such a distinction as it is no longer generally recognised that the perception of flicker is related to film content, although this is certainly the case given flicker's relation to luminance: flicker will be much more apparent in light areas of the picture than in dark. The lack of recognition for this fact is due to our almost universal experience of moving images mediated via technologies which have a high flicker fusion frequency. However, the heterogeneous devices of early cinema projection would have been operating at much lower flicker frequencies and with some parts of the picture apparently flickering more than others due to variations in brightness in different areas of the image. In the case of very short films, consisting of only one shot, it made sense to factor in an assessment of the film image in terms of its light and dark elements when considering strategies to control the perceptual impact of the film. Having a shutter with blades of variable angle would enable the operator to choose, on a film by film basis, the point at which travel ghost and brightness were in optimal balance – where the effect of ghosting was tolerable and brightness was most impactful. As films became longer and inevitably more varied in pictorial content this advantage would have become negligible.

As Hepworth doesn't describe the type of shutter that he fitted to his Bioscope, we cannot assume that it was of the four-arm variety seen on the Model C and D of 1899 and continued with minor changes on the Model E of 1900. If it was of a Hepworth design, then it would have been a continuation of the experiments he describes in 1897 and carried out on an unspecified machine with a 3 to 1 pull down and a shutter with a single blade of 120-degree sector. The rapid 8 to 1 pull down of the Bioscope would have allowed a much narrower blade of 45 degrees. The decision to make a shutter of four such blades could well have been an extension of Hepworth's earlier experiments but the excursion into multiple blades is more likely to have been dictated by the need to take drive for the shutter from a convenient place, a bevel gear on the upper sprocket shaft being the chosen spot. This would have dictated the speed the shutter could revolve and this in turn the number of blades required to cover the pull down of successive frames. While later shutters were usually geared to make one revolution per frame, it is likely therefore that the first two shutters seen on Models C, D and E were revolving at a rate of one per four frames and that, as Hopwood says, each blade acted as a shutter. This is important to work out because without such data we cannot establish the likely flicker frequency of each device and any consequent effect on the spectator. Later developments in shutter design deployed multiple blades within a single frame cycle, where only one of the blades functioned as a mask for the pull-down, the other two or three being used solely for doubling or tripling the flicker frequency. We could therefore misconstrue the initial appearance of these early 4 bladed shutters to suggest a very high 64Hz flicker as opposed to the likely 16Hz.

The next significant changes are not illustrated in catalogues, existing solely in the fabric of Bioscopes no. 502 and no. 537 and an image from the journal 'Der Artist' from 7 Feb 1904 in which an identical projector carries a single bladed shutter of approximately 90 degrees. They are however written up in the 1900 WTC catalogue as the 'Improved Bioscope Model F', available from April of that year. Apology is made that 'Owing to the advanced stage of publication […] we were unable to have illustrative blocks of the New Model made in time for insertion therein.' (Warwick Trading Company, 1900, 14)

Two changes are described. The first involves new types of clutch rollers that mean fewer perforations are engaged on the sprockets and therefore permits a greater range of film types to be run through the mechanism without damage. The second is proclaimed thus

> A further great Improvement –
>
> Has been made by altering the gear of the shutter and using 1 blade instead of 4 (as in the previous Models), which facilitates a greater speed during change of picture in covering the movement of film,
>
> … Thus reducing the flicker to absolutely Nil,
>
> While in reproducing pictures which have been taken too slowly, and in order to convey natural movement in the subject, and must of necessity be reproduced slowly, the flicker is greatly reduced as is also the case with films in which there is a great amount of sky or other transparent sections to the picture. (1900)

By removing the limitation of the low gearing of the previous designs, the Model F had thus attained a one rotation per frame shutter that was less of an afterthought. The shutter would now travel four times as fast and was closed for only a quarter of its cycle in place of the half of the previous version. The change is further evidence of the Bioscope's developers' attention to the problem of flicker as well as their awareness of its dependence on photographic content, as seen in the similar comment by Herbert Maclean, cited on p.174, and also published in 1900. The quotation from the Warwick catalogue also provides interesting evidence of a phenomenon of early cinema where projector operators would have to compensate for undercranked cinematography by similarly undercranking the projector and thereby running the gauntlet of exposing their audience to increased flicker. This reveals another decision point for the operator: the choice between noticeable flicker and unrealistic movement.

Although the description above is helpful evidence, this change is rather more evident from the active inspection of no. 537 and its rapidly rotating shutter shaft. Additionally, the alterations to the gearing and the shutter described in the catalogue can be seen in more detail. The new assembly for mounting the shutter has shifted position to be level with the lens and has been incorporated into the other side of the main chassis casting. The first designs had placed the shaft for mounting the lens in this space which had been vacated by the lens mounting introduced on the Model E. The new shutter shaft takes its power from the central linking gear in the train, rather than the upper sprocket as on Models C, D and E. As discussed in the previous section, the physical evidence of no. 537 shows that these modifications were carried out on existing castings of the ⊥ shape with the BIOSCOPE name and rounded top, the extra appendage of the repositioned shutter assembly being professionally joined, before final painting, to the earlier main body casting.

The rapidity of the Bioscope's evolution up to this point, the introduction of the Model F in 1900, is remarkable and it is not surprising it has never been successfully traced before, given the necessity of unearthing both the 1900 catalogue and a surviving example.[193] The confusing nature of the physical evidence with traces of this evolution left in single machines as well as across the spread of surviving examples, is amusingly matched by the virtual inability of WTC itself to keep up with the changes, as witnessed by the narrative of the 1900 catalogue, in which the improvements to the Model E are proudly described in detail before the announcement on page 14 that is it being withdrawn in favour of the 'Improved Model F.'

By the time of the manufacture of the next known example, no. 904, these somewhat provisional modifications have been assimilated into a redesigned main body casting that incorporates the changes to the gear train and shutter position while taking the opportunity to make a much stronger fixing point for the top spool arm, in the process losing the distinctive rounded top of the earlier models. This change accommodated larger and heavier film reels which in turn indicates a

[193] I refer here to the previous attempts of Barnes and Gardiakos to establish an evolution of Bioscope design, neither of whom were aware of the existence of the Model F.

practice of longer programme length. The public's appetite for increased screen time can itself be partly credited to the technological changes which made the experience more comfortable as well as increasing familiarity in general. These changes are documented in an illustration in the November 1903 catalogue of the newly established Charles Urban Trading Company (CUTC).[194] The fact that they portray the first fully new chassis casting since initial production may reflect the substantial changes behind the scenes and even a change of manufacturing partner. In February 1903, Urban had left the WTC in order to set up on his own and escape a deteriorating working relationship with Maguire and Baucus. From this point on, Bioscopes were produced by both Urban at CUTC and Warwick, under new management. The designs diverge slightly and in the philology I follow the development only through the CUTC, maintaining the link with Urban and his various collaborators.

The flamboyant 1903 catalogue going by the title, *We put the world before you by means of the Bioscope and Urban films,* is testament to Urban's confident salesmanship. The full scope of the CUTC product range is set before the reader, including the extensive film catalogue as well as the technology required to shoot, produce and exhibit films. A detailed description of the specification of the new

[194] In fact, the 1903 illustration and description is still in use in the 1907 and 1910 CUTC catalogues, alongside other illustrations which depict newer designs. I believe this is due to inertia in the publishing process rather than indicating deliberate concurrent availability of earlier and later designs. It should be noted that the Model H designation only appears in print beginning with the 1907 catalogue. In the philology, I have related it back to all models of the design first appearing in 1903.

Bioscope for the first time includes mention of a special two-bladed shutter which balances an opaque blade with a translucent violet blade. This would appear to be the same 90-degree sector opaque blade as seen on the interim model with a narrower translucent violet blade positioned opposite and secured in place by a brass fastener also performing duty as a balance weight. This type of shutter survives on no. 904 and no. 1051 though crucially without the intriguing violet blade. In fact, the only known material evidence of such a blade is a fragment of violet plastic found sandwiched between the brass flanges of the shutter boss on no. 1351. This mechanism, which I acquired about a year after no. 537, is a later model K dating from 1908 or later but it too was offered from new with the violet blade which by 1910 was now named 'Anti-Flicker Shutter'.[195] Indeed, it was still advertised in CUTC catalogues as late as 1914, alongside the new Silent Knight projector with Maltese cross intermittent and three-bladed shutter – equipment which would become standard specification for showing silent-era film for the rest of the century.

This special shutter is significant for its translucency and its colour as well as the fact that it has been entirely ignored by film history. Experiments with translucent blades are already mentioned by Hepworth in 1897, though the introduction of colour appears to be a new tactic. The choice of a violet tint would probably have been

[195] The dating of no.1351 is partly based on the presence of a plaque giving the address of Urbanora House, Charles Urban's headquarters in the Soho district of London which were newly opened in 1908.

made on empirical grounds but significantly also corresponds to the results of flicker experiments carried out by TC Porter. In 1898, he published the results of his first experiments with a white and black sectored disk illuminated firstly in white light and then the individual colours of the spectrum. He was able to show that

> there is a very great difference in the rates of rotation necessary for the disappearance of flicker in the different parts of the spectrum, the speed for the yellow being very nearly double that for the violet. (Porter, 1898, 349)

He confirmed these results in his paper of 1902, where he further stated that the finding 'depends solely on the luminosity of the colours, and not on their wave frequency.'(Porter, 1902, 327) In other words, violet has a CFF of 16Hz compared to yellow at 32Hz because it is less luminous, not because it is violet.[196] These findings were logical in that they followed the different brightnesses of the individual colours and would mean that the violet tinted anti-flick 'fishtail' could well have contributed to limiting the perception of flicker, although one wonders too what effect it may have had on the increasing number of films that were themselves tinted, toned or stencil-coloured.

By machine no. 984, one further change to the chassis casting takes place in which the gear train is modified and the shutter position shifts again, now below the lens and held further away. At this point, which would appear to be around 1906, the

[196] Interestingly, there is later scientific evidence that, irrespective of luminance, flicker-fusion occurs at much lower frequencies for the blue-sensitive mechanism of colour vision than for the red or green-sensitive. See Brindley, Du Croz, & Rushton, (1966)

Bioscope has finally settled on the form it will have until superseded by more elaborate designs intended for permanent installation in the purpose-built cinemas of the teens.[197] After nearly a decade of development its chief components have found a degree of equilibrium and indeed the Bioscope Model K on offer in the 1914 Urbanora catalogue is of this same pattern established eight years earlier, which, given the rate of change in its design in its first decade, represents a remarkable turn to stability in the second half of its commercial life. The only major changes introduced from the Model H to the Model K concern extra safety or 'anti-firing' devices. These were significant improvements but they did not require modification of the chassis casting. They were developed and patented by John Harris and Henry Joy, additional engineering talent brought in by Urban and co-opted to the cause of Urbanora.[198] These mechanical changes would have had no effect on audience perception, although given their Urban-assigned soubriquet of 'PP – Panic Prevention', a calming effect on spectator's nerves was implied.[199]

In drawing attention to the shutter's journey around the body of the Bioscope, it is important to acknowledge the prosaic but fundamental need to avoid contact with the operator's hand. The arc described by the operator's hand on the crank and

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[197] This form of chassis casting is first seen referred to as the 1906 Model U, 'Cheap Model' Bioscope.

[198] Urbanora House, Urban's purpose-built headquarters in the heart of London's Soho was opened in 1908. In the same year the young William Vinten, cinematographic engineer and eventual founder of the company of Vinten Ltd., joined the in-house expertise and was put in charge of the engineering workshop. (Sansom & Vinten, 1993, 5)

[199] Film industry professionals felt obliged to accommodate contemporary concerns about nitrate fires despite often characterising them as hysterical over reaction.

another hand on the focus and framing controls put a large area of the machine off limits to the rapidly revolving *blades* and may well have been the motivating factor behind its initial peripatetic existence. Nevertheless, there would have been an ambition to keep the shutter as close to the lens as possible in order to increase the efficiency of the cut-off and this perceptually motivated criterion would have been in opposition to the need to protect manual access.

The specification of the shutter itself is of rather more consequence than its position. It's speed of rotation, number of blades, their width, transparency and colour were all taken into consideration and put into live practice within the first five years of production. For the next ten years Bioscopes were apparently supplied with a two-bladed shutter one blade of which was tinted violet. None of these material practices have however been taken into account in the presentation of early cinema since the mid-teens. Their effect on the experience of watching such films can only be guessed at.

4.4 Hands-on: engaging with apparatus collections

It will be noted from the preceding sections that points of historical value were gained by the almost forensic inspection of the actual remains of Bioscopes no. 537 and no. 1351. This approach was possible because of the absence of sensory limits to the investigation. Licence to freely handle and even dismantle the devices was therefore crucial and obviously only permitted by the privilege of ownership. Given the contingent nature of their acquisition, it is highly unlikely that they are the sole repositories of such evidence, rather, it implies that further valuable insights could be obtained if such an approach were to be taken with other surviving mechanisms.

The motivations for the design changes detailed in the above philology and observed in both the material fabric and largely pictorial record of Bioscopes would be more apparent if it were possible to compare surviving mechanisms with one another and witness them in operation, having where necessary restored them to original configurations. The practical issues preventing such a comparison make the present work necessarily incomplete but, given that it is a theoretical possibility, it is important to consider as an extension of this chapter's methodology. In all likelihood, no such comparison has occurred since a new model was first submitted to a test screening, as one might imagine, in the company of its designers and valued clients in the offices at Warwick Court. We do not know the specifics of testing procedures but my supposition is that it was a heuristic process, a back and forth between observation and evaluation on the one hand and design and manufacture on the other. Hepworth's casual summation of his experiments with shutter design is the best contemporary evidence of such a process and it seems likely that a similar process would have occurred at WTC and CUTC, though involving the input of a small group of people rather than a single individual: a group consisting of business partners such as Hepworth and Prestwich and the showmen and operators generously given credit in the 1899 and 1900 catalogues.

The proposed evaluation of restored mechanisms would seek to reverse engineer this creative process of the designers and their user group as well as the literal engineering. An obvious example from the evolution of the Bioscope would be the comparison of the four-bladed Model C and E with the later single-bladed machines.

Such a theoretical project of comparative assessment would seem to be the logical implication of the several significant collections of early cinema apparatus. It would be an extension of the high-water mark of aspiration, as cited in the introduction in the words of Jean-Pierre Verscheure, to have a working collection in which it was possible to show any film using technology appropriate to its original sound and image formats.

In this regard, it is worth considering the vast collection of machines assembled by the brothers John and Bill Barnes and ordered, along with the evidence of much printed discourse, into the five volumes of *The Beginnings of Cinema in England*. From 1963 to 1986, the brothers exhibited many objects from their collection in their own Museum of Cinematography in St. Ives. (Gray & Herbert, 2008) Well before the advent of media archaeology, the Barnes' work was recognised as an archaeological project. A reporter for a Westward Television magazine programme about the museum summed it up as,

> [a] serious and valuable attempt to preserve the nuts and bolts of an industry that has influenced the hearts and the minds of countless millions throughout the world. It's the industrial archaeology of the dream factory.'[200]

Assembling the collection obviously deeply informed the research published in *The Beginnings*, research based on 'the detailed observation of the material of cinema itself.' (Barnes, 1997, xii)[201] The 'detailed observation' points however to the rather static interaction with the evidence of the apparatus which seems to exist in the same epistemological dimension as the extensively referenced paper trail, although there is little interaction between these two classes of evidence. The apparatuses are observed rather like a poster or handbill and, as David Robinson says in his foreword to volume one, the scholarship has a 'fascination with the words that were written at the time and the look of the original artefacts.' (1998, x) It is an archaeology of the cinema which rather literally follows its parent discipline by marshalling its treasures in display cases and archival boxes. There is little in *The Beginnings* to suggest that the apparatuses themselves have been given the chance to speak through an analysis of their active operation, although at least the idea of carrying out tests is briefly acknowledged.

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[200] (horipet, n.d.) https://www.youtube.com/watch?v=aHo_cH65GQA 25:20

[201] From Richard Maltby's introduction to volume 5. (Barnes, 1997) Maltby also terms the work an 'archaeology of Victorian cinema'.

> Not many early projectors have survived in a complete state, or in working order, which means that considerable labour and expense would be entailed putting them to rights. This has precluded us from carrying out our own tests and so we are largely dependent on contemporary sources regarding their performance. (Barnes, 1996, 50)

Certainly, the labour and expense of reanimating the entire collection would be vast. However, that need not foreclose the opportunity to so engage with a selection of apparatus from the entire corpus in order to begin to assess likely contributory influences on the workings of 'the hearts and the minds.'

An assessment of an object's suitability for such a project would need to be made. Remembering the advice of the Zar projector literature, it is probable that any surviving inactive mechanisms will exhibit issues of wear according to their material specification as well as service history. A projector such as the Bioscope, with a train of relatively soft brass gears, and in constant use could fall into the 'scrap heap' class fairly quickly, even if state of the art in 1900. Interventions would have to be made in order to make the machine 'match-fit', such as the replacement of the worn bevel gear on the Bioscope.

Of course, with any proposal to reactivate museum artifacts, there are serious considerations regarding conservation sanctions that may need to be applied to very delicate or scarce objects. The process would undoubtedly be more straightforward in private collections in which responsibility for the integrity of a museum artefact is not bound by a necessarily restrictive duty of care for publicly-owned heritage. Nevertheless, I feel there is traction in this approach for FHIs concerned about the productivity of their apparatus collections as well as their missions of public outreach. A slightly less ambitious route which FHIs could embrace is that of workshop style collaborations with academic partners, a version, in fact, of the occasion reported on in this chapter, taking a hands-on approach but not making serious interventions in the object. Already the 'apparatus-oriented seminars' (Fossati & Van den Oever, 2016, 32) practised by the Film Archive Groningen and the University of Groningen are a good example of this. One surprising virtue of the Film Archive Groningen collection is that because its items are neither particularly valuable nor unduly scarce, its active use is less bound by restrictive museum-style policy and conventions.

Some of these issues have been confronted in a project set up independently by two film archive and industry professionals, David Cleveland and Brian Pritchard. Intrigued by the Kinemacolor process developed by Charles Urban and George Albert Smith, they wished to experience it as its original audience would have done, rather than through any of the restorations which have converted the system to modern film or digital formats. Otherwise, as Cleveland says,

> Audiences will not witness the projection of alternate red and green frames and they will not experience the way the human brain merges these two colour records together. (Jackson, 2010, 152)

To do this, Cleveland and Pritchard, sourced a Kinemacolor projector from the Wirral Museum in Birkenhead. They were allowed to work with it providing they did not make any permanent alterations to it. (2010, 154) The museum piece required very extensive repairs as it had been converted to conventional projection specification later in its life but with Pritchard's engineering skills, it was brought back into operational condition. A limited number of screenings were carried out before the machine was returned to the museum so that audiences were able to experience the flickering and colour fringing mentioned in contemporary accounts of Kinemacolor projection for themselves (2010, 157). Cleveland and Pritchard reported on the project and were interviewed by Bristol University researcher, Victoria Jackson, so that this particular case of a recreation of obsolete film technology is one of the most thoroughly documented.[202] The project was passively supported by the BFI and Nederlands Filmmuseum (now Eye Filmmuseum) but was not adopted by either institution for further development despite it being an impressive means of communicating past cinema experience to a modern public.

Conclusion

The solidity of the object described in this chapter would at first glance seem to translate to a status of irrefutable fact. However, the closer inspection of its own

[202] A similar self-financed project, *The Race for Cinema*, which excitingly recreated from scratch prototypical motion picture cameras made before 1895, did not produce reporting beyond the showcase of its website such that dissemination of the knowledge obtained by those involved in the project is rather limited. (Trewinnard, n.d.)

internal evidence as well as that of comparable examples belies that initial impression. Even the name cast into the steel chassis changes with bizarre (ir)regularity and, such was the frantic pace of development, no two surviving mechanisms are entirely alike. The evidence in the expanded archive suggests, therefore, that the early cinema apparatus was in a state of flux, although applying that term to an assembly of brass gears and cast steel may seem an unlikely choice. The films of the period have already been characterised as a 'semi-finished product' to which exhibitors would add finishing touches.[203] More surprisingly, this designation would also appear to serve the technology. Like other machines, the Bioscope was sold to showmen but left open to individual adaptation. Successful 'hacks' were then incorporated into the official product and there was a process of on-going evolution through critical feedback.

This chapter has provided evidence for the relevance of employing objects as text and subjecting them to a close reading. The Warwick Bioscope No. 537 is a typical example of a beater movement projector of the turn of the century which may have, initially, seemed to present little new evidence about shutter history because its shutter was missing and records of its original shutter show a conventional single blade. In a depository of film technology, it would not stand out as having a

[203] (Elsaesser, 2006, 72) The phrase is particularly intended to convey the importance of the exhibitor, from adjusting the speed of the projector to arranging the order of the short films in the programme.

contribution to make to such research. The approach taken in this chapter has, however, revealed it as a single object that embodies a fascinating narrative of continued attention to the matter of shutter design, starting off life as a Model E with four-bladed shutter before very quickly being converted to Model F with rearranged gearing and single shutter blade. The fact that existing machines were converted to later specification confirms that these changes delivered an immediate practical dividend and were not simply motivated by, for example, an improvement to the cost or ease of manufacture. The change to the on-screen performance must have been significant enough to merit the extra labour involved in the retrofit. The flux in this machine has surrendered traces of the technological imaginary of early cinema.

The fragment of violet shutter blade that was hidden within no. 1351 is the sole known surviving material remnant of an exhibition practice that was a decade long and involved the specification of the most commonly used projector of the time, as well as other less popular machines. It is somewhat akin to finding paint fragments on the Parthenon Marbles. Previous aesthetic assumptions need to be not just revised but overturned. To my knowledge, no one has even commented on this since the time of its use and it has certainly not been taken into consideration as an element of the early cinema spectator's experience. The variety of actual historical practice has been forgotten due to the successful substitution of a universal standard that satisfactorily accommodates the films of early cinema. Apart from being neglectful of historical fact in its own right this threatens to be the model by which current technologies of digital projection will take over the projection of analogue born film and mask the dissembling with the assumption of equivalence. Because apparatuses are simply collected and not activated we do not have a sense of how different the experience might be in comparison to the accepted standard of the 3-bladed shutter. Although a disregarded trace still existed in the printed discourse, as both text and illustration, the exceptionally modest survival of the physical evidence of translucent blades meant that there had been no stimulus to connect these different classes of evidence. This discovery should 1) spur on the search for further evidence of arcane shutter design and perceptual tweaking – as undertaken in chapter 5 – and 2) stimulate the reconstruction and testing of such designs. Collectors and curators such as the Barnes brothers have saved many fascinating examples of the material traces of early film culture from the scrap heap. It is now up to subsequent generations of cultural workers to give voice to the hidden narratives within these stilled mechanisms. It may well be that the impetus for this work is received at the point where the replacement of everyday cinema technology with digital systems has made its mechanical heritage sufficiently rich and strange to attract the requisite attention, but if not, then the direct relevance of these devices to the perceptual experience of early cinema should further make the case for action.

5. Adventures in the Flickerscape

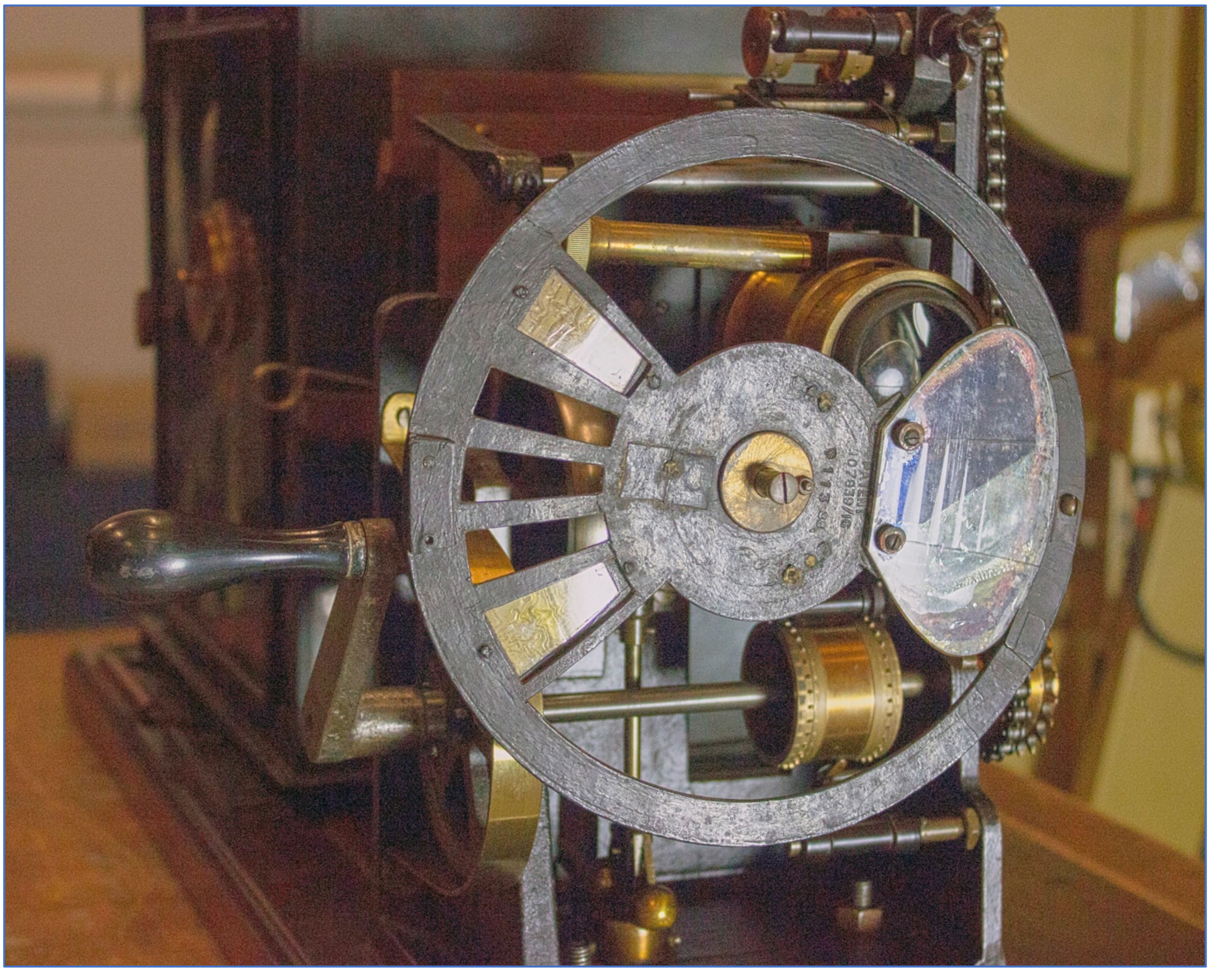

Figure 3. A William Branson patent shutter attached to a Walturdaw projector, in the Eye Filmmuseum apparatus collection.

Introduction

Previous chapters have shown that flicker was not the monotonous feature of early film screenings that one might expect. Although distinctly noticeable, it was not a stable entity. It varied in frequency and intensity and consequent perceptual impact on audiences. Though reported widely and named as a single phenomenon, its meaning, too, was unstable, being sometimes bound together in popular reception with other forms of instability. Perceived flicker was not only present in subtly varying degrees according to the design parameters of different types of apparatus, it was also dependent on exhibition practices and even film content. It had an onscreen and an environmental presence which stimulated the spectator's consciousness and constantly alluded to cinema's direct connection to our nervous system. The (aberrant) shutters that I discuss in the second part of this chapter are a crystallization of this negotiation of the terms of experience as it took place between technologists and audiences. They are one of the physical remains of a flow of ideas; a cognitive trace of the 'thinkering' processes conducted in the machine shops and performance spaces of early cinema.[204] Intriguingly, it is a dialogue that seems to have continued long after an adequate solution for reportable flicker was found.

Alongside the orthodox view, informed by contemporary negative reaction and maintained by film history, that flicker was gradually designed out, becoming with the advent of the three-bladed shutter more or less unreportable, this chapter will consider an alternative perspective: To what extent was flicker also an accepted part of the experience of early cinema? A phenomenon that, rather than being thoroughly eliminated, was tolerated, manipulated and even playfully engaged with in the manner of Gorky's 'strange flicker' (Leyda, 1983, 407-9) or as intimated by Tille's 'nimbly and playfully flickering swarms of shadows' (Anděl & Szczepanik,

[204] The term 'thinkering' indicates a process of thinking through making. (Francis, Haines, & Briazu, 2017, 113). However, I am here proposing to include the film audience as part of the thinkering 'community of practice' gathered around the design of projection technology. Within the proposed practice of experimental media archaeology, Van den Oever advocates employing thinkering as 'a methodological supplement, whose greatest heuristic potential may well lie on the didactic, educational front.' (Van den Oever, Rosendaal, & Warnders, 2016, 3)

2008, 90). Although the overwhelming impression received from the written discourse is that flicker was considered a necessary evil and something to be overcome, with a technological solution applied as quickly as possible, I review evidence that accommodates its retention and suggests even a recurrence of the playfulness of nineteenth century disc spinning and the public game of perception which has been indicated in chapter 3. Why did operator-inventors such as William Branson continue to advocate designs using translucent blades over ten years after the first documented used of three-bladed shutters? Did various forms of flicker inadvertently serve purposes other than the one for which it was inserted into the system of cinema, that is other than its role in hiding the vertical descent of the next image in the film strip? As suggested in chapter 3, for example, were some forms of modulated flicker curiously pleasant to the beholder?

My aim here, therefore, is to contribute a more nuanced account of the role of flicker in early cinema than that to which it is nearly always subjected. I will show that the general view that the eventual adoption of a three-bladed shutter effectively eliminated flicker denies the existence of a period of continued experimentation with the materiality of the shutter and impoverishes our understanding of the flickerscape of early cinema. Flicker's relation to luminance was sometimes addressed more thoroughly than its relation to frequency. Through designs which experimented with translucency, the shutter's light bearing qualities as well as its light slicing function were investigated. In place of the commonly understood binary opposition of light and dark, on and off, I therefore reveal an expanded role for the shutter of providing a variable admixture of muddled light. The evidence for this view derives from an assessment of the patent record but also importantly includes the material traces of shutters in the expanded archive, thus an archaeological examination of surviving hardware. These sources give a more nuanced view to the flicker reductionist perspective of contemporary manuals and trade catalogues. As in earlier chapters, the analysis of these sources is informed by knowledge of the role of the human visual system in making sense of the mechanically produced stimuli with which it is presented.

The position of the shutter in early projector designs, usually extending out from the front of the device, was such that it facilitated easy exchange and experimentation, although the Cinématographe and Projecting Kinetoscope were notable exceptions. Once the position settled in later designs on being between the condenser and the film gate, shutters would have been more complicated to remove.[205] The relative ease of access raised the interesting possibility of maintaining a range of shutters with different properties that could be changed at will. Given the variables affecting flicker already identified, from film content to electricity supply, it seems plausible that projectionists could have maintained a

[205] This practice was beginning to change towards the end of the early cinema period with designs such as those created and manufactured by Leonard Kamm, (Kamm, 1914) that advocates a shutter with angled blades close to the gate in order to act as a fan and assist in the cooling of the film as well as the occlusion of the light. Placing the shutter between the light source and the film had a perhaps more significant advantage, not mentioned by Kamm, of reducing the heat arriving on the film by 50 percent. (Richardson, 1940, 483)

palette of different shutters and experimented with different forms as film materials and production practices were themselves changing. Neither is it unrealistic to imagine that different forms of shutter could have been self-fabricated by the operators. The essentially two-dimensional simplicity of a basic shutter would have been within the scope of most operators' skillset, although to produce one that was balanced in its weight distribution would have required care and attention. Evidence within the patent record would appear to formalise this level of informal experimentation. Of the patentees whose work I will discuss in this section, William Branson, Emil Alexander and William Diggle all gave their profession as 'Kinematograph Operator'.

Flicker was easily traced to its primary source, the action of the shutter in the film projector, and it was the shutter which was the primary though not unique site of efforts to remove it and bring it under control. The research is divided into two sections with their own subsections. The first section covers strategies for managing flicker through aspects of projector design other than the shutter, while the second section concentrates on the shutter as the site of hopeful, imaginative and counter-intuitive variations on the basic fabric of the sectored disc.

5.1 Managing Flicker through Apparatus Design

While much effort addressed the main source of flicker in the shutter itself, some designers offered strategies of avoidance or compensation for managing the gap imposed by the projector shutter. Foster's 1915 revised edition of Hopwood's *Living Pictures*, enumerated four methods for removing flicker that had been implemented up to that point.

> 1. By maintaining a constant illumination on the screen.
> 2. By synchronously switching the projecting light off and on.
> 3. By a sufficiently quick shift movement of the film to avoid the necessity of the shutter.
> 4. By special constructions and arrangement of the shutter.
> (1915, 229)

Although, in the early cinema period, these first three categories did not represent fully practical solutions, in order to better describe the technological imaginary and potential flickerscape of the period, I will briefly discuss examples of these methods, before starting a new section concentrating on 'special constructions and arrangement of the shutter'. Not mentioned by Foster but worthy of consideration, are further compensatory measures which expand the issue beyond the confines of projection apparatus. In this section, I will therefore also give brief attention to two further categories, which I number 5 and 6 to follow on from Foster's 1 to 4.

5) actions taken by the spectators to ameliorate the effects of flicker and

6) actions taken by film makers to adapt the content of their films.

1. Constant illumination

Foster's intention in this category is to cover continuous projection systems using mirror prisms and paired projectors. He describes proposals for the doubling up of the mechanism in which shutters are still present but in which the occluded phase would be immediately replaced by light from the second image source, so that neither shutter would ever be visible and generating flicker on the screen. Although Foster only mentions early prototype designs by Birt Acres and Friese-Greene, this was also the principle adopted by the German pioneer, Max Skladanowsky, in his Bioskop projector of 1895, the public exhibition of which predated the Lumières' show in the Grand Café by nearly two months. The twin strips of film were alternately exposed by the operation of a single large shutter, the leading edges of which were furnished with vicious serrations. Such shutters were already familiar from phantasmagoria-type paired magic lanterns which were designed for showing dissolving views.[206] The dual image single shutter approach is seen in another machine presented in 1895, the Animatoscope of Owen Eames.[207] 'Constant passage of light' was one of Eames' design criteria along with continuous movement and the use of more than one lens to reduce the necessary speed of film advance.[208] Eames' approach is given short shrift by Hopwood who quickly surmises that the pair of lenses would have photographed images from slightly different perspectives (as in stereoscopic photography) and that, when projected onto a screen as a single image, the result would have been 'a false vibration of objects' (Hopwood, 1899, 91). The Animatoscope thus achieved its potentially flickerless, continuously lit picture at a great cost to visual continuity, producing a moving image experience which one imagines would have been rather like blinking one eye

[206] Skladanowsky's striking looking projector is preserved in the Potsdam Film Museum. See, Ilgner & Linke, (2001, 16-19)
[207] (Patent No. GB189617224 (A), 1897) It seems to have been presented but not demonstrated at the Boston Camera Club, April 1 1895. (Rossell, 1998, 112)
[208] Eames is quoted in Rossell, (1998, 112)

and then the other, or a rapid lateral shaking of the head. Hopwood concludes that '[i]t cannot be denied that enough trepidation exists in the average Living Picture without risking a further importation of so little desirable a characteristic!' (1899, 91)

These complicated systems required the sequence of photographed frames to be spread across two film strips or reordered within the single strip. This latter situation applied to the patented duplex projector of Prestwich and Friese-Greene from 1896 for a mechanism with two lenses and apertures arranged one above the other running a single film with the sequential images printed seven frames apart.[209] In 1905, Theodore Brown proposed a system which used two standard Gaumont Chrono projectors mechanically linked and operating simultaneously but with one geared in advance of the other. Brown concluded the exposition of his solution to flicker with some frustration at what seemed to him to be stalled progress.

> And now, although it has been shown that "flickerlessness" is possible, we ask selves the question, How comes it that flicker still persists speaking generally of the Living Picture Shows of to-day? How is it that we do not find a general adoption of such apparatus as have been devised for the dismissal of flicker? Is the cost excessive, and are the special printing and special projectors the things that block the way? We cannot yet say, and must leave for the present a subject that deserves the most serious concentration of thought, from those whose genius and powers of application, we trust, will deliver us from this darkness. (Brown, 1905, 198)

The Polish pioneer Kasimir Proszynski had also tried a variation on this system, apparently as early as 1895-1898. His twin lens Biopleograf sought to improve on

[209] (Greene & Prestwich, 1897) The apparatus survives in the NSMM. Object number, 1930-755.

the single lens Pleograf.[210] Although flicker was much reduced, stability and likely registration issues still plagued the device. With the benefit of hindsight, he was able to conclude, probably not dissimilarly from the proponents of other twin headed projectors, that,

> the use of two films and two lenses was too complicated and not sufficiently practical; we know that one single film gives trouble enough to the operator. (1913, 101)

By this time, Proszynski had taken up a more productive line of research turning his attention to multiple blade shutters that would increase the flicker frequency to unreportable levels.

2. Intermittent light sources

The simplicity and elegance of the mechanical solution of the rotating shutter was hard to beat although theoretically the same effect could be achieved without a shutter by switching the light source on and off. Ottomar Anschütz's Schnellseher of 1887 had operated on this principle. It employed a disc of 24 glass plate chronophotographs revolving at a hand-cranked speed of approximately 30 images per second. A handful of spectators viewed the images through a sheet of milk-glass and there was no need for a shutter or a dwell period because, as they sped

[210] see Hendrykowski (1998) for mention of Proszynski's Biopleograf, 'which partially eliminated flicker, and employed two lenses and two positive film strips.' In 2017 the Polish national centre for film culture, NCKF, in Łódź created a replica Biopleograf. 'The reconstruction of the bio-pleograph will be an exceptional experiment not only on the Polish but also international scale - says Piotr Kulesza, head of the Exhibition and Projection Department of the National Center for Film Culture. - This is a huge constructor challenge due to the fact that we plan to reconstruct a completely functional device whose mechanism will be based on materials and technologies used in original objects from the late 19th century.' (*NCKF Zrekonstruuje Bio-Pleograf Prószyńskiego*, n.d.)

around, the pictures were illuminated by the flash of a Geissler tube lasting just 1/1000th of a second. The high speed of the flash would have effectively frozen the image but would not necessarily have offered relief from flicker.[211]

Foster mentioned an anonymous 'recent' (1915, 231) method which switched the projection lamp on when the film is in the gate and off while the picture is changed. It was suggested that the off phase of the lamp could be synchronised with the projection of a clear white disc from an auxiliary lamp to produce a kind of negative of the conventional shutter phasing. This experimental system would have removed the all but unseen darkness which is nevertheless felt as flicker. It amounted to a negation of the cinema experience of light and dark but it is likely that this inversion would have replaced a flickering image with a very low contrast one.

A 1911 patent of Gustav Dietz emulated this line of thinking with a shutter-based solution that created a flashing effect at the moment of pulldown so that the passage of the film was hidden by light rather than darkness.[212] Predictably, it involved a lot of mechanical complexity, with four double-bladed shutters revolving in concert, and it is not known if it was ever put into production. As well as a flash of light appearing through the star shaped opening formed by the blades, the patent also describes a constant variation of light intensity, effectively like an iris opening

[211] Wordsworth Donisthorpe had proposed the use of electric sparks in a system for viewing a talking picture of Mr. Gladstone in a letter in *Nature* in early 1878. (Herbert, 2017, 42)
[212] (Dietz, 1912)

and closing through every picture cycle.[213] Just like the double-headed projectors, designs such as this may well have faltered through their complexity rather than a lack of merit in problem solving.

3. Fast pulldown

A pull down or 'shift movement' that was fast enough to entirely eliminate the need for a shutter was not a practical possibility in the early cinema period although in the beginning of the period some manufacturers tried to persuade customers that the speed of their machines rendered a shutter superfluous. The earliest version of the Bioscope of 1897, discussed in the previous chapter, was one such machine that advocated complete eschewal. Other projection machines also did without. The Hughes Moto-Photoscope was emphatic in despising the shutter, although its use of the verb eclipse was ironic in such a context. 'No Shutter, therefore No Flickering. Eclipses all others. No Eyesache [sic], no Headache, as with shutter machines.' (Bedding, 1898, 369) A very similar projector made by Prestwich however made the matter optional: 'Detachable shutters are also an advantage, as some films show very much better without' (Bedding, 1898, 937) The truth was that none of these designs had fast enough movements to avoid the visitation of the 'ghost' or 'rain'

[213] 'The variations are so numerous that the changes from one to the other cannot be perceived by the eye and the resulting effect is a constant illumination of the screen and of the image projected thereon which is without flicker and much greater in extent than the illumination secured when the ordinary anti-flicker shutter comprising alternate opaque and transparent sections is employed.'

effect, although if a film was very dense or had subdued highlights, it might just show 'better without'.

Increasing the speed of the picture shift was a line of research undertaken by Robert Paul who made some headway in engineering a very fast pull down. He used his innovation to reduce the size of the shutter blade rather than remove it entirely and gained the benefit of an increase in picture brightness. His 1907 model Reliance Animatograph was advertised thus:

> **Almost all of the light from the lantern is utilised on the screen.**
> The amount of light which must be cut off by the shutter during the movement of the film depends on the rapidity with which this movement is effected. No other machine has yet been produced commercially which cuts off less than one-sixth of the light, but, owing to the **rapid, yet gradual,** movement of the film in the Reliance Animatograph, only **one-sixteenth** part of the light is lost; compare its extremely small shutter with the shutters of other machines, and test the wonderful superiority of the result on the screen, using films of equal density. The maker will be glad to give every facility for comparative tests of this and other features of his machine.
> (*Reliance Animatograph: Special Features of the New 1907 Model*, 1907)

Reducing the shutter size so significantly was an engineering achievement for Paul when other machines would have had 90 or 60-degree cover blades. Ironically though, increasing the screen luminance in this way, as well as the inequality of the light dark ratio, would also have increased the appearance of flicker. It is unlikely that the sort of side by side comparison suggested by Paul would have convinced flickerphobes, although it should have impressed customers looking for the brightest picture.

Modern digital projection technology and its extremely fast switching of individual images, electro-micromechanically, has effectively realised the truth of the fast pulldown concept and of Hepworth's 'mild prophecy' of 1897, probably rather later than he expected, that 'in the instrument of the future the shutter will not be found'. (1897, 56)

5. Flicker avoidance by accessory prosthetics

One of the most interesting solutions to flicker phenomena involved the mobilisation of the hands of the audience, not just the hands of the projectionist. Apart from the home-made anti-flicker therapies such as the use of black paper with two small peepholes that T.C. Porter had witnessed in Colorado, an even more elementary defence involved waving a hand with outstretched fingers in front of the eyes. This was perhaps an instinctive reaction to flickering light as old as hands but not one which many would have wished to conduct for an entire film show. This instinct had been reversed by the Czech researcher Jan Evangelista Purkinje who had conducted experiments in which, while looking at the bright sky, he had used his fingers to create flickering light. It was for him a repurposed game from his childhood, 'from that beautiful time'.(N. Wade, Brozek, & Hoskovec, 2001, 65) The results recorded in his doctoral dissertation of 1819 charted the patterns produced in his vision as a consequence: 'checkerboards, zigzags, spirals, and ray patterns' (Wade, Brozek, & Hoskovec, 2001, 39) [214]

[214] Purkinje's dissertation is printed in full in Wade et al.

These most basic approaches to flicker were formalised into a device produced by Gaumont in the 1890s. Called La Grille, it took the form of a fan made from black card perforated with many holes and designed for waving in front of the eyes. La Grille proposes a spectator almost as bodily active as the projectionist, engaged in repetitive manual activity. Apart from its entry in *The Beginnings of Cinema in England*, it has been forgotten since its last mention as an 'old device' (1915, 236) in Foster's Hopwood and I know of no surviving examples. As Barnes relates, Gaumont had already tried using some experimental semi opaque shutters made from tissue paper layered on glass in their Chronophotographes whose large 60mm film format would have exaggerated flicker effects, at least in the event that it was employed to project a larger picture. (Barnes, 1996, 140) Though perhaps more significant and not mentioned by Barnes in this regard, was that its concept as combination camera and projector would have led to a compromised shutter design for one or other, or both, functions. La Grille was more than the 'simple anti-flicker' device noted by Barnes, it was an ultimate defence against a whole host of irksome issues. The claims for its effectiveness embrace the widest definition of flicker, not only the literal flicker and movement produced by the projector but other artifacts in the film itself such as 'tears, scratches and defects' which could produce irregular flashes on the screen.[215] The irregularity of such anomalous artifacts puts them in a quite separate perceptual category.

[215] 'en même temps qu'elle supprime tout scintillement, elle amoindrit, d'une façon très notable, les éclats provenant d'arrachements, d'égratignures et de défauts de la couche sensible de la pellicule.' (Gaumont et Cie., 1897, 395)

La Grille has the advantage of allowing for individual difference, being operated by the spectator, rather than being under the control of the projectionist. It was an embodied solution to flicker that could be applied depending on one's personal threshold of sensitivity and the degree to which one was willing to experiment with those boundaries. It could also be applied accordingly to the variable qualities and quantities of flicker emerging from the vast array of heterogeneous projection technologies.

Although long forgotten, La Grille was noteworthy enough at the time to engender its own parody version, itself a return to primordial instinct. Both Hopwood and Barnes refer to this parody, the 'Kinedodgescope'. It was a suggestion of Mr. Appleton of Bradford, reported in the *Amateur Photographer*, to make use of, 'the human hand, which, extended fan-like, is held close to the eye and moved quickly from right to left so as to break up the field of vision.' (Barnes, 1996, 140).[216]

6. Flicker avoidance by film content

This short section could be a vast study in itself and a new way to approach the surviving corpus of the films of early cinema. Previous studies of early film aesthetics have not considered conscious or subconscious management of flicker as a possible

[216] See also, Hopwood (1899, 211) One is tempted to read this as a response to the effete fan-waving French by a plain-speaking Yorkshireman, presumably the same Mr. Appleton of Bradford who was designer and manufacturer of the now extinct Cieroscope combined camera, printer and projector.

factor.[217] This is therefore only an indication of a hypothesis which would state that early cinema pioneers, fully immersed in the heuristic of capturing and exhibiting moving images created barely conscious strategies for their filmmaking that would avoid or compensate for excessive flicker in projection.

Hepworth knew that, 'different forms of shutter are suitable for different classes of picture' (1897, 54) and further, that certain films permit the shutter to have 'a different degree of perforation' (1897, 56). For a filmmaker and exhibitor such as Hepworth, therefore, it would have been logical to avoid shooting scenes with large expanses of flat sky, if other considerations permitted. It is unlikely, however, that avoidance of subject matter that carried a high risk of flickering in projection would have trumped other considerations such as topicality, good photographic composition and dynamic movement. Control of the photographic quality of the film image through printing techniques would however have offered some tools in managing apparent flicker. Early orthochromatic film stocks with limited tonal range and high contrast would be at risk of producing large areas of highlight which would have exaggerated the effect of flicker. Adjustments introduced in printing and developing could reduce the highlights but with a balance to be struck between creating a dense print that would reduce flicker but at the cost of a dark image.

[217] See for example, Turvey, (2004) for a comprehensive review of the aesthetic approach of early British film subjects based on surviving catalogue entries.

A second opportunity to reduce the impression of flicker was rather more literally born of the movies. The connection is expressed in Adolph Zukor's Biography.

> The imperfect machine still blurred slow motion with irritating flashes; rapid action suited it best. Hence rose the "chase pictures"; in half the films of that period, someone ran after someone else.' (Irwin & Zukor, 1928, 89)

Although the precise meaning here is not perfectly clear, it seems to suggest that the rapid action of chase films distracted attention from irritating flashes, and by extension, flicker. Although filmmakers taking flicker into account may not have been the only reason for the creation of the chase film genre, as Irwin seems to imply, it does suggest that such considerations could form part of production strategy, and influence film form as a consequence. In this case, performing a sleight of hand by choosing and directing scenes with an alternative focus for the spectator's attention, so that subjective flicker perceived in projection would be reduced. If the spectator is attending to fast motion, they are less likely to perceive flicker because mental resources used for visual perception and cognition are already fully occupied. Furthermore, if frequency of content was raised to synchronise with frequency of projection (c16fps) it could have the effect of subduing innate perceptual mechanisms which use flicker frequency to search for difference.[218] It may be possible therefore to loosely characterise film content as an extra gear in the mechanism of the projector and that it was apt to mesh at certain times rather more than others, depending on the tempo of the action. Such an idea

[218] 'First, for efficient search to occur, the target and distractor frequencies must differ enough (~5 Hz) to drive separate temporal frequency channels' (Cass et al., 2011)

proposes an extra layer to the artistry and engagement of the operator in choosing a speed which is not only lifelike but which feels perceptually pleasant.

When flicker frequency in cinema theatres had been raised sufficiently it was possible to create a different kind of cinema that was independent of the base tempos of the depicted action and was able to indulge in *longeurs*. In his memoir Hepworth recalled a point of tradecraft: the 'direction of attention'. He was referring to the development of acting styles suited to film as opposed to theatre and the film director's ability to deploy subtle detail. The attention of the audience, he says, can be directed 'by the deft manipulation of small, quite unobtrusive movements opposed to stillness.' (1951, 121). In this sense, the 48Hz of the three-bladed shutter became the more or less blank canvas for developing forms of film style, rather than a canvas to interact with, or even, in the case of the Veriscope film, a canvas to be pummelled against.

5.2 Managing Flicker through Shutter Design

The need for a shutter in projection followed on naturally from one having been used in the taking of the film in the first place. To have used one in the camera but not the projector would propose an illogical asymmetry to the deconstruction and reconstruction of the profilmic reality.[219] Furthermore, the mechanical linkage of the

[219] Of course, the flicker 'experienced' by the camera, of the light entering the lens and being intermittently cut off by the shutter, goes unrecorded by film or eye. (At least, with the exception of much later cameras, such as the Arriflex, which have a mirror shutter reflex viewing system which conveys the flicker of the shutter to the eye.)

intermittent mechanism to the shutter, as seen in Demeny's 1893 camera patent, established a kind of a symbiotic relation between the stop-start of the mechanism and the stop-start of the light that could not easily be challenged.

In 1899, Hopwood posed the questions: 'Will the shutter remain? How will flicker be overcome?' (1899, 233) By the time of the book's second edition in 1915, there were still no categorical answers offered although there was a discussion of Proszynski's 1913 paper advocating the three-bladed shutter.[220]

The shutter is a deceptively simple component. Designers actually had many elements with which to work. These included the number of blades, their form and arrangement, the blade material, its opacity or translucency and its colour, and functional considerations such as the ability to vary the sector of the blade. All the designs I refer to in this section are based on the spinning disc, but equally barrel and conical shutters have been used successfully by projector designers and are only disregarded here because of their limited differences in terms of perceptual effect.

[220] Equally, from the pages of *The Modern Bioscope Operator* of 1911 we find no consensus as yet. 'Changes and alterations in the arrangement of the shutter are still taking place, and much doubt as to the best form yet remains. […] Extra blades are often added with the idea of minimising " flicker "; these extra blades vary in number and size, and are usually opaque, but occasionally transparent and colored.' (*The Modern Bioscope Operator*, 1911, 18-19)

Certain issues arise when considering the shutters of early cinema as a research object. One problem in tracing the evolution of shutter design centres around the survival of original shutters and indeed the discernment of originality. They were one of the most exposed and easily damaged components of an apparatus that, considering the peripatetic nature of early travelling cinema shows, was constantly subject to wear and tear in transit as well as the shared public space of the screening. Shutters were therefore designed to be easily removed and replaced, a trait which also lent itself to easy modification by hobby experimentalists. In the case of most surviving shutters, the simplicity of construction makes it difficult to distinguish with certainty between what might be original equipment or a later replacement or modification. If a personal inspection of the artefact is possible then an assessment of the quality of workmanship can help to identify what might be a home-made attempt to engage with the shutter design discourse rather than original equipment, although such judgements are naturally somewhat subjective. Especially in regard to professional devices, the shutter of a surviving projector rarely corresponds to that seen in the manufacturer's catalogues and therefore caution needs to be applied to questions explored in this section, such as the early uses of multiple blades or violet-tinted blades. These questions can be informed but not categorically answered by the apparatus collections because of the practice of replacing newer shutters on older mechanisms.

This section on shutter design is organised into three sub-sections. Although my intention is to challenge our notion of conformity to a solution to flicker based on the development of the multiple blade shutter, I have adopted the date of its assumed introduction as a means of structuring the investigation. This section therefore pivots around the year of 1903 and looks at aspects of shutter design before, during and after the inception of the counter-intuitive solution to apparent flicker in cinema. It also examines in detail the legends surrounding the eureka moment of its inception in the minds of at least two different individuals. Although I do not hold literally to this class of 'evidence', the narratives have the potential to reveal certain insights into the process of creative cognition.

Before 1903: the ghost and the darkness

The earliest iterations of the Bioscope projector discussed in the previous chapter revealed traces of a negotiation taking place in regard to the specification of the shutter. No shutter or too little shutter would lead to streaks in the projected image called ghost or rain. Too much shutter would result in a dark picture, and waste the valuable, impactful, commodity of light which powered the projected image. Maintaining the balance between ghost and darkness, while also trying to reduce perceivable flicker, exercised the minds of film pioneers.[221]

[221] In one of cinema's many substitutions, the 'ghost' of the images' descent is replaced with the darkness of the shutter blade. The rapid transition from the bright image to the dark of the shutter produces a flash perceivable to a human spectator if it is not sufficiently rapid to elude the sensitivity of their visual system. It is ironic that the contrasting darkness serves to make the consecutive pulses of light more visible but in the trade-off between flicker and ghost, the flicker was still the least objectionable in most cases.

Cecil Hepworth devoted a chapter to *'The Shutter'* in his 1897 book, *Animated Photography*. In it he maintains that the first line of defence against flicker is the speed of the pull down. Once the 'unalterable limits' of the mechanism have been reached, however, the second line of defence is to introduce alterations to the shutter. With typical humour, he summarises the multiplicity of early forays into this *terra incognita*.

> It may safely be said that upon no part of the cinematograph does so much diversity of opinion exist as upon the shutter. Some people contend that the lens should be absolutely covered during every instant that the film behind it is in motion; others go so far as to say that there is no need for any shutter at all. Some seek a middle course by making the shutter of some translucent material, such as semi-opaque celluloid of a ground-glass appearance; others pierce a few large holes in an opaque shutter, while others, again, favour a number of small ones. Then some carry it a step farther, and introduce perforated zinc or wire gauze in their efforts to minimise the flicker without destroying the brilliancy of the effect upon the screen. […] Some serrate the edges; some don't. Many like it in front of the lens, while many more say it should be behind, and many more still put it between the film and the condenser. And so each one goes his own way, which is different from all the others. But there is one common attribute of all classes of shutter or no shutter - one tie which binds all systems together in an indissoluble bond of brotherhood; and that is that each and every description of kind or shape or place or absence of shutter is positively the only one that gives the best results, and by its aid "the flicker so noticeable in most machines," etc., etc. (1897, 52)

Although the list seems comprehensive, Hepworth does not at this point mention the coloured tinting of blades or, more crucially, the number of blades. What we can see retrospectively is that all the ideas listed by Hepworth were concerned only with modifying the intensity of the light rather than the frequency of its interruption. Maclean's update appended to the 1900 edition was similarly unaware of flicker frequency as an issue but certainly mindful of luminance.

> in order to reduce flicker to a minimum, the movement of the film should be accomplished in as short a time as possible; the film should be free from staring, blank, high lights; and the illuminant should not be excessively powerful. (1900, 113)

This last point may seem surprising but it is interesting that even when considering early lighting technology, it was possible that thin prints combined with a powerful light could indeed produce unpleasant flickering, especially given the understandable habit of most operators to 'put on just as much power as they can get.' (1900, 113)

The translucent cover blades mentioned by Hepworth were already a feature of the 1895 patent of the Lumière Cinématographe. When used as a camera the shutter was opaque but when employed as a projector a different disc was substituted which was 'made of translucent material, such as oiled paper, paraffined paper, celluloid, etc, the effect of which is to diminish the scintillation due to the periodic suppression of the light.'[222] This shutter seems not to have lasted long as, the following year, an updated patent describes a shutter with 'radial slits'.[223] Even allowing for only subtle improvement over the previous version, it is tempting to wonder whether the effect of the modified Lumière shutter would have been enough for Gorky's attention to be otherwise diverted and so deprive us of the epigraph to chapter 3. While, it is an entertaining notion, the answer is, 'probably

[222] See 1895 patent no. 7187 reproduced in Mannoni, Campagnoni, & Robinson, (1997, 403)
[223] Patent No. GB189607801. The accompanying drawing shows an opaque blade of about 120 degrees perforated with 9 narrow slits. (Lumière & Lumière, 1897)

not', because that instance of flicker was very much defined by the frame rate and therefore the flicker frequency rather than its intensity.

Hepworth continues his account by giving a detailed description of his own investigation of issues surrounding shutter design which is in itself fascinating evidence of the experimentation and analysis carried out by film pioneers. He reports on trials with a conventional single opaque blade, no shutter, a translucent blade and a perforated blade. While noting the issue of the highlights and shadows of film content, he finds the absence of a shutter and the translucent blade the least satisfactory options. The latter 'illuminates the whole room in a series of flashes' and fogs the picture 'with a flood of grey mist that blocks out all the brilliancy'. (1897, 55). Reason enough then for the Lumières to have abandoned the translucent shutter for a perforated one, and reason, too perhaps, for Gorky's overwhelming impression of greyness, assuming, that is, that the 1896 performance used the earlier model. Following the result of the experiments described in his book, Hepworth advocated his own design of shutter as a DIY option to his readers. It resembled the updated 1896 design of Lumière, but with four lozenge shaped slits cut into the cover blade and with better mechanical balance. Potentially, it could have been widely disseminated due to its appearance in print and its continued citation in later works (Brown, 1905), (Bennett, 1911).

Although Hepworth's preference tended towards perforation, the alternative of translucency was by no means ignored and had surprising lasting power, as I will show in the later discussion of accessory shutters in the 1910s. Materials which allowed only a portion of light to pass included the mineral, mica and although there is little surviving physical evidence, there are references to its use as a shutter blade.[224] Mica was a highly suitable material for this function because unlike the celluloid or oiled paper, previously mentioned, it was not flammable, indeed its common applications were in situations which required transparency and heat resistance.[225] Mica is also known to have been used in the 1900 model Professional Chrono made by Gaumont, which, with the aim of the usual 'complete elimination of flicker', had a redesigned cam for faster pull down and a small mica bladed shutter (Barnes 1997, 95). The Gaumont Chrono in its different iterations become a very successful projector, in widespread use in Europe, but later versions dispensed with the mica blade and adopted conventional opaque shutters.

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[224] The catalogue of the Cinematheque francaise describes a mica shutter of one blade on a machine from 1897, the Edison Projecting Kinetoscope (AP-95-1652). Hopwood describes the Mouvementograph of Joseph Zion and Eugène Gautier as having a mica shutter (1899, 165), although the rare example in the CNC collection (CNC-AP-15-1214) survives in the form of camera rather than projector and has a metal shutter.

[225] It was employed, for example, in signalling devices and as windows in stoves. It was also used in some projector safety shutters as a baffle that would descend when the projection slowed or came to a halt and to prevent the film's damage or combustion. Jenkins suggested using a piece of mica scratched with lines as a focusing aid for the projectionist – again a transparent inflammable substance that could be placed in the gate long enough to set focus. (Jenkins, 1908, 66) In the 1920s, it was used as the base of the animated scenic effect slides for the Brenograph lantern, a device employed in the larger Movie Palaces to produce ancillary light effects to accompany the non-film sections of the cinema programme such as musical overtures, intermissions and the entrance and exit period. As noted in chapter 3, mica also featured as the substrate for the designs of the Wheel of Life and one wonders whether the cultural memory of that device influenced its use by shutter designers some decades later.

1903: three blades are better than one

Given the importance of the multiple blade shutter as a component of the standardised film experience, scant attention has been given to its origins and even less to the matter of its subsequent diffusion. As Marek Jančovič has observed, 'Origin stories of the multiple-blade shutter are somewhat elusive' (2013, 28). In fact, the stories are available but either as unreliable reminiscence of self-mythologising pioneers (Ramsaye and Smith) or incomplete researches of latter day film historians (Musser; Rossell).[226] I review these sources while also looking at rarely discussed but relevant patent records. [227]

Evidence of a decidedly anecdotal nature is presented by Terry Ramsaye in his 'romantic history of the motion picture,' as the material for his book was first termed when serialised in *The Photoplay*. He accords the invention of the multiple-blade shutter and the discovery that – at least in terms of flicker – more is less, to the Anglo-American pioneer Albert E. Smith, partner in the Vitagraph concern with James Stuart Blackton.[228] The story which describes Smith's eureka moment as

[226] My comment here is in no way meant to be disparaging. Musser and Rossell are exceptional in that they have, at least, given *some* attention to the matter of the influence of shutter design on the experience of Early Cinema. I also have no illusions as to the completeness of my own contribution but wish to augment the record with a new consideration of the evidence.

[227] An exception is Thomas Armat writing in 1935, who counted Pross' patent as one of the eight most important to the 'motion picture art'. His list, of entirely American patents dating from 1893-1903, were at that point 'all in universal use today in the most modern and up-to-date equipment'. (Armat, 1935)

[228] American Vitagraph was established in 1897 by these two stage performers, Blackton a cartoonist and Smith a magician. Engaging in haphazard film production and exhibition, the company emerged from the chaotic business environment of the earliest years of cinema in the US as preeminent, Smith developing into a talented businessman. He was also, in his own words, the 'official machinist' of the outfit. (Smith & Koury, 1985, 33). See Musser, (1983) for a reliable account of the early days of Vitagraph.

occurring while he observed fence posts and telegraph poles from a train window resembles a re-telling for the Railway Age of the legendary illusion of curved spokes provided by a wagon wheel seen through fence slats and described by Peter Mark Roget in 1824.[229]

> As Smith regarded the New Jersey meadow landscape through the train window he noted the similarity of the screen flicker to that produced by the sweeping past of the telegraph poles. And again as the train flashed through a station he compared the slow flicker of the poles with the dancing but almost imperceptible flicker on the line of vision as he looked through the picket fence separating the tracks. This gave him the notion of dividing up the flicker of the motion picture by adding blades to the then single bladed shutter. He tried this out and found that by multiplying the flicker in fact he eliminated it in effect. (Ramsaye, 1926, 351)

Smith himself takes up the story in his ‘singularly inaccurate autobiography’ (McKernan, 2014),*Two Reels and a Crank*.

> I was on a train one day en route to Philadelphia, and my eye fell on the picket fences separating the eastbound from the westbound tracks. There was of course no movement on the part of the fence. But the pickets seemed to sweep past at a speed that made them almost invisible. The next thing I knew, my mind was idly connecting the picket fences with the flicker of the projector. Then, in a pounding flash, I began to wonder whether, if I had a lot of little flickers instead of the big one, it might not improve the projection of moving pictures.
>
> As I turned it over in my mind it seemed more and more plausible. Returning to New York, I went to work shaping a small shutter to fit on the shutter shaft. I geared it up with a spur gear attached to the main drive so that the auxiliary shutter made eight turns to every single turn of the main shutter.
>
> It was the answer! The flickers now followed one another so closely that they were scarcely noticeable to the eye. Later experiments showed it wasn't necessary to have an eight to one ratio, and, after many trials, we reduced the number of flickers to three. The same device, now more skillfully tooled, is a part of many present-day projection machines.
> (Smith & Koury, 1985, 36)

[229] Known as the Palisade illusion. See (Roget, 1825)

The historical fact of the patent record provides a less satisfying narrative but greater reliability. Almost surprisingly, it confirms a 1903 patent in Smith's name for a double shutter, the smaller internal blade of the concentric pair rotating eight times faster than the larger cover blade. The design described in the patent does in fact resemble a mechanical model of the experience of telegraph poles and picket fence as recounted by Ramsaye, whereas Smith's own account from 1952 misses the important detail of the more widely spaced, lower frequency poles which represent the action of the standard single bladed shutter. On the other hand, Smith's account features a better summary of his actual device, which with its twin single blades, was not yet the classic configuration of a single disc of three equal blades that, by the 1920s, would become standard equipment in most projectors. That said, the principle was very similar and probably too the effect. No doubt keen to employ the irresistible narrative of Smith's eureka moment, Ramsaye allows Smith's design to stand in for the retrospective ultimate solution, for which credit actually lies elsewhere: In fact, the mechanically simpler three-bladed shutter that was widely adopted in 'present-day projection machines' is the subject of another 1903 US patent in the name of John Pross on behalf of his employer, the American Mutoscope and Biograph Company (AMBC).[230] Figure 3 of his March 10th 1903 patent is possibly therefore the first appearance of the now familiar classic design of the three-bladed shutter with three equally-spaced blades of 60-degree sector.

[230] United States Patent No. US722382A, 1903.

Pross describes his invention as a 'departure from hitherto accepted theories' in which efforts to reduce flicker had concentrated on minimising the period of change and maximising the exposure. His counter intuitive notion of increasing the interruptions was certainly novel at this time but was identical to that which had also occurred to Albert Smith during his railroad epiphany. Pross has not provided us with such a spectacular narrative but he does employ a powerful analogy, which not only likens the motion picture experience to a flow of energy, but characterises the potential for both good and bad experiences based on the rate of flow. His concept is explained as,

> analogous to the case of an incandescent electric lamp, which when operated by current of low frequency has an objectionable pulsation, whereas if operated upon a current of the proper high frequency appears to give a steady uniform light. (Pross, 1903)

Despite the unreliable reputations and questionable subjectivity of Ramsaye and Smith's accounts, they can nevertheless provide insight into the circumstances surrounding invention.[231] The thrusting modernity of the railways and their manifold connections to cinematic vision are well known, particularly through having been charted in Lynne Kirby's book, *Parallel Tracks*, which proposes that, 'as a machine of vision and an instrument for conquering space and time, the train is a mechanical double for the cinema' (1997, 2) Naturally, she cites Ramsaye's fable as exemplary of the paradigmatic relation of railways and cinema. (1997, 47) Experience of railway travel prepared cinema's new audience with 'an established mode of perception

[231] I have previously referred to Smith's story of invention as it relates to my own experience of a creative 'eureka' moment in devising a new form of panorama photography. See appendix 4.

that assisted in instituting the new medium and in constituting its public and its subjects'. (1997, 3) This perceptual mode included engaging their visual sense with dynamic optic flow while their bodies remained passive and sedentary.[232] This heightened visual awareness and active mental state combined with a relaxed physical state may itself have provided the conditions for Smith's moment of inspiration.

It is significant that the accounts of Smith and Pross are both framed in modernist tropes of shock and flow as related to visual experience: railway travel and the flow of energy made visible through a flickering lamp. This latter analogy would also appear to be an example of the 'new sensibility' of oscillation noted by Asendorf and Tsivian, as previously cited in chapter 4. Both Smith's experience and Pross' analogy set forth models or visualisations of oscillation and importantly illustrate the issue of flicker in terms of frequency rather than luminance.

Pross' patent also discusses an underlying economic motive related to the flow of images in which the three-bladed shutter can be said to cut costs by two thirds. To achieve the same effect of a continuous image with a single blade shutter the film would need to travel three times as fast, 'forty or fifty pictures per second'. Given that Pross was working for the AMBC, he would have been especially aware of their

[232] The early cinema genre of the Phantom Ride perfectly characterises this synthesis of technologies around a novel form of perceptual experience.

proprietary technology of large format filmmaking and projection which employed just such a high frame rate. Despite its excellent picture quality and enthusiastic reception, Biograph were in the process of abandoning their USP in favour of the ubiquitous 35mm format. Theoretically, a Biograph fitted with a three-blade shutter would have introduced benefits in terms of costs and ease of operation, allowing for a reduction in the amount of film used, the sheer quantity of which made both the camera and projector notoriously hard to manage. Although it was not to be, this does perhaps add a motive for AMBC's sponsorship of Pross' research.

Pross' research also showed that equality of the closed and open sections of the shutter is advantageous. It is a finding which others such as Proszynski would reiterate, but which in practice was often compromised, the anti-flicker blade(s) often being made with a smaller sector than the cover blade in a bid to achieve a brighter image.

In the typical language of patents, neither Smith nor Pross commit themselves to the use of only three blades. Smith's patent describes having experimented with ratios of interception of between four to twelve times the period of rest, and that 'Eight I have found to be a good number.' (Smith, 1903). Like Hepworth, he also comments that it can be advantageous to vary the size of the cover blade for pictures of differing 'subject' or 'class'. It is also noteworthy that the claims for flicker are rather more modest than in much of the sales literature: 'although I do not entirely remove it I do remove so much of it that its disagreeable features are done away with.' (Smith, 1903). Smith's form of words here seems to suggest the question, if no longer disagreeable then, is it agreeable?

A European debut for the three-bladed shutter is ascribed by Deac Rossell to the German travelling showman, Theodor Pätzold, as a one-off adaption to his Messter projector. His innovation was quickly taken up by Max Gliewe, Oskar Messter's engineer, and incorporated into the Messter Modell XI projector of 1902.[233] In this way, the heuristic process of the exhibitor/tinkerer working in the worldwide open 'laboratory' of early cinema is seen to give rise to more or less simultaneous solutions. Of course, given this method of invention, there may well be earlier and later inventors of the multiple-blade shutter secreted amongst the scattered remaining evidence of the international community of film pioneers.[234]

Having sifted through the origin stories of the three-bladed shutter, my main concern remains the danger of an assumption, made retrospectively from the position of its eventual near-universal adoption, that once summoned into existence by Pross, or Smith or Pätzold, it was seen as a panacea and rapidly spread throughout the world's screens. This is certainly not the impression received from a

[233] Rossell makes this creditable claim at least three times (1998a, 32 note 5); (2001, 52); (2014, 337, note 45) on the basis of the same secondary source: (Ilgner & Linke, 1994) Unfortunately, Ilgner and Linke do not give their source and apparently there is no known documentation of the Modell XI. 'Von dem ab 1902 hergestellten Modell XI sind keine Unterlagen bekannt.' (Ilgner & Linke, 1994, 105) A Modell XII from 1904 with three-bladed shutter does exist, however, and is illustrated in their article, although in such a way as to hide the shutter. (Ilgner & Linke, 1994, 104).

[234] For example, Jancovic, (2013, 29), conscientiously mentions a comment of F H Richardson made *en passant* implying an earlier use of a three-blade shutter by Thomas Armat in the Vitascope (Richardson, 1940, 469) I feel, however, that Richardson's text is not sufficiently defined to be useful as historical evidence.

host of references to other forms of shutter design that continue to appear for the remainder of the early cinema period and longer. The important task is to gauge the actual uptake of the invention and this research has not, to my knowledge, been carried out. It would require not just more thorough documentary research but extensive cross referencing in the apparatus record. Practically speaking, the current inaccessibility of the apparatus record for such a finely framed yet necessarily broad enquiry is likely to frustrate any such attempt.[235]

Charles Musser claims that, upon switching production to 35mm from its proprietary large format system, Biograph fitted the new shutter to its own Urban Bioscopes and that 'The company also apparently shared the technology with Charles Urban, providing him with one of the key assets that launched his business.' (Musser,1994, 345 and note 10 p.520). Rossell merely repeats Musser's claim (Rossell, 1998, 32, note 5). However, neither Musser nor Rossell give the source for these claims and certainly three blade shutters are not shown in the catalogues or present on the extant equipment which I have referred to in Chapter 4. Rather to the contrary, the 1903 catalogue, the first from Urban's new company shows the latest model Bioscopes incorporating the debut of a two-bladed shutter with an opaque cover blade and a translucent violet 'anti-flicker' blade. While qualifying as a multi-blade shutter the design is distinctly different from Pross's patent which makes no mention

[235] Research on shutters specifically is particularly challenging as they are not catalogued as separate items and rarely mentioned in the catalogue descriptions of projectors.

of translucent blades of any colour. It is possible that there were national differences in the uptake of the three-bladed shutter but it seems highly unlikely that Urban's Bioscopes in the UK would have been advertised for another ten years with twin blade shutters, as they were, if this uptake was as universal as it is imagined to have been. In a paper delivered to the Royal Photographic Society in 1913, Kasimir Proszynski estimates that the three-wing shutter 'has been in general use especially by important firms of cinematographic apparatus manufacturers for about three years.' (Proszynski, 1913, 100). Proszynski gives this date due to his delivery of an earlier paper on 7 June 1909 to the Academie des Sciences in Paris, the import of which had apparently been taken up by Gaumont. Despite the detailed research into the problem of flicker that he had conducted up to 1913, he shows no awareness of the work of Pross or Messter, indeed he is disparaging of the eccentric shutter designs of German projectionists.

The lack of clarity over the prevalence of three-bladed shutters means that we have to be more cautious about applying the benefits of three blade projection to the experience of cinema in the early cinema period. Musser is reasonably qualified when he writes,

> With the rise of the story film coinciding with the introduction of the three-blade shutter (1903), which reduced the flicker effect, the spectator potentially achieved a new level of sustained attention. (Musser, 1994/2006; 405)

However, although the potential existed from 1903, my impression is that uptake was very gradual and somewhat haphazard. Indeed, use of a three-bladed shutter at this time would have been exceptional rather than commonplace. Furthermore, the interaction of flicker and attention is a delicate and complex one. There is the question of attention to what? Presumably, Musser means attention to the film content and its story, as the way is paved for the arrival of the cinema of narrative integration. However, attention to the story is to some extent in opposition to attention to the experience, or at least the dual perception of story + experience. Elsewhere, Musser has mobilised the known fact of '1903' rather less cautiously, extrapolating immediate changes to the logistics and profitability of early film shows.

> Before the introduction of the three-blade shutter for projectors in 1903, traveling exhibition was logistically challenging and often of limited profitability. (Musser, 2005, 341)

The work that has so far been carried out on the adoption of the multiple blade shutter needs not only to be refined in its own terms but cross-referenced with the apparatus record to gain a better understanding of the likely perceptual reality of film projection in the mid early cinema period. The possibility of national difference in the uptake of the crucial innovation is especially intriguing, unlikely as it may seem given the global nature of other aspects of cinema. However, the above evidence would seem to indicate introductory dates for three blade shutters of 1903 for the US and Germany, 1909 for France and even later for the UK.

Post 1903: a continued belief in translucency

The discussion in this section is informed by seemingly anomalous discoveries in the apparatus archive. Firstly, following on from the fragment of violet tinted shutter blade found on Bioscope no. 1351 and discussed in the previous chapter, the forgotten practice of violet tinting is briefly revisited. Secondly, an unusually complicated, mostly translucent, shutter carrying the number of a 1916 patent and part of a Walturdaw projector present in the Eye Filmmuseum collection, initiates a wider research into some extravagant shutter designs created at the end of the early cinema period. A photograph of this latter device is presented at the beginning of this chapter. Neither item bears any resemblance to the orthodox three-bladed shutter supposedly in use from 1903 despite both being of a later date. They point, rather, to a continued belief in the crafting of light in terms of luminance rather than frequency.

Violet fishtails

A single translucent cover blade was a short-lived feature of some projectors of the late 1890s, although most were opaque. However, by 1903, the new Bioscopes made by Charles Urban's freshly established company revisited translucency by adding a second blade opposite an opaque cover blade. Unlike the earlier translucent blades it was now also tinted violet. The CUTC Bioscope catalogues from 1903 and 1907 name the shutter in two parts, 'K: Opaque Revolving Shutter; L: Translucent Violet Shutter Blade,' which may imply that they could be employed separately or in combination, according to the user's intention. Catalogue illustrations appear to describe a sector of 60 to 90 degrees for the opaque cover blade and somewhat less for the translucent one. In the 1910 and 1914 catalogues they are still available but the names have changed to 'K—Cut-off Shutter; L—Anti-Flicker Shutter.' Other companies also offered violet blades. They cost 3d each, or five shillings for a complete shutter, from Walturdaw who also fitted them to their own bioscopes.(*Walturdaw Bioscope Specialities*, n.d.) Colin Bennett details their use in 1911.

> A more recent and still very generally accepted way of minimising flicker has been, not by experimenting with the regular light intercepting shutter blade, but by balancing it with a 'non-flick' fishtail of violet celluloid or gelatine attached to the shutter shaft so as to cross the light beam at the moment when the regular cover sector reaches the middle of its off position
> Bennett (1911, 120)

Although as another trade writer, Frederick Talbot, says of the practice only a year later, 'This is effective to a certain degree; but it has been superseded by a shutter having three blades.' (1912, 95) Bennett had to wait for a subsequent edition to update his account, finally concluding ten years later that,

> There seems to be no doubt the three blade shutter cures flicker simply through increasing the frequency of alternating light and dark sensations till they become too fast for the eye (or brain) to register individually. We should not be surprised at that if we spare a moment to recollect how the man who plays the side drum in the military band makes a similar illusion of continuous sound with his drum-sticks whenever he produces a "roll." Only it is wonderful no one thought of the additional second " non-flick " blade before they did. (1923, 59)

It is indeed wonderful not only that no one thought of the idea of increasing the frequency with another blade 'before they did', but that once they had done, in

1903, it took twenty years for it to be widely adopted! I would suggest this was not just the cussedness of reality but due to there being more at stake than a simple pursuit of flicker reduction. As the example of the violet fishtail shows, the addition of a second blade would have already doubled the flicker frequency and reduced the apparent flicker, but was the second blade non-flicker because it was a multiple of the first or because it was tinted violet? The answer of course, is both but if it had been solid it would have reduced flicker even more while at the same time decreasing the brightness of the image. In other words, the violet fishtails were not seeking to eliminate flicker at the expense of a bright image but maintain a balance between flicker and luminance. Flicker was not so despised that its subjugation to unreportable levels merited a dull picture.

Despite apparent widespread use, at least in the UK, there are hardly any surviving violet blades. Of the 24 Bioscopes listed in the philology only no. 1351 retains a small fragment. If we take Talbot literally, that would be because of their rapid obsolescence but they were also made of brittle plastic or gelatin and thus easily damaged. Although the existence of violet blades for shutters is well attested in sales and advice literature and handbooks, the rationale for their use is rarely discussed. The only source I have found comes from a shutter designer who reported on the reduction in luminosity which violet or deep blue achieves in comparison to other colours in the spectrum and the consequent virtual elimination of travel ghost when employed as a translucent masking blade.[236] As was known from Porter's experiments, discussed in the previous chapter, the luminance of colours in the spectrum varies and with it their critical flicker frequency. Later experimental research also discovered that '[t]he weight of the evidence indicates that color itself over and above the luminance of the color acts as an independent determinant of CFF.' (Landis, 1954, 283).[237]

Mica and silk: the forgotten materiality of the shutter

Specialist accessory shutters such as the Branson patent device pictured at the beginning of this chapter were probably available independently of the major manufacturers. They may have been intended either as a direct replacement for standard equipment or to be kept on hand alongside other shutters as a means of compensating for a variety of different projection situations. Two surviving Branson shutters help materialise the questions provoked by such a device as well as indicating some of the practical issues surrounding research into physical objects.

It was the physical example in the Eye Filmmuseum collection that was my first contact with any of the traces of its existence.[238] It was attached to a Walturdaw

[236] See W. Osborne Runcie's 1922 presentation to the Society of Motion Picture Engineers. (Runcie, 1922)

[237] See also the research of Brindley previously cited in chapter 4. 'It is argued that the maximum flicker fusion frequency is about three times lower for the blue-sensitive mechanism of colour vision than for the red- or green-sensitive.' (Brindley et al., 1966)

[238] My 'discovery' of this shutter came about through a series of conversations with the collection custodian, Hans van de Kraan, and was the result of an extended deployment at Eye, rather than a more typical, targeted, research visit.

projector, possibly up to ten years older.[239] It is not known at which point the shutter was fitted to the projector but on the evidence of at least one Walturdaw catalogue it would seem not to have been part of the initial commercial offering of the projector.[240] My first impression of the shutter was one of a fussily complicated and slightly mysterious version of a familiar device. It was curious, to say the least, to find an example of a shutter from the late period of early cinema that carried a translucent cover blade, something already disparaged by Hepworth in the 1890s. Its embossed patent number led directly to a copy of the 1916 patent which indicated that the blade was, however, designed not to be entirely translucent but to be tinted, 'either being formed of a tinted transparent medium or by the superposition of a tinted film'. (Branson, 1917). In later consultation with Nick Hiley, I was made aware of a second example of the Branson shutter in his collection which bore an untinted translucent cover blade made from mica. On a return visit to the Eye Filmmuseum depot, it was possible to examine and photograph the shutter in more detail. I could therefore confirm the presence of a composite cover blade made of both mica and plastic with such 'ribs, flutings or corrugations' (Branson, 1917) as mentioned in the patent. The detail of these layers of material was virtually invisible in the half-light of the depot when not specifically looking for them. On very close inspection, a tiny trace of violet was still visible on the blade, though

[239] Eye catalogue number: APP358. The catalogue entry is for the projector and does not separately mention the shutter.
[240] See, *Walturdaw bioscope specialities*. (n.d.)

most had faded to nothing.[241] The cover blade was thus revealed to be a cocktail of once coloured mica and transparent striated plastic, the complete 'recipe' for which only survives on the Eye example, and in faded condition, at that.

Branson's design also features an 'intermediate' or 'auxiliary' blade which is adjustable and can be rendered opaque, in a confusing reversal of the practice established by the Bioscope and other machines of an opaque cover blade and a violet tinted 'anti-flicker' auxiliary blade. The Branson shutter is adjustable by virtue of two smaller sectors attached to each side of the auxiliary blade. These sectors are missing from the Eye example but present on the Hiley example which, in turn, has only the untinted mica layer of the cover blade present. In fact, due to these losses, only between them can these two shutters be considered a fully complete example.

According to his patent, Branson's aim with this semi-transparent cover blade was to 'avoid the great wastage of light' incumbent upon use of an opaque blade for the period of picture change. It is, in fact, nonchalant about the issue of flicker. The desire is to give brighter illumination, 'without undue flicker', a phrase which certainly seems to indicate a tolerance of some flicker. Rather than obstructing the light, he wished to scatter it, thus subduing the harsh exchange of light and dark produced by an opaque blade and the correspondingly intense flicker. He is aware

[241] The violet remnant can be seen in the photograph, but only because I made deliberate efforts to find an angle that would render it visible.

of the issue of ghosting raised by the use of a translucent cover blade and proposes a solution.

> To prevent the appearance of misty streams of light on the screen picture […], I provide the surface or surfaces of the blade with suitable ridges, prisms, or other corrugations, or vary the thickness of the material in different parts of the blade. (Branson, 1917)

Branson claimed that, 'during the cover period a shadowy image is shown on the screen which forms a sort of groundwork for the following picture exposed.' This phrase seems to evoke a partial ghosting and even combines it with the concept of persistence of vision: Any persistence would be mingled with the semi-revealed pull-down of the film in the gate. Despite this, Branson's theory suggests that he effectively achieves a half way state between the evils of the ghost and the darkness.

> Thus the illumination of the screen is maintained, thereby eliminating all flicker which would be due to alternating periods of contrasting degrees of illumination, and at the same time the streaks of light known as travel ghost are so diffused or spread over the screen as to be indistinguishable.' (Branson, 1917)

One wonders whether the intricate crystalline structure of the mica aided the light muddling and scattering which Branson described as desirable. While single sheet mica is uniformly transparent, thicker pieces made up of multiple sheets acquire subtle variations in opacity.[242] Certainly, it is clear from an even later patent by James Gordon that mica's light bearing properties were pliable.

> In order to present an increased translucent medium for the transmission of the light the mica segment [..] may be roughened, such as by emery paper.' (Gordon, 1920)

[242] See Thompson, (1901, 9)

Frederick Berg was adamant that the success of the translucent shutter blade must be in diffusing the passage of light. His shutter patent described 'particles of lustrous material' (Berg, 1915) on one side with the other side ground or frosted. Despite these experimental designs, it is difficult not to conclude that the spread of light indicates a weakness in Branson's design that would result in a loss of contrast in the projected image which would affect its overall impact. Hepworth's experiments of 1897 had already found translucent materials for shutters unsatisfactory. He preferred the flicker of an opaque blade to the fog of a translucent one. (1897, 55)

The opportunity to demonstrate the Walturdaw and its Branson shutter was taken during the *From Matter to Mind* workshop convened as part of this project.[243] Interestingly, no trace of ghosting was perceived, although the image projected was very dim, this despite the projector being placed close to the screen in the auditorium. This was undoubtedly due to the weak illuminant, an incandescent electric lamp, added to the projector at a later date. A precise evaluation of the performance of the shutter was therefore not possible without further modifying the projector and in any case, would have had to take into account the fading of the masking blade and the incomplete auxiliary blade. That said, the impression

[243] *From Matter to Mind: Expanding the reach of film preservation to include the cinema experience* took place on Friday 2 December 2016 at EYE Collections Centre, Amsterdam.

remains that the shutter's ability to make travel ghost 'indistinguishable' even at such low illumination was surprising.

On the evidence of the patent record, Gordon and Branson were by no means alone in their experiments with the translucency of the shutter.[244] In fact, Branson's patent had to be amended to avoid similarities with Edward Halford's earlier claim of 1914 which involved a semi-transparent masking blade composed not of mica, glass or plastic but of 'gelatinous or fibrous silk' (Halford, 1914). It was matched with fully transparent but coloured anti-flicker blades. Contrary to the expected spread of light, Halford claimed that 'the colored transparent light balancing blades prevent any appearance of milkiness in the projected picture.' Although describing himself as an 'inventor' in 1914, Halford's previous profession of Clothier must have been connected to his imaginative, tangential approach to cinema technology, just as Branson's work as a Kinematograph Operator had presumably informed his design. A patent of 1919 referred to earlier proposals for translucent blades but went further than Halford, suggesting use of 'one of the "well-known" shot silks now on the market' and sandwiching it between mica panels. The applicants, were Emil Alexander, another Cinematograph Operator, and J. O. Wyndham and Co., Cinematograph Engineers. Their preferred specification of silk had interwoven

[244] See for example, William Diggle's 1919 patent (No. GB135711A) for a transparent cover blade of wire gauze, silk, linen or cotton possessing the similar motive that 'there shall be no dark moment on the screen.' (Diggle, 1919). Like Branson, Diggle's profession was Kinematograph Operator.

transparently dyed threads of bronze and peacock blue. This exotic device was intended to improve,

> illumination to the screen by allowing a very large percentage of light to pass through the shutter, but also to advance the so-called stereoscopic effect produced on the screen, by giving an improved tint to the picture and to prevent flicker even when the film is running slow. (Wyndham & Co., & Alexander, 1919)

This raises the issue of a shutter-produced tinting effect which, as far as I am aware, has not been addressed by the recent research focus on colour in silent film.[245] It is relevant to all the patents discussed here as they all describe some kind of tinting process applied to the different blades of the shutters.[246] Branson's patent suggests the fixed leading and trailing sectors of the auxiliary blade can be tinted orange or yellow in order to complement the blue of the masking blade, effectively cancelling out a colour tint. Apparently further manipulating these sectors could also adjust the 'distribution of the tinted light on the screen', in order to 'correct the tinting on the lighter parts of the picture while leaving a "tone" effect on the darker parts.' (Branson, 1917)

What would be the effect of these proposed visual concoctions and how would they interact with the tint of the light source and the film material? How would these

[245] Colour in silent film has been the subject of multiple recent conferences and publications and is now thought of as a distinct research area. See for example ((Fossati et al., 2018) and the online resource, Timeline of Historical Film Colors at www.filmcolors.org

[246] John Cowan's 1920 patent (No. GB139225A) describes three ways to achieve the tinting of a transparent shutter blade. It can be introduced into an adhesive medium and painted on, mixed into the material during manufacture or sandwiched between the sections of mica sheet. Cowan's 'spectrum blue' tinted blade would seem to be a throwback to the Bioscope blades of the 1900s except that in this case it is used on all three blades including the cover blade or 'cutter'. It would supposedly increase the contrast in the picture enough to eliminate ghosting while the semi-transparent blades would also ensure minimal flicker. (Cowan, 1920)

shutters affect even a black and white film let alone one featuring tinting and toning of its own? With such competing colour mixing was there simply a drift to smother screens in antique brown? In any case, the logical corollary of tinted blades having an effect on flicker reduction is that the additions of colour tints and tones to the films themselves were not merely aesthetic or symbolic interventions but could also have an anti-flicker function. This has not to my knowledge been taken into account in considering the admittedly haphazard application of colour to silent film.[247]

It is worth noting that while the shutter was the predominant and logical site for efforts to control flicker, other experiments placed it as central to a solution for the desire to add 'natural' colour to the motion picture. While colour had been hand-applied to film from early on, in a simple remediation of lantern slide practice, much research was devoted to the goal of recording the colours of nature directly on to film stock and many of these endeavours utilised coloured filters incorporated into the shutters of both camera and projector, as with Smith and Urban's Kinemacolor process. Thus, in the early cinema period the shutter was seen not only as bearing the responsibility for maintaining the illusion of continuity in moving images, through control of the tell-tale flicker, but also as holding the key to unlocking the anticipated delights of colour cinematography. Later research would shift the site of colour back to the film material itself, but at this time the shutter was seen as central

[247] For discussion of the pitfalls in applying meaning to the applied colour of silent film, see (Hertogs & de Klerk, 1996)

to the maintenance of the illusions of constancy, movement and colour which were part of the developing realist ambition of cinema. In this period, the shutter was at the centre of the technological imaginary of cinema. It would not be so again until its ghost returned to haunt the technology of digital cinema with its absence.

Conclusion

These intriguing discoveries in the apparatus and patent archive arouse curiosity about their contribution to cinema aesthetics and experience. They have not, as far as I am aware, been given any prior consideration in film historical research or published writing. Few of the patents here discussed are likely to have had commercial lives and they have made little impact on the industry as it developed. They have therefore been overlooked until now but, even if not widely adopted, I would suggest that they are valuable evidence of the continuation of the technological imaginary of early cinema as it morphed into an industrialised and standardised product during the teens and twenties. They are evidence of a deep engagement with cinematic phenomena; showing careful observation, analysis and experimentation of an order which does not appear elsewhere in the sources of film history, and often carried out by the bystanders of the standard film histories. With modifications by projectionists taken on by manufacturers such as Messter or patents taken out by operator/inventors such as William Branson, Emil Alexander and William Diggle or even interested spectators, this is shutter design from the bottom up.

Given the sometimes-fanciful concoctions of materials, it seems many aspiring shutter designers paid only intermittent attention to what one might have thought of as the decisive researches of Porter, Pross, and Proszynski. This was certainly the view of Proszynski who commented bemusedly on the proliferation of these exotic shutter designs and their publication by the Patent Office in a 1924 article which was a follow up to what he felt had been a definitive statement of the solution to flicker in his 1913 article. He had noted shutter wings covered in silk and, more bizarrely, 'some sort of rare Australian or Egyptian clay, having evidently some magical power over the projector or over the audience'. (Proszynski, 1924)

Apart from wondering whether 'spiritistic phenomena' have influenced people's thinking, his reason for the neglect of his sound advice was that the case for the three-bladed shutter had been hindered by a lack of adherence to the necessity of having equal blades, so that sub-optimal three-bladed shutters still exhibited flicker. However, we can see that device's such as Branson's shutter had additional ambitions aside from a monolithic pursuit of flicker avoidance, they wished also to prevent light loss and offer a degree of aesthetic choice to the operator. Such shutters would have most likely been used in situations where the illuminant was under-powered and light intensity was at a premium, although this is not alluded to in the patent itself. The need for light in many situations was likely so great that some flicker was tolerated. This is further evidence that the effect of light sources and power sources needs to be considered and reconstructed, as suggested in chapter 3.

It seems in fact that there were two traditions running in parallel throughout this period. One giving priority to the question of flicker reduction and to minimising the disruption of the illusion of continuity and the other concentrating on modulating the quality of light in order to increase perceptual impact. Tuning in to modernity's shocks and flows, one might even say the frequencies vibrating around them, inspired by observations drawn from their increasingly mechanised surroundings as well as first-hand experience of film exhibition and spurred on by the reactions of their equally stimulated audiences, film pioneers such as Smith and Pross drove the development of new ways of managing that flow of almost 'unseen energies', and coaxing out of them a refined yet still subtly animated version of existence.[248]

However, other members of the laboratory of early cinema sought a more personal stake in crafting the perceptual experience of projected motion pictures. Interpreting familiar elements of their own lived reality, they came up with designs which retrospectively can seem puzzling, given the apparent return to ideas of flicker management based on degrees of translucency as first used in the 1890s and later moderated by the use of blue or violet tinted blades. Their sensibility and

[248] The phrase comes from an article in the *New York Mail and Express*, 25 September 1897, describing the first Phantom Ride film, Biograph's *Haverstraw Tunnel*. The review has been extensively discussed by Tom Gunning, in a series of articles. (Gunning, 1983, 1989, 2010)

approach were perhaps more pre-modern, and indeed 'spiritistic', with a penchant for arcane materials, a less theoretically informed and more instinctive approach to crafting with light or at least being thrifty with it.

Transparent shutters had the potential to bathe the whole room in flickering light. Although a displeasing spectacle to Hepworth, versions of it were perhaps attractive to those, such as Tille, inclined toward the 'astonishing and the alluring' or, for that matter, those, such as Barthes, who wished to luxuriate in the sensation of dual experience, of associating with a 'there', while simultaneously still feeling connected to a 'here'.

The consensus on the history of the shutter and the efficacy of multi-bladed shutters has had the effect of 'disappearing' these parallel and alternative histories and innovations. The agreed eventual outcome, and its roots in a bias towards the investigation of flicker frequency, has had the retrospective effect of limiting consideration of these designs and of a variable flickerscape of early cinema, firstly of its existence per se, but also of its duration and motivation. The possibility of its acknowledgement seems confined to early cinema's earliest, itinerant years, with historians such as Musser arguing for an adoption of the three-bladed solution as early as 1903, its first appearance in the patent record. However, in re-reading contemporary sources, and re-examining the material record, the period of experimentation seems to extend right through the category of early cinema and beyond into the 1920s, with the urbane Proszynski still feeling obliged to confront the preternatural beliefs of applicants to the Patent Office. The conventional narrative obscures the value of these recovered traces as evidence of the technological imaginary. It obscures what was a lively contemporary debate that can inform issues in our own time such as interest in the nuanced qualities of analogue and digital projected images or, indeed, the materiality and noisiness of a whole range of media.[249]

[249] See, for example, the recent book and podcast, *Ways of Hearing,* which investigates analogue and digital audio technologies and the taste for a certain amount of noise to be present in audio signals. (Krukowski, 2019)

Conclusion

> [t]he feeling that I got from looking at an empty room on film is of a rising potential, as if somebody was about to come in […] [a]nd the feeling I got on video was of somebody just having left.
>
> Walter Murch, quoted by Robbie Collin, 'Is it time to bring back the projectionist?' *The Telegraph*, 27 October 2015 [250]

The disregarding of the relation of the mechanical and perceptual in our experience of early cinema has been underestimated as problematic due to a number of fundamental factors. The apparent invisibility of technology in mainstream cinema experience, its ability to operate with a considerable degree of backwards compatibility and the remarkable resilience of our perceptual faculties to make sense of what they are presented with have all helped obscure the relation. Practices in archives and museums as well as methods of historiography employed by film historians have not generally challenged the situation established by these conditions. The film image has been the central object of the activities of preservation, exhibition and interpretation which have created the history of cinema. The *dispositif* of (early) cinema has been dissected and it has been repackaged for conventional film exhibition, during which process the traces of its technological mediation have been removed. The difficulty, not to say impossibility of preserving all aspects of the *dispositif* of early cinema has led to the modest ambition of accepting that which is aesthetically sufficient. It has been sufficient to corral the heterogeneity of early cinema technology on to standardised 35mm film

[250] (Collin, 2015)

running on standardised 35mm projectors. Then, following the end of 35mm as the mass medium of film distribution and exhibition, it has been sufficient, though more controversial, for digital methods of preservation and presentation to take its place.

The fine detail of the interaction of the mechanical and the perceptual has been lost within this general schema. By changing the focus to the relation of the mechanical and perceptual a different kind of early cinema history can be achieved. One which can be written, as I have here attempted, but also one which can be experienced. The story of the projector shutter and its varying degrees of flicker is exemplary of the kind of history as experience which can be recovered with this change of focus. It is a story that has been informed not just by the study of the apparatus but by a series of enacted film projections.

By attending to remnants of film technology as neglected texts and reading them through an informed understanding of perceptual mechanisms – understandings which were themselves being formed within the early cinema era – this thesis has aimed to release the potential of such sources and contribute to our knowledge – actual and sensed – of cinema experience. It has cross referenced this data with contemporary testimony of the technology in performance and its effect on cinema experience. Especially in the earliest period of early cinema this shows certain correspondences between the liveliness of technological artifacts and the lifelike movement and naturalism of the living pictures. Such testimony is less easy to disregard when cross referenced in this way and strengthens the argument that present-day presentations within FHIs should at least occasionally pull together the usually separated elements of the historical exhibition environment and enact demonstrations of representative examples of the early cinema *dispositif.*

In accepting that the 'invention of cinema was a collective activity by a broad selection of late Victorian society' (McKernan, 1996, 107) we may think of film projection technology and the moment of exhibition as the meeting place of this network of invention. Early cinema experience was co-produced and co-designed by the film equipment manufacturers, film making pioneers, projectionists and audience of early cinema. It was a vast network of distributed cognition. In some cases, these roles were combined in one individual, in the likes of Robert Paul, or Cecil Hepworth, who were making and operating their own equipment and using it to produce films and give film shows, and thus one imagines the sparks of innovation flowing seamlessly about their highly-informed person. In other cases, a showman may have been responsible only for operating the projection equipment and connecting with his audience. Either way, there is no single nervous system at work in early cinema. There is a negotiation between the audience and the operator which takes place through a mechanical medium which has been shown to have its own (within metaphorical limits) nervous system.[251] Such a situation still provided

[251] The work of Ken Jacobs has arrived at a similar conclusion through his artistic practice. His projection performances were even called *Nervous System* (Pierson, 2017) 'The *Nervous System* is the name given by Jacobs to the live projection setup that he developed and used for performances from 1975 to 2000. It consists of two identical motion-picture film prints on two 16mm analytic or

ample opportunity for creativity and interventions in a system which was accessible and open to adjustment. Emphasis in previous histories on flicker as a problem to be solved – perhaps following the lead of the technical sources of the period – has shut down consideration of a more nuanced environment, a wider technological imaginary, which allowed negotiation between flicker, ghosting and light intensity to be played out. It has over-simplified twenty years of cinema experience by suggesting that flicker-free three-bladed shutters took over from 1903 and minimised the ongoing negotiations and creativity represented by a significant body of alternative shutter designs.

The materiality of flicker

Over the last two decades, the increasing use of analogue film projection as an artistic medium exhibited in gallery spaces has in fact been posing and answering this question though it has not often been literally stated or commented upon as such. Use of film by artists corresponds with a 'truth to materials' perspective in which the origin of the experience of the artwork is indicated by reference to its material qualities. Where the visible (and audible) operation of the film projector is included as part of the installation the making of the experience is to some extent revealed. Additional to the presence of the projector materialising the process,

35mm filmstrip projectors capable of advancing one frame at a time and freezing single images on screen. An exterior shutter, in the form of a spinning propeller positioned between the two projectors, is used to rapidly alternate between, and blend together, the two frames by interrupting the projections with imageless intervals. […] The Nervous System operates on the temporal and spatial differences between two near-identical film-frames that are often only one frame apart from one another in filmic sequence.' (Jacobs, n.d.)

flicker gives a material presence to the images themselves which can aid engagement. By contrast, experience of film content which is static or consists of long takes can subjectively become tiring or boring when presented via video technology. It loses the inherent weight of time that is metronomically counted out by the borderline perceptible visual and sometimes auditory throb of the film projector. This can even translate into an almost uncanny feeling of presence such as intimated by the film editor, Walter Murch, in the quotation at the beginning of this conclusion. Flicker is also a material sign of the operation of the cinematic *dispositif*, of the connections between its seemingly separate components, the projector, the screen, the auditorium and the senses and mind of the spectator. As such its study - the study of temporal, and in its wider sense spatial, instability in the image - can be a key to unlocking access to all the frames of cinema - the obvious and less obvious - and establishing practices and initiatives in FHIs and university-based media studies education that provide this access. Of all the material signs of cinema only the now rarely encountered light cone has a similar power of connectivity. The appearance of the sign of flicker is variable, from barely perceptible to painfully aware, and likewise evokes a scale of reaction in the viewer, from ambivalence, through attraction to repulsion. However, at all registers of this scale it is still conducting its binding function. By making the flow of time slightly apparent, by overlaying intermittency on the apparent continuity of existence, flicker materialises our perception of reality, which otherwise slips us by. We cannot see the waves of light nor hear the waves of sound but, through the mediation of flicker, we can perceive an analogue of the vibrations of existence.

Image as experience vs. Image as evidence

Along with many other incremental changes to the cinematic dispositif over the last 120 years, the absence of flicker in digital cinema affects especially that part of 'filmic experience' that is an awareness of the 'fact of viewing' (Casetti, 2009). In analogue cinema, thanks to flicker, there is an experiential quality to the image itself as well as any other additional factors in the environment such as noted by Barthes. In digital cinema, the environment must supply all such interest, although rather to the contrary, the *dispositif* of digital cinema is one which wishes to concentrate solely on the immersive content of the film and remove all traces of external experience from its black box container.[252]

In addition, flicker is also likely to have a modest impact on cognitive engagement with the visual stimulus itself. In de-flickered imagery attention can be subtly diverted from a global awareness of the represented scene to a tendency to alight on certain details in the profilmic reality. [253] This effect can combine with the lack of

[252] With the unfortunate exceptions of fire exit signage and the smell of your neighbour's popcorn.

[253] This effect was commented on by a spectator at the demonstration which I conducted at 'The New Projectionists' event at Centrala, Birmingham, 24 February 2018. I presented two versions consecutively of the same Nöggerath film *De Dam Omstreeks 1901*. One was a 35mm print projected on a hand cranked projector with a single blade shutter and the other was a HD video copy of the film projected on a digital projector. The single shot film depicts much bustling activity, a horse drawn tram and people walking in all directions. The observation concerned the inclination in the video condition to track the detail of certain of the on-screen activities rather than taking in the totality of the scene

other artifacts removed during the digitisation and digital projection process as well as the already present nostalgia potential of the content to further shift the received meaning and inhibit the likelihood of a direct response to image *and* environment such as would have been available to original spectators. The effect can be summarised as a shift in the mode of reception from image as experience to image as evidence. Unsurprisingly, this configuration maps onto the archival dilemma detailed in the introduction concerning the preservation of experience and the preservation of information.

The example of flicker, with its attenuated scale of effects embracing attraction, repulsion and sublimated attraction, is emblematic of the whole host of merry vibrations thrown at the screen and the spectator in early cinema's frenetic offering. It took its place among the vibrations of the age, an age of 'vibratory modernism' (Henderson, 2002). When films made in that period are seen without the accompanying flicker a different 'way of seeing' is inadvertently encouraged which treats the film as isolated artifact rather than live experience. It is perhaps akin to putting it into a glass display cabinet, an aestheticisation and reification of an object shorn of its wider context.

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and its means of projection as in the film condition. The event was organized by The Projection Project, an AHRC funded research project run by the University of Warwick.

Paraphrasing

In this sense flicker is a frame to our experience of moving images. It is not of course one of the more literal frames of cinema such as the theatre architecture or the drapery of the proscenium arch, or, most literally, and if the posters are to be believed, the golden frame of the first gala presentations of Edison's Projecting Kinetoscope. However, flicker which, as we have seen is present in the screen, the screening space and the mind of the spectator, contributes to the unique context for cinematic experience and is a unifiying factor between individual components of the *dispositif.*

If we are to be historically informed spectators when viewing 'technological images' which have been migrated through different technologies, if we are to be heirs to Tsivian's medium sensitive viewers, we need to be aware of the system of frames at play in any given viewing situation. In order to be able to calibrate our senses and in order to be able to imaginatively extrapolate the effect of the addition, removal or replacement of framing devices a process, which one might call paraphrasing, is necessary. For effective paraphrasing to be possible, however, more opportunities are required to build and maintain the perceptual and cognitive experience which is its foundation. This should be taken seriously as a new mission for FHIs and it will fulfil in part their commitment to education both of student populations and the interested public. As moving image technologies draw ever further away from the 1890s, FHIs would do well to make a space for the kind of enactment activities discussed in this thesis, in which diverse technologies can be compared and in which the modular transfer function (MTF) of a century or more of media migration can be applied to the paraphrasing process of spectatorship and help us to acquire 'an open and adaptive cinematic consciousness.' (Edmonds, 2018, 82)

Implications for the work of the archive

Artists' involvement in the investigation of exceptional qualities of cinematic experience has produced a body of work which demands a highly defined *dispositif* for its exhibition. As time goes on, it would be anathema for these recently created works which deal directly with subtle distinctions of the analogue film system to be made accessible or even preserved through transfer to a digital medium. The authorities charged with the preservation of this work, such as the Tate conservation department are fully aware of this situation and, treating such works as installations, make careful studies of the complete environment to ensure they can be accurately installed with all aspects intact at a later date. The relatively new field of preservation of media art has already produced a body of literature on these issues.[254] By contrast, however, the authentic performance of early cinema has not received this kind of attention.

[254] Nevertheless, artists' own response to this situation is disconcertingly disparate.

This gives rise to the logical absurdity of a situation in which works from the recent past are preserved with a rigorously intact *dispositif* – one which in its technological component happens to be in direct descent from that of early cinema – while works from 120 years ago, from the period of early cinema itself, are exhibited via a medium which comes from 120 years into its future and which in technological terms is scarcely recognizable as related (albeit that its function is accepted as virtually identical).

This thesis is not about the insistence of a purist approach to early cinema, rather it seeks to recover the dimension of experience in order to more fully address some important and outstanding questions. Just as proponents of early music do not insist that *all* performances of music written in the early music period are given on period instruments they do however benefit from insights into the text and context of compositions that such performances reveal. It is important to stand against the slippage by which such transformations become understood as representative of an idea of the original. Without this acknowledgement there can be the danger of an assumption of equivalence. A film, once it is restored and then made available to theatres and released in a consumer format for home cinema, is often assumed to be returned to an original state, perhaps with textual corrections made, and damage removed but where no thought has given to the recovery of contemporary exhibition technology.

It’s what they saw but it’s not how they saw it.

To luxuriate in the detail of digital Imax biograph films is a fine thing; the ability to watch silent comedies on one’s iPad in the bath is a treat, but it is easily conflated into thinking that we have experienced the film as its contemporary audience would have done, that we know the film in the same way as its first audience knew it. And let us not think that we therefore have a sound basis for writing film history, having watched *The Great Train Robbery* (1903) on youtube, anymore than previous histories written on the basis of an acquaintance with a set of scene stills.

The paradox that the most perfect presentation of archival film content must accept the preservation of many imperfections has been recognised in some cases at the level of film material but not at the point of film exhibition. The revelation of the variability of the experience of flickering film technology and the extended period in which it was reportable and subject to negotiation and experimentation implies the need to rethink the archive and other components of FHIs to accommodate a preservation of cinema that considers the hardware, the software and the wetware. There is a need to raise awareness of the historical complexity of cinema technology which is in danger of being flattened out or distorted in the digitisation process and we need to find effective ways of communicating that historical experience to modern audiences. The archive needs to connect in the most profound way possible with the objects with which it is charged with preserving, thereby bolstering the arguments for their continued collection and preservation and finding ways to make them productive and relevant to a new generation of researchers.

A figure like T. C. Porter can be a model in carrying out this new work of the archive. The transdisciplinary approach of this research has revealed Porter, previously unknown in film studies, as central to defining the terms of cinema experience, through his work on the relation of luminance and flicker frequency and its control over our response to flickering light. He was one of many interested observers of the new technologies of the moving image whose observations, research and feedback nudged its amorphous potential into the direction of what became cinema. However, he is rare amongst the intellectuals of his time for a specific engagement with the new phenomenon of 'living pictures'. His contribution to our understanding of the mechanical and the perceptual is exactly the sort of story which needs to be introduced into film historical debates in order to counter the bias towards the 'software'. The further investigation of the figure of Porter and the detail of his cinema going habits is potentially one of the most productive avenues for future research to emerge from this current work.

Activating the apparatus collections

Of the 20 Bioscopes listed in the philology only one is on public display. The example in the Museu del Cinema Girona is presented in a traditional display which does little to convey its relevance as evidence of a lively interactive link between film exhibitor and spectator and remnant of the flickerscape of early cinema. It is a 1903 Model H, representing a midpoint in the continuous record of development discussed in chapter 4, with at least five prior models preceding it. The museum label, however, describes it as 'vers 1897' and it is not even identified as a Bioscope but 'marca desconeguda', despite its cast in name of 'Warwick Bioscope'. Apart from insufficient research, what is apparent in this misattribution is the desire to claim the earliest date possible for an object. This indicates a teleological approach which values 1890s devices as representative of the culmination of pre-cinema and the beginning of cinema and is less interested in later phases of development. However, a more interesting story can be revealed by taking the object on its own merits, as an ossified moment of a mechano-perceptual process in live development amongst a community with an 'experiential common ground' (Gauvin, 2016). Such devices are a snapshot, or snapshots in the case of modified machines, of the flow of innovation. The challenge is to find ways to communicate that story and the extra sensory involvement of a live demonstration is a good place to start. If the visual, aural, olfactory, sensory event of early cinema that I experienced in Bologna could be delivered as a regular component of FHIs programming, then its public would start to have a common foundation of experience on which to build an understanding of the decidedly 'foreign' objects currently housed in their vaults.

I would propose a step further. Just as my research into the mechano-perceptual circumstances of early cinema performance demands a performed response, then the discovery in the apparatus archive of a rich vein of technological experimentation demands an experimental response. The 'mystery' of the Branson shutter can only be fully revealed by a more thorough activation, ideally by comparative testing against a wide range of the competing shutter designs and shutter materials operating in the early cinema period. Such experimentation – which could well take the form of an experimental media archaeological workshop – would shed light on a range of perceptual effects available in the early cinema period. Seen *en masse* it would help to chart the early cinema flickerscape and begin to perform an impression of its true variety.

This thesis thickens the work begun by the Brighton generation of scholars in the 1980s who paid increased attention to the images of early cinema as well as their wider social, economic and cultural context. More particularly, it focuses on something of the audience experience which cannot be revealed by the images themselves but which can be discerned in the interaction between technological infrastructure and human perception. The method used to uncover this connection can be applied to other aspects of the apparatus and suggests further avenues for research in the activation of the hardware of cinema, especially lighting technology, as well as the biographical details of certain key individuals, like Porter, whose work brought together the fields of the mechanical and the perceptual in early cinema.

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Appendices

Appendix 1.

Edmonds, G. (2014). Reading 'Hand-Powered Mentalism'. In *Media Archaeology and Cognition—Transtechnology Research Reader 2014-2015* (pp. 120–134). Plymouth.

Appendix 2.

Edmonds, G. (2016). Electrophysiology of Cinema Spectatorship. In *Off the Lip Conference—Transdisciplinary Approaches to Cognitive Innovation. Conference Proceedings* (pp. 43–50). Plymouth: Plymouth University.

Appendix 3.

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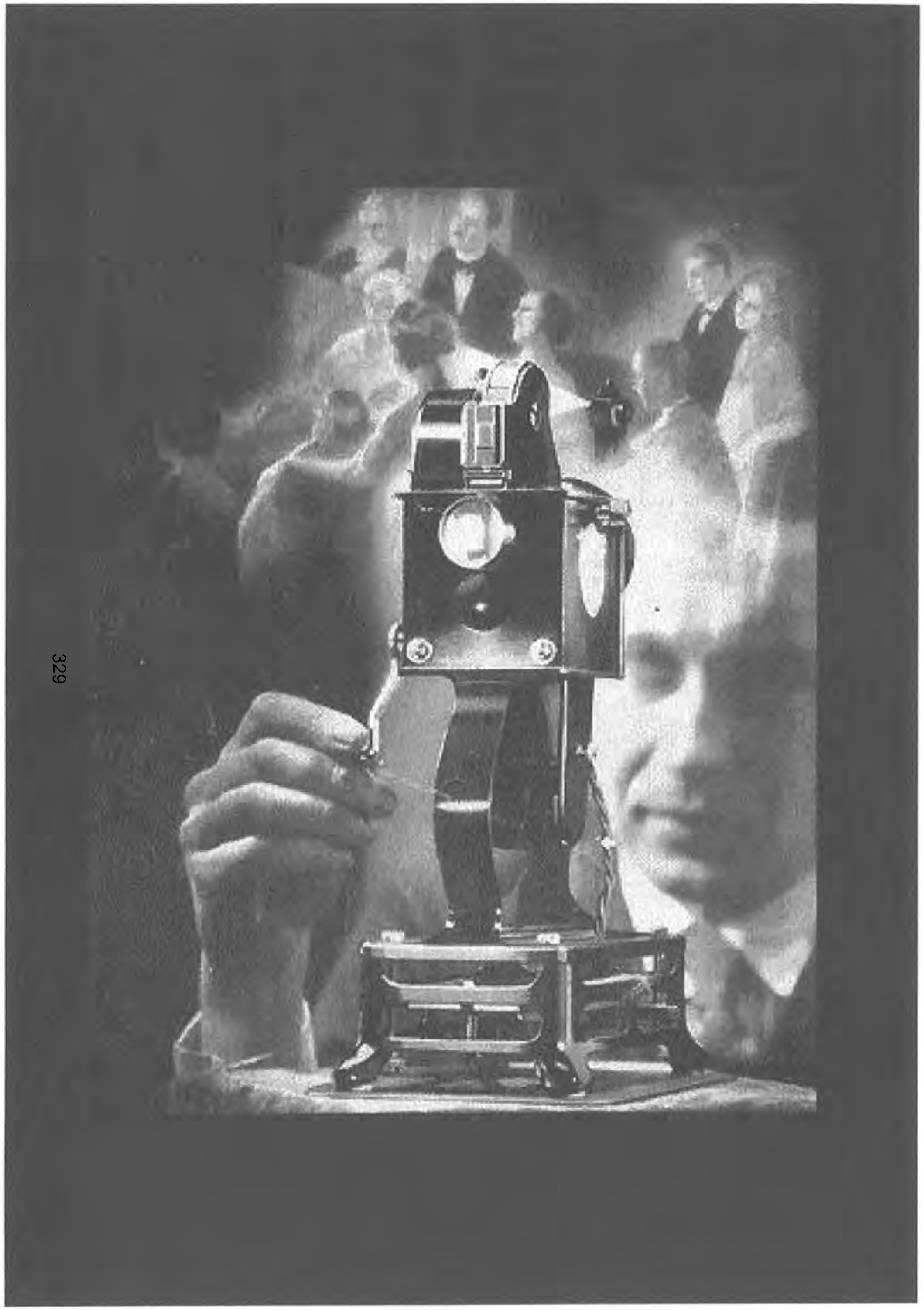

Reading 'Hand-Powered Mentalism'

Guy Edmonds

The image *French Poster, 1926* is one of many commissioned from commercial artists by Pathé during the 1920s in order to introduce their 9.5mm film gauge to the newly expanded market of home movie making[1]. The camera, projector and film stock were first made available in 1922, shortly before Eastman Kodak launched their 16mm gauge. The advent of these two formats finally established the widespread practice of home movie making, two decades after the beginnings of professional filmmaking and exhibition at the hands of pioneers such as the Lumière brothers and Robert Paul.

The publicity images produced by Pathé employed many different visual styles and included some very attractive Art Deco examples. This image however seems to have a different heritage and set of visual associations. It invites an approach, using the tools of media archaeology, to investigate moving image projection technologies and their impact on human perception and cognition. As we will see, this image has much to say about coeval ideas concerning the psychology of film spectatorship. However it is first necessary to approach a slightly older tradition to which the image refers. Among the class of images that show moving image technology in use, many of which are to be found in promotional literature, this is one of the most layered and enigmatic and is particularly striking because of the visual elision of that technology with the iconography of spirit photography.

The first spirit photographs actively framed as such are generally acknowledged to have been taken by William Mumler in the 1860s in

Boston, Massachusetts[2]. Mumler's fortunes waxed and waned considerably until his impoverished death at the age of 52 in 1884 as his initially unique brand of photography was enthusiastically adopted and then hurriedly dropped following allegations of fraud. This cycle repeated itself in the careers of later spirit photographers but despite being constantly challenged by the literal minded the practice was popular enough to survive any number of revelations of foul play, undergoing a renaissance, like much spiritualist activity, after the First World War. A spirit photograph would typically consist of a portrait of a sitter with an additional soft-focus partial image of what was presumed to be a deceased relative, though there were many variations on the theme and images of dead celebrities might also make an appearance. Some of these stray images are rather carelessly sprinkled about the pictorial space while others are more artfully gathered around the sitter's head such as those by Ada Emma Deane created in the years 1920-23 (Chéroux *et al.* 2005, pp. 82-85).

This Pathé image seems to engage in a visual play with what would have been at that time a more commonly recognized photographic genre. Although it is unlikely that an advertising image would have sought to fully provoke such occult associations, I would argue that we can see here a residue of the initial reception of the cinematograph as a resurrection machine.[3] Such associations also place the device fully in the heritage of the magic lantern and the phantasmagoria, a technology famous particularly for the ghost raising séances practiced immediately after the French Revolution, but also familiar to many of the Victorians still living in the 1920s.[4] The engagement with occult imagery is somewhat lessened by the obvious gaiety of the scene depicted but nevertheless refers to what are presumably close friends and relatives of the operator, just as a spirit photograph would connect the disparate figures within its frame with a pre-existing emotional bond. That said, even the operator himself here seems to have a vague transparency, as though only the machine itself is reliably and solidly manifest.

Another aspect of the assembled familial host also bears comparison to a trope of spirit photography: in contrast to the photographic origins of

the image of the projector and its operator, the depiction of the ghostly *soirée* is obviously an illustration. Not only does it have a less veridical status, but it is actually a pre-existing image from Pathé's library. A more complete and less ghostly version of the image is used on the cover of the catalogue for the Baby produced in October 1923. That iteration also includes the all-important screen with a projected image of a sailing boat as well as two extra viewers near the screen. In the image under discussion this recycled illustration is also reversed, echoing the operation of photographic and indeed physiological visual imaging systems and reminiscent even of a peculiarity of the 9.5mm gauge itself, which, with its distinctive central perforation was all too easy to project accidentally as a mirror image. This practice of recycling and mixing photographic and illustrative material was no doubt common amongst commercial artists and indeed amateur scrapbook makers but it also has precedence in the construction of certain spirit photographs as well as the famous Cottingley fairy photographs of 1917 and 1920.[5] The reworking and knitting together of different pictorial sources was the hands on reality of a practice which often alluded to its hidden literal manipulations with performed rituals, such as the laying of the medium's hand on the photographic plate in order to sensitize it to spirit manifestations.

Looking at this image in the light of spirit photography encourages the idea of seeing the projector (and related technologies) as a resurrection machine especially when situated as it is in a domestic environment in which family members alive and dead are connected by the invisible bonds of memory. However, the cinematographic apparatus has other, less esoteric, functions which are nonetheless tied to the mental life of the observer. It is unclear whether the operator in this picture is remembering, imagining or thinking but it seems indisputable that it is an image of some kind of cognition mediated by technology. The pictorial device of the thought cloud encourages us to read the image in this way especially in combination with the central figure's pensive, concentrated expression. It is a visualization of the act of mental projection underscored by the concurrent use of a literal projection apparatus. As such it is interesting to relate this image to the work of Hugo Munsterberg, the first psychologist to write a theoretical account of the effect of cinema on its human subject. As others have noted, "Projection metaphors abound in Munsterberg's The Photoplay and related writings on cinema"(Brain, 2012, p. 330). Munsterberg, who took up residence in Boston, as the director of the newly established Harvard Psychological Laboratory, just ten years after the death of Mumler, was the first to examine at length the mental life of the film viewer and noted that cognitive functions such as memory and imagination as well as emotions, are projected into the moving pictures by the spectator's minds.

Looking at the poster within this context, we can see a man imagining giving a film show and associate ourselves with the same activity, as a film spectator associates themselves with the screen presence. Or, to put it another way, the cycling of the image within the image continues in the mind of the observer of the image and is perhaps even emphasized by what we know to be the cyclical action of the projector's hand crank. One may mischievously wonder if the homunculus projectionist is also imagining giving a film show in his own tiny head. Interestingly, the poster achieves its effect using the equivalent of filmic techniques analysed by Munsterberg. The main part of the picture is a close up of the projector and its operator. This immediately holds our attention. As Munsterberg says;

> The close-up has objectified in our world of perception our mental act of attention (Münsterberg, 1916, p. 87)

But buried in the close up is a secondary image, the medium shot of the film show and audience, which we read either as a memory or expectation, a flashback or flash forward or "cut-back" as Munsterberg terms it. What is more, the transition between what one might call the two shots of this 'film' is completed using a dissolve, another piece of the filmmaker's craft, to which Munsterberg has noted

> ...the effect indeed somewhat symbolizes the appearance and disappearance of a reminiscence. (Münsterberg, 1916, p. 99)

The poster echoes a new awareness of the psychological language of the cinema as theorized by Munsterberg ten years earlier but which many cinemagoers would have intuitively assimilated. Fittingly enough, this language is used to advertise the apparatus itself and to place in your mind the idea of importing the technology into your home.

Munsterberg's lab at Harvard was full of apparatus, including projection lanterns and treadle-powered and hand-cranked machines. Much of it was recorded in beautifully composed photographs made for the Chicago World's Fair Exhibition of 1893 (Schmidgen 2008). Skilled instrument makers such as Hermann Elbs would fabricate the apparatus to Munsterberg's designs in the same way that the Lumieres employed the engineer Jules Carpentier to construct the first Cinematographs. In this regard, it seems important to raise a further concern: In addition to the clear imagery of cognition, the picture also powerfully represents a physical, manual process. The hand of the projectionist is a dominant element in the composition, rendered larger in relation to the man's head than is natural because of the foreshortened viewpoint. Cameras and projectors of the early cinema era were often operated solely by hand, electrical power being used only for the light source, if indeed at all. The projectionist therefore had a greater degree of control over the presentation of the films and could vary the speed of projection at will. Although later developments in cinema technology would reduce the projectionist's role to almost nothing, at this stage the projector was more of an extension of the projectionist. It was a machine that required coaxing and attention in order to fulfill its function.

The conjunction in this image of the manual and mental therefore makes it an advocate for more present day theories in the field of embodied cognition, which are themselves linked to earlier traditions.[6] Raymond Tallis has argued for a re-evaluation of the importance of the hand in defining what makes us human, even at the expense of the reputation of our amazing brains, adopting the term handkind in order to make his point. Turning the frames of the film, the fragments of time, can be seen as a tactile experience like turning the pages of a book, promoting a bond between the technology and the user, which is absent in more black box style technologies. The hand-cranked projector offers a material resistance that is literally incorporated by the sensorimotor actions of the projectionist.

This image describes a synthesis of the functions of mind and hand operating through a mechanical extension, and implies a condition in which perception is manipulated through the manual use of apparatus. What's more, so the iconography of the image suggests, this integrated system controls not just perception of the immediate material world but also makes forays into that murkier world of memory, imagination and the afterlife. It suggests a kind of feedback loop that traverses both the mechanical and the handkind and it advances an argument in favour of early cinema technology in terms of its human / machine connectedness.

Notes:

[1]The image here is drawn from Jerry Wagner's website, Pathex.com, "The picture is of a Pathe Baby ad from the 1920's published in France. The one on the website is the best copy I have." (email to author, 21/06/2008). A more cropped and black and white version captioned "French Poster, 1926" is published by Jurgen Lossau (Lossau 2005, p. 201). Enquiries for further information from the Fondation Jérôme Seydoux-Pathé have so far proved fruitless.

[2]As noted by Colin Harding, there are earlier examples of photographs of ghosts but these were framed "as novelties and amusements and no attempt was made to present them as genuine spirit photographs" (Harding 2014).

[3]For example, both newspaper reviews of the Lumières' foundational screening on December 28 1895 acknowledged that this new device would change our relationship with our dead loved ones.

[4]The hated Robespierre, for example, was brought back in order to be "struck by lightning and reduced, tomb and all, to powder." (Heard 2006, 98)

[5]The fairies were drawn by Frances Griffiths and Elsie Wright, who copied illustrations from Princess Mary's Gift Book (1915) and then glued them to cardboard and supported them in situ with hat pins. (Chéroux et al. 2005,

p. 95) For "a timeline of fantastic photomontage and its possible influences, 1857 – 2007", see http://www.d-log.info/timeline/index.html

[6]Lisa Cartwright cites the mid-twentieth century work of Merleau-Ponty (Cartwright 2011)

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Plates -

Facing Page.
French Poster, 1926. See note 1.

Plate 1.
A. Radeno, Pathé Baby poster c.1925 from plates between pp 432-433, *Pathé à la conquête du cinéma, 1896-1929* by Stéphanie Salmon, Tallandier, Paris 2014

Plate 2.
Ada Emma Deane, page from album of spirit photographs, 1920-1923 [Chéroux et al. 2005, 82]

Plate 3.
Frances Griffiths and Elsie Wright, 'Frances and the Leaping Fairy', 1920 [[Chéroux et al. 2005, 97]

Plate 4.
Pathé Baby catalogue cover, October 1923 [collection, EYE Film Institute, F027(44) Pathé.film]

Plate 5.
author's compilation using elements from:

9.5mm filmstrip from *Motion Pictures with the Baby Ciné* by Harold B. Abbott Iliffe and Sons Ltd, London c.1926

'The Homunculus Objection'
Adapted by Dave Cantrell, originally published in Smithsonian 16 (1) (April 1985):97., see http://cns-alumni.bu.edu/~slehar/epist/rep4.html

Image as Plate 4., cropped and flipped horizontally.

Photograph and detail. Anonymous. 1892. 'Harvard Psychological Laboratory in Dane Hall: Instruments for Experiments on Sight'. (Harvard University Archives - HUPSF Psychological Laboratories (7))
See http://vlp.mpiwg-berlin.mpg.de/library/data/lit38688?

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Punt, M & Blassnigg, M. (eds.)
Media Archaeology and Cognition: Transtechnology Research Reader
2014/15, Plymouth University, 2014

Appendix 2.

Edmonds, G. (2016). Electrophysiology of Cinema Spectatorship. In Off the Lip Conference—Transdisciplinary Approaches to Cognitive Innovation. Conference Proceedings (pp. 43–50). Plymouth: Plymouth University.

Electrophysiology of Cinema Spectatorship

Guy Edmonds

Plymouth University, Plymouth, UK
guy.edmonds@plymouth.ac.uk

Abstract

This paper describes the background and preparatory research for an experiment that I will carry out as part of my PhD research into Early Cinema and Cognitive Creativity. With this work I intend to contribute to our understanding of the role of technology in the cinematic experience through forming a bridge between two quite distinct disciplines, that is the historical study of Early Cinema usually conducted within Film Studies communities and the investigation of human perception and cognition as undertaken within many branches of neuroscience.

Scholarly attention within film studies has been focused, naturally enough, on the content of the frame and not the spaces between frames. Film narratives have fascinated theorists as well as audiences and have also caught the attention of experimental psychologists from the pioneering work of Hugo Münsterberg a century ago to recent developments such as Neurocinematics. However, my concern is rather to trace the effect of changing film technologies on the cognitive life of the film spectator. This matters because in 120 years of public film viewing and especially the first twenty years there was a great variety of means by which moving images were produced and projected, the experience of which is not currently historically recoverable. I propose to engage with the diachronic challenge of accurately representing the experience of century old media by employing a combination of experimental media archaeology and techniques of electrophysiology.

An ongoing debate amongst the cinephile community of film professionals and dedicated cinemagoers has centred on the effects of the widespread shift from analogue to digital methods of image capture and exhibition over the last twenty years. In more recent times this debate has shifted from aesthetic concerns of the material differences to the experiential qualities of both systems. However, despite the common binary opposition of analogue and digital, in truth the debate only restates concerns that have always been present about the effect of the technological infrastructure of cinema and its frequent obscuration by much wider debates about the content of film. From my perspective as a practicing film restorer it is important to ensure fidelity to both material and content but in this current work my driving concern is about the misrepresentation of one form of media by another and consequent misinterpretation by audiences.

It is true that this issue may not trouble general audiences. Indeed the brain and visual system is highly adept at inferring meaning from degraded stimuli and it is likely that most viewers simply see through the medium and focus on the content. However we are also able to sense stimuli which are never consciously acknowledged and it is understood that, although we are unaware of it, such information builds and influences our worldview. This points to at least the potential for a barely sensed audiovisual medium to have an effect on the perception and cognition of a viewer and although a generic contemporary audience may not reflect deeply on the means by which it views moving images, for film historians, conservators and curators, working with the remains of 120 years of film exhibition, these are very real problems: The historian wants to know what effect a certain film had on its first public, the conservator with a quasi-Hippocratic duty to 'do no harm' needs to know how their necessary interventions may alter an object and therefore the historical record and curators want to know how to best communicate the essential qualities of a historical film to a contemporary audience. In each case there is the danger of a kind of short-circuiting of history if incorrect decisions or analysis is made, so that what is presented as historical argument, artifact or experience is actually only an ersatz copy or parody. The pioneering work carried out in the 1960s by the likes of Kevin Brownlow (Brownlow, 1968) and George Pratt (Pratt, 1973) which saved the reputation of Silent films from the slander perpetrated by unsympathetic appropriations is an early example of this desire. What I now wish to add to such work and the subsequent decades' efforts of film preservationists is an understanding of how, despite our best efforts, changes in the technology itself have gone unaccounted for in terms of their potential influence on our experience.

In the collaborative, interdisciplinary environment fostered by the educational programme of CogNovo, I was able to match my interest in better defining the special character of the experience of watching a film and my concern that preservation of that experience, complete with ancillary services and collections, was being neglected, with knowledge gleaned from the science of visual perception. Through consultation with the psychophysicist, William Simpson, I learned that there is considerable evidence in the form of brain wave recordings (Electroencephalograms or EEG) that suggest that the human visual system accommodates its operating frequency to that of the perceived stimulus. These findings, which originate in research carried out by WG Walter in the 1940s and 1950s (Walter, 1953), are accepted as part of the scientific record in the study of visual perception and indeed used widely in clinical applications. However, they are very rarely found in the discourse in film and media studies with which I am familiar through my background in film archiving and restoration. Given that brain rhythms are also thought to be widely responsible for moderating cognition, it therefore follows that a flickering stimulus has the power to alter and direct our cognitive state.(Herrmann, 2001)

The resonance phenomena seen in EEG tests, also called steady-state visual evoked potentials or SSVEPSs, can be evoked well beyond even consciously perceived flicker, up to at least 75Hz, suggesting that the entire range of historical through to modern day cinema spectatorship is potentially implicated in the creation of technologically driven brain states. The variety of technological solutions to creating apparent motion extends not only to the speeds of projection (frame rate), shutter design and synchronisation employed but also through hand-cranked and continuously variable motor driven mechanisms which would have created a stimulus of variable frequency. A major difference in the design of digital projectors is the absence of a shutter, the component of analogue film projectors that is primarily responsible for creating flicker, although only as a side effect of the requirement to invisibly pull down the next frame in the filmstrip. The later adoption of standards masks a proliferation of alternative and developing technologies within the early cinema period that are mostly overlooked by the mainstream of media history but which have the potential to richly thicken our understanding of the historical media landscape.

This knowledge has not yet been applied to the extensive scholarship of early cinema and is not even found in discussion in the journal of Society for the Cognitive Study of the Moving Image (SCSMI). More recent interdisciplinary work carried out by film scholars such as those collected together in SCSMI has still assumed film studies' traditional object of study, the film narrative, to be a technologically independent entity. Textual studies have been extended with the application of laboratory techniques to usually mainstream film viewing. This relatively new work is collected under the name of Neurocinematics (Hasson et al., 2008) or Psychocinematics (Shimamura, 2013) but within such studies there is surprisingly little regard for the sheer variety of cinematic technology and its potential for eliciting varied subject responses. Neurocinematics tends to concern itself exclusively with classic mainstream fiction filmmaking and has apparently attracted the attention of film studios, keen to make the art of backing the blockbuster and avoiding the flop more of a science (Randall, 2011). Interestingly enough, in this way it signals a cultural revival of a more or less forgotten history of physiological testing of cinema spectators which Ana Olenina has recently brought to light in her investigation of the work of William Marston, a pupil of Hugo Münsterberg, the Harvard professor often credited with writing the first psychological analysis of cinema (Münsterberg, 1916). Working in the 1920s as a consultant for Paramount and Universal studios, Marston conducted studies which measured blood pressure and respiration changes in subjects watching film scenes selected for their emotional content.(Olenina, 2015)

Employing the knowledge I have gained from the history of EEG testing, I will also carry out experimental work on film viewers. My investigation will seek to compare the brain response of human subjects, while they view differently mediated projected moving images, produced by historic and modern projection technologies, operating at characteristic but different frequencies. I will compare participants' brain response to projections of analogue and digital versions of the same film stimulus. The intention is to combine experimental media archaeology (Fickers and van den Oever, 2014) – that is media archaeology in which the active use of historic technology is central to the investigation - with electrophysiological techniques.

Archival films from the early cinema period (1895-1915) will be used as stimulus. The content of the images will be the same but the means by which they are delivered will vary. For example, the same content will be delivered via 1) a DCP file through a 2K digital projector; 2) a 35mm film through a modern analogue projector; 3) a 35mm film through a c.1910 hand-cranked projector. In order to control for prior experience, participants will also be asked to complete a questionnaire that will assess their familiarity with viewing (historical) film images and the typical conditions in which they do so. Results from the experiment will be analysed for differences between the different conditions and the SSVEPs which they produce. This will enable me to see if the differences in frequency of stimuli are represented in the evoked potentials, as expected. It will also indicate how these differences relate to the induced, or resting state, potentials which are effectively the brain's default position.

Film studies uses the term *dispositif* to indicate the total environment and agents of an experience, including in the case of the cinema the space of the theatre, the projection technology involved and the eyes and brains of the spectators. It is a useful concept which in recent years has been refined further to encompass the distinct *dispositif* of early cinema (Kessler, 2006), (Parente and de Carvalho, 2008). The proposed amalgamation of the *dispositifs* of theatrical and home cinema with the EEG laboratory may in itself (regardless of outcome) creatively challenge debate. It will also have the effect of forming a curious critique of current neurophysiological investigations of flicker in which testing is carried out using simple stimuli and modern apparatus which aim to model different real life situations for laboratory enactment rather than engaging with a real object.

As both practical example and philosophical toy, I have obtained an original Butcher's Empire Cinematograph, a typical hand-cranked domestic projector from the 1910s, in order to gain first hand experience with early film technology. I demonstrated this machine to attendees during the Off The Lip conference because I believe it is important to engage fully with the object of research and indeed to give interlocutors the chance to respond to more than a PowerPoint image. (See Figure 1.)

In this case the text of the research is a machine and while it may be studied via the textual analysis of a printed discourse of photographs, patents, sales brochures and the like, interaction with the actual object is most likely to generate original insights.

Figure 1. The author demonstrating the Butcher's Empire Cinematograph Model A during Off The Lip. In the background hangs a poster incorporating a 1920s Pathé publicity image depicting a man hand-cranking a 9.5mm home cinema projector.

Indeed, while the use of such a machine in the experiment proposes a kind of limit case with which to contrast the specification of a modern digital projector, the active experience of its use also provides an interesting source for hypotheses about the nature of flicker in general and how in the case of early and home cinema it was under the control of an operator who was part of the regulatory mechanism. The stimulus was in the hands (literally) and mind of whoever was hand-cranking the projector. The projectionist was also usually in a shared space with other audience members and therefore at the centre of both an individual and collective feedback loop full of affective and creative potential. This situation is imaginatively demonstrated in an image produced by Pathé in order to advertise its 9.5mm home cinema projector about which I have previously written and incorporated into my project poster (see figure 1). This image, which dates from the early 1920s, a time in which Münsterberg had recognized the potential of cinema to mirror mental processes and in which Marston was one of the first to record the physiological responses of cinema spectators, serves to some extent as an inspiration for my experimental design. This project proposal, however, aims to replace the miasma of the thought cloud with the apparatus of scientific instrumentation with the intention that analysis of the experimental data can account for at least a small part of the fog of affect, which constitutes the experience of cinema spectatorship.

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Appendix 3.

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The Displaced *Dispositif*

Guy Edmonds

CogNovo
Plymouth University, UK
guy.edmonds@cognovo.eu

Shaun Lewin

Plymouth University, UK
sionlewin@googlemail.com

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Abstract

"*Dispositif*" is a term used in film studies since the 1970s to describe the entire system of mechanical and human factors which together bring about the cinema experience. It therefore refers to (amongst other things) the space of the auditorium, the screen, the projection technology and the physiology of the spectator. Many of its qualifying components are masked from the view of participants in the system. The *dispositif's* purpose is to set up the conditions for a specific type of cognitive experience, one which mirrors and extends (and in some readings, controls) the experience of its participants.

The Displaced *Dispositif* is a performance designed for the space of a cinema theatre, but featuring the projection of fragments of early silent cinema on a coeval (1910s) film projector from the auditorium. The film fragments are live-scored by the sound artist, Shaun Lewin, using a combination of closely mic'd sources on the projector itself, luminance data from the projected image and EEG brainwave data recorded from participants during previous projections of the film. Displacing elements in the *dispositif* in this way, by shifting modalities, situating in parallel, feeding back and layering, draws attention to its hidden existence and creates the potential for a more knowing and informed participation in the cinema experience. It also serves to demonstrate the degree to which *dispositifs* of modern cinema spectatorship, which have morphed and proliferated since the widespread digitization of film heritage, have radically altered both the technological and experiential qualities of the medium. By integrating EEG data, the performance adds the dimension of electrophysiological experience to the long tradition within experimental cinema of artists calling attention to Cinema's hidden structures. As well as challenging the dominance of the worldview propagated

by the film industry, the performance also signals a means of re-engaging with the creative potential of the system itself, once unshackled from its bonds to the reality effect and freed from the limits imposed by its commercializing instincts.

Keywords: early cinema; EEG; flicker; performance; sonification.

Qu'est-ce que c'est, dispositif?

From a technological point of view, what we know of as Cinema is an agglomeration of many different technologies which achieved a certain critical mass in the dynamic interaction of social, economic and technological conditions available in the late 19th century (Punt, 2000). Since then, while retaining the name Cinema, albeit sometimes with qualifying epithets such as Silent or Classical, it has continued to accumulate additional features, most obviously perhaps those which appeal to the auditory as well as visual sense. The concept of sensory appeal itself points to the fact that this composite technological system would be nothing, or rather do nothing, without the human agents who have both designed it and queued up in their masses to experience it. This construction of Cinema, specifically, the projection of moving images, with or without sound, to an audience in the shared space of a theatre, can be contained by the term *dispositif*, first brought into use by the French theorist, Jean-Louis Baudry, in the early 1970s (Baudry, 1970, 1975, 1986). Although translated awkwardly as "apparatus" in some publications, it is now often used untranslated in English texts and has proved useful in defining a concept of the conditions of cinematic reception which can contain a wide variety of practices and experiences. It facilitates theoretical distinctions between one type of cinematic experience and another, and helps in parsing the contributions of the individual components while retaining awareness of a greater whole (Kessler, 2006). It also grants an equal place to those components such that, for example, the human subject of cinema is not lost to sight while considering the role of film technology, and vice versa, making it particularly valuable for interdisciplinary research. As a term, therefore, *dispositif* is valuable to interdisciplinary studies of cinema, describing a system of "surrogate" (Hochberg & Brooks, 1996) experience which includes darkness, a screen, projection equipment, a film, and human spectators and operators. Each of these features bears individual scrutiny and can be examined in much finer detail in terms of their role in the experience of cinema across time, a research process which, in turn, informs our understanding of film history.

One of the joys of studying early cinema is that the components of the *dispositif* are more obviously part of the experience. The subject/participant/spectator is more aware of them because less veils are drawn over the components of the system than in later forms of commercial cinema, which vigorously pursue the ever more virtually real. In contrast to the contemporaneous séance room or even the too-shapely leg of a table, the pioneer of early cinema, projecting from amongst the audience, took a showman's delight in placing the technological component 'on stage,' a practice which effectively co-opted the auditorium into the performance space, certainly augmenting and perhaps even challenging the spectacle of the screen. By implication, therefore, the spectators were also drawn in to 'treading the boards' and would consequently be more aware of themselves as a component of the *dispositif*.

Within ten years or so of the first public cinema shows, the prosaic demands of fire safety regulations forced a significant change in the *dipositif* by enclosing the projector (and projectionist) in a metal box or bricking them up behind the walls of the projection booths in the first purpose-built cinemas (Enticknap, 2005). At the same time, the projection mechanism itself became more enclosed. For example, individual components such as the intermittent movement were encased in a cast metal oil bath and the external shutter moved closer to the lens and was lost to sight behind a protective housing. The noise of the film advance mechanism became overlaid with the hum of electric motors. This trend towards the black boxing of cinema's components ceded power to the screen and promoted greater immersion in the image. With the bolstering of the reality effect of the screen stimulus, the reflection of the spectators on their own agency would have decreased along with awareness of their presence in a system with potential for creative response and feedback.

Subsequent technological developments, such as the advent of synchronous sound, further rooted attention to the screen such that by the time of television's challenge to cinema's cultural hegemony in the 1950s, cinema's response and argument of differentiation was to expand the size of the screen and attempt to add a third dimension rather than to adopt an alternative strategy of revealing its true nature. This instead was the response of the avant-garde of experimental film makers, whose *dispositifs* of small halls, cafes and basements and portable 16mm projectors re-established something of early cinema's potential for a dynamic viewing environment, which would itself lead to developments termed expanded cinema in the 1960s and 1970s (Youngblood, 1970).

Is Cinema Also Digital?

In the present day, what we know of as Cinema has undergone a momentous decade-long transition, shifting both means of capture and delivery from analog to digital technology, yet this has gone all but unnoticed by its mass audience. However, the gradual convergence of the technologies of cinema and electronic imaging, finally arriving around 2011 into the viewing *dispositif* under discussion here (that of the cinema theatre itself), has led to concerns from cinema's specialists (filmmakers, theorists, archivists and enthusiasts) that the basic structure of Cinema has been too substantially altered for it still to *be* Cinema (Rodowick, 2007). Undoubtedly, these concerns regarding Cinema's ontology have implications for the contemporary media landscape, but they are perhaps most pertinent to the question of how we now experience those films created in what we might retrospectively refer to as the analog era.

What degree of truth is there in the idea that a film made in, for example, 1910 would be gratuitously misrepresented by presentation via a 2010 digital projector, despite the fact that the digital copy (digitization) may be of the best type with no apparent difference in image quality, as would follow with current film restoration practice? Would the different temporal resolution of analog projection (actually theoretically inferior) make a difference not just to an entrained aesthetic experience, but also at a more basic perceptual level? Does the removal of mechanical film technology and the splicing in of video technology affect the other constituent parts of the *dispositif*, especially the physiological response and consequent perceptual and cognitive experience of the human subject? In order to work through some of these concerns, and in collaboration with neuroscientist colleagues Stephen Hall and Edward Rhodes, we collected some data on brain activity (specifically area V1 of the visual cortex) of various volunteers while watching projections of early cinema content. A ten-minute reel of four different clips (representing different genres of film) was presented across two different conditions, the first projected by a 1910s hand-cranked film projector and the second, a 2010s High Definition video projector, typical of the sort used to present archival film in modern exhibition contexts (Edmonds, 2016).

EEG recordings from three sensors in area V1 were taken along with luminance data from the projection screen which determined the flicker rate of each of the projectors: a variable 14–16hz for the hand-cranked projector with a single-blade shutter and 120hz for the video projector with a single Digital Mirror Device chip and a six-blade color wheel. Would the intrinsic brain rhythms of the participants be affected or driven by the similar frequencies of the film projector? What effect would the 120hz stimulus of the video projector create? Could the low frequencies of the film projector create a Steady State Visually Evoked Potential (SSVEP; Herrmann, 2001) which would effectively synchronize the basic perception of the spectator with the technology? Such a link at the level of technology as opposed to higher level cognitive interaction with the image content would suggest a basic framework to the early cinema *dispositif* which is not accommodated by the technically highly accomplished digital projection.

Observations made while collecting the data included the perhaps obvious realization that the projected film image is of much greater complexity than the simple black and white stimuli normally used in psychophysical experiments, which would be more likely to produce an SSVEP. Flicker is much more consciously perceptible in large bright areas of the image than in dark areas, although interestingly both the visual cortex (from the V1 EEG recording) and the photometer picked up the modulated light in the entirely black sequences of the film which linked the clips together, despite this being invisible to the evidently not so 'naked eye' of the experimenters.

Out of necessity, the testing was conducted in a lab in which the non-portable EEG recording device was installed, although ideally it would have taken place in the space of a cinema theatre. Once recorded, however, the data was far more portable and it seemed fitting to take this record of cinema experience and 'return' it to the *dispositif* of the cinema. The question of how to present such data was suggested by another known absence: nearly all the original participants had commented on the sound of the film projector, such that it seemed to be a very significant, yet unrecorded part of the test. By combining a sonification of the existing EEG data with the sound of the projector mechanism, key elements of the *dispositif* could be drawn together and viscerally unified. The data of both the electrical activity of the brain and the screen luminance were sampled at a rate of 2048hz, thus giving a very fine temporal grid against which to isolate brainwaves and light modulation operating at much lower levels. Interestingly though, the ear can discern much higher levels of auditory flicker, "above 1000 interruptions per second" (Miller, 1947), so how better to recast the data than in an ear-readable form? What can the ear tell us that the eye has missed?

A rationale for the sonification of the data was worked out collaboratively between Guy Edmonds and the sound artist, Shaun Lewin. The aim was to incorporate it with the hand-cranked projection of the film used during data collection and present it as a live performance which should afford an individually subjective interpretation of the data alongside other sonic, mechanical and visual elements of the *dispositif*—a modus operandi which allowed for a certain amount of processing to be applied to the raw data, as detailed in the following description.

A Max/MSP patch was used to ratchet the sound of the projector's shutter mechanism to the light-modulated sonification of EEG recordings of 10 spectators, in a system analogous to the tined drum found in player pianos. Each shutter event triggered the playback of 1 frame's duration of EEG data (defined as 62ms, equivalent to 136 data points within the EEG recordings); these values were determined as an average 15 frames per second and derived from the results of the luminance data from the slightly variable-rate projections presented to the 10 subjects. Initial explorations in the sonification of the EEG recordings revealed that the simple transduction of a floating-point data stream into 44.1KHz digital audio produced a sound work that would place substantial demands upon an audience seated for the full duration of the film. Experimentation revealed that adding a second instance of the transduced EEG audio to itself with a very short interval of time separating these instances created a resonant tone with some harmonic characteristics (a process often described as comb filtering). In order to differentiate between the 10 subjects' neural activity, a different interval of time was applied to each EEG data stream's comb filtering; these intervals were determined through exploration of the emergent sound work and do not have a semiotic value beyond that of an arbitrary index of identities. The intensity of each comb filter is proportional to the quantity of darkness captured by a webcam facing the projector screen, in a negative emulation of the use of a photometer in the original test.

The production of multiple resonant tones with pronounced harmonic and inharmonic components, the complex syncopation of the EEG data streams and the role of the audio within a larger multimedia piece all suggested a relationship with the use of a gamelan orchestra within Indonesian shadow puppet theatre events. This relationship was rendered explicit through the use of audio processing that translates the frequencies produced by the comb filtering into their nearest equivalent within the 7 note Pelog scale (tuned to concert pitch).

The first performance of this Displaced *Dispositif* was given on August 17, 2017 during the Off the Lip colloquium (See Figure 1). Although not scientifically readable and technically needing further development, the performance succeeded in establishing a symbolic link to the operation of brainwaves within the *dispositif*, such that those present may well have questioned their role as the *eleventh* spectator.

Figure 1. Guy Edmonds and Sean Lewin set up the equipment used for the performance of "The Displaced *Dispositif*."

The transferability of *dispositif* is the key to its usefulness as a concept. We can talk of *dispositifs* of early cinema, of amateur cinema, classical Hollywood cinema, avant-garde cinema and indeed digital cinema, and we know we are talking about the specific viewing conditions of a specific type of cinema, all of which differ from each other (Parente & de Carvalho, 2008). For film archives and museums, this 'film as *dispositif*' (Fossati, 2009) concept plays a significant role in modern collection policy, which accepts the impossibility of replicating any one historical film moment in all its complexity and instead offers new *dispositifs* for old films by, for example, self-consciously commissioning new scores for silent films. This is already one level of displacement that our title alludes to; however, with this performance we aim to displace elements within the *dispositif* into other modalities, to make them apparent and call them more powerfully into our conscious experience. Rather than a new score then, this performance invites the audience to listen to that most silent of film accompaniments—the brain activity of the spectator—while hopefully bringing its relation to the rhythmic propulsion of the film strip further into the realm of conscious perception. Notwithstanding the fact that every screening is to some extent a displacement of all previous ones, the performance takes a step further in displacing some of the contents of cinema's black boxes and making the hidden dimensions of the cinema experience more apparent, revealing the potential for 'liveness' in what might otherwise be taken for a uniform product. The show must go on!

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First response to "The Displaced *Dispositif*" by Jacqui Knight

In Edmonds' performance, we are offered a unified experience of both EEG experiment and results that reveal something about the nature of neurophysiological experiments whilst simultaneously exposing hidden elements of the filmic dispositive—the brain activity of the spectator. Using an analogue projector, the flicker, winding noise of the apparatus and the performative presence of the projectionist all typically keep a spectator aware of the production of the filmic illusion. However, Edmonds' performance work further reveals some of the hidden contents of the black box, the component parts of the system which allow him to manipulate the hierarchies in the filmic *dispositif*. Understanding less the specific role of each determinant in the *dispositif* but more the relationships between the film, the darkness, the viewers experience, the apparatus, the projectionist and so on shows the infinite potential of each cinematic experience to unfold differently each time.

The importance of Edmonds' work lies in the transferability of this method, useful in an archival capacity to think about the network of technologies concerning the process of duplication, and in a curatorial capacity to expose new narratives and provoke alternative readings of particular film works. In addition, from a filmmakers' perspective, this method could be used as a device in the creation of new film work. This would follow the Structural Materialist filmmaking philosophies from the 1960s and 70s that attempted to demystify the film process, an antidote to the highly ideological mainstream narrative cinema. You could say Structural Materialists' films explicitly pointed to different aspects of the *dispositif* through using anti-illusive techniques. Your investigation follows and extends these Brechtian traditions, keeping us actively aware of the construction of the cinematic reality but also aware of the emergent, infinite dynamics and relationships between all the determinants of the *dispositif* system. This work then perhaps offers a "New Structural Materialist" approach, drawing to attention other materialisms such as electrophysiological experiences that were certainly not available during this experimental film movement in the 1960s and 70s.

In Edmonds' performance I question whether the sonification of EEG brainwave data and luminance data can actually mirror or give us any empirical information about its participants' cognitive experience, since this interpreted data is already a representation. To make a further reinterpretation of this data (through this performance) is producing something that would probably have no correlation to its source. I suspect this is not the purpose of this performance anyway, and in fact we are offered something more akin to an experimental visualization of this data which questions new ways to understand the cinematic experience, other than those experiences directly articulated to us using our sensory apparatus.

From a performative point of view, I would be interested to see a live sound score taken directly from EEG data of a spectator in situ. The film spectator being part of a more authentic *dispositif* system—within the cinema—which would not isolate the subject from the audience and the cinema context.

Second response to "The Displaced *Dispositif*" by Mark-Paul Meyer

The live performance at OTLip17 on August 17, 2017, was a memorable one. Edmonds and Lewin projected a 35mm film with a hand-cranked projector, accompanied with a sonification of the EEG frequency recordings of persons who had watched the films in a laboratory setting. This performance was highly experimental and not as perfect as Edmonds and Lewin had wished, but overall it was an experience that raised enthusiasm and relevant issues for debate. Concerns about the synchronicity between film and sound were foregrounded during the performance, but for most attendees the performance was an intriguing experience, in particular from the perspective of making visible (and audible) the hidden structures of the cinema *dispositif*.

However, this also raised the question of what we were actually listening to. The sonification of 10 EEG recordings resulted in a noise with little tonal variation and little clearly distinguishable punctuation. The question is whether other strategies of sonification would have had better results. Sonification of data is already a well-developed practice in different domains of scientific research and it seems that much can be learned from these experiences in other disciplines. Without being familiar with these developments it seems that there must be a way to make a sonification that is not only more pleasurable to the ear, but that is also more informative about what is exactly happening in the human brain while watching films.

Since Guy Edmonds' research project is also about the difference between analog and digital projection, there is also a question of whether the sonification of comparable data from a spectator watching a digital projection would result in a noticeable difference. If the claim is right that, for instance, the memory of the spectator is activated differently when watching an analog or digital film, this could partly be supported by a difference in data and a hearable difference in sonification.

This brings me to the title of the paper that Guy Edmonds presented—the 'displaced' *dispositif*, which refers to displacing elements in the *dispositif*—and one could ask whether the activity of the human brain should not be considered an inherent part of the *dispositif* as it is hidden, invisible, almost immeasurable, but nonetheless a crucial part of it. Edmonds does not elaborate much on the term 'displaced,' but I would argue for an 'expanded' *dispositif*, since the cornerstones of the *dispositif* are known and well defined, but a lot can still be said about these cornerstones. If we can disassemble a film projector into its many constituent parts and units to understand its working, we may also be able to "disassemble" the mechanism of human perception and integrate that in the concept of the *dispositif*.

As an archivist, I like to raise the question of whether this expanded *dispositif* can/should be used as a parameter in the restoration, preservation and presentation strategies of historical cinema. In particular with regard to films from the silent era, but also from the later years of analogue cinema. In the digital era resolution, bit depth, color space and so forth are important considerations which have been identified as being critical to accurately reproducing an analog image in a digital format. This is understandable since visual quality is dominant in all discussions on reproduction of film images. But this paper suggests that invisible properties should also be considered. Differences in frequency between the analog and digital apparatuses—either the cinema machines or the apparatus of human perception—have never been discussed and this paper implicitly poses the question of whether these frequencies should be considered as part of the restoration, preservation and presentation of archival films. Does “authentic perception” of an analogue film exist and is it relevant and possible to recreate or remediate this authentic perception with new digital technologies? It seems that sonification could be an innovative strategy to give a partial answer to this question.

Third response to "The Displaced *Dispositif*" by Aska Sakuta

While watching the film, I felt a strong emotional response, which consisted of three experiential levels (or layers?), each relating to different elements of the experience: the content of the film, the visual quality of the film, and the presence of the conductor (I suppose the proper term is projectionist) of the film.

At the first level, I could see that the film was recorded a long time ago; the sites and people in it seemed to be from previous eras. This made me ponder—as such things usually do—what it would have been like to see, feel, and experience those things then and there.

At the second level, I could also see that the film was in "black and white," shown on a small area of the screen, flickering, and sped up; all of these qualities are different from what we would normally encounter today in a modern movie theatre—all in all, much less "accessible" in terms of one's ability to experience what is happening in the film as if one were there. This "inaccessibility" somehow increased my desire to connect to the content of the film (a desire that had already existed at the first level). It was almost as if I was naturally led to place more effort into achieving that goal, once difficulties appeared in its path. This strong connection (or desire to connect) to the sites and people in the film then led to a piercing realization that these things no longer exist (people have passed, sites have changed...); or, in other words, I can *never* experience these happenings as they had happened in real life. This realization induced a sinking feeling of loss, or perhaps longing. The aforementioned "inaccessibility" of the content of the film seemed to reinforce that realization ("I can never experience this") even further.

Finally, at the third level, I was made hyper-aware of the effort that was put into the presentation of that film—a feeling that one rarely experiences in modern-day film screenings; as the author has mentioned in the paper, the work that lies behind showing a film is usually "hidden." The audience does not even know whether anything is manually operated—for all we know, everything could be completely automatized. However, in this screening, I could see the projectionist and hear the projector; the "work" is exposed. I could see him operating the machine, from beginning to end, never stopping, working with careful precision. I often enjoy such transparencies in live theatre productions (performers, stage managers, lighting and sound technicians, all working together to make the show happen), but for me to encounter this feeling during a film viewing was a novel experience. Nonetheless, my emotional response towards this particular awareness was just the same as that of a theatre performance: deep gratitude and appreciation for the fact that so much work was put into realizing this experience.

The three emotions (curiosity and wonder towards another world, the attachment, loss and longing towards that unknown world, and the appreciation towards the work of "bringing that world back to the present") accumulated into an overflow of emotions, which resulted in tears.

I would say that the levels were all present by the end of the experience, but appeared in the order that I mention, one layer over another (which is why I debated between using the word "level" or "layer"). Interestingly, however, in live theatre performances, the last level (appreciation towards the "work") would normally appear before anything else. My guess is that this is because that level is more viscerally (as opposed to cognitively) grounded than the others, as it is caused by an explicit, real-life exposure to the "workers" in the space—a type of presence that reaches me without the need for conscious interpretation (seeing the performer, hearing an orchestra, seeing the spotlight move across the stage with the actor, etc.). Whereas, the first level (curiosity towards content) takes a more interpretive attitude to access (knowing the intention behind the performance, understanding the aesthetic and contextual value of the work, etc.), and the second level (enhanced attachment towards content due to its "inaccessibility") is almost completely dependent on whether the first level even exists; were I to be uninterested in the content to begin with, its "inaccessibility" would just surface as a mild frustration. In reference to speed, I suppose I could say that the more "visceral" response (i.e., third level) would reach me faster than the "cognitive," but it is interesting that it did not happen in that order during this presentation. It may have something to do with my expectation (or ingrained understanding) towards film screenings; that I am to focus on what is on the screen rather than who is doing the screening. It was not until later that I became aware of the fact that this is in fact also a "performance," and that a person, right here, right now, is putting work into it.

Appendix 4.

Edmonds, G. (2018). Deviating Devices, or, the Camera with a Brain. In Transtechnology Research Reader 2015-2017 (pp. 18–35). Plymouth: Plymouth University.

Deviating Devices, or, the Camera with a Brain

Guy Edmonds

Abstract

This paper is drawn from reflections on my image making practice and in particular refers to work produced with one specific camera, the utterly ubiquitous iPhone 5c.

In general, I use this mobile phone, or smartphone, for making and receiving calls and text messages and for taking photographs in what can be summed up as a visual notebook mode. However, I have developed one further, modestly radical, use for it, which will be the subject of this paper, a use which may be better termed misuse and which perhaps demonstrates that a new technology is most productive when used incorrectly. While it may be instinctive for an artist working with any new medium to immediately test its limits, making it reveal its true nature by picking at the seams and provoking a malfunction, the sealed nature of this device, its seamlessness, indeed, would appear to close off such opportunities. It is at this point that misuse can stand in for the parallel artistic strategy of material resistance and exert leverage on a mostly immaterial medium to be artistically useful. In writing a first-person account of this interaction with a pre-programmed technological device, I will show how its productivity emerges slowly over time, through the back and forth of repeated use/misuse and critical reflection. I will conclude that this process of working with and playing against an apparently closed-off technological device has informed, challenged and modified my own perceptual apparatus.

Given the publishing constraints of this book, the images under discussion here should be thought of as only a basic reference for the much larger, full colour images printed on high quality, heavyweight paper. (*See figures 1, 2, 3 & 4*)

Diverting the intent

Directly after purchasing the phone, in April 2014, I explored the capabilities of the embedded camera. The interface requires selection of one of four different operating modes – Video, Photo, Square or Panorama. In the latter mode it is possible to take a panoramic photo by moving the camera from side to side, panning left to right or right to left, over a number of seconds. (*See figure 5*). I found the results fun but underwhelming, without any sense of having transcended mere gimmick. In the summer of 2014, on a long train journey from Bologna to Ancona – a journey I have made many times over the years – which passes along the Adriatic overlooking beach resorts and the petrochemical plant at Falconara, it somehow occurred to me to use the movement of the train to create the 'Panorama' rather than panning the scene with a bodily twist, as the manufacturer had catered for. The idea, I suppose, was to track the view from the track.

The first result was not pretty but pointed to a certain potential – there was something going on that deserved further investigation. And, after all, it's digital so there's no cost to multiple attempts. On the return journey, now holding the camera against the glass rather than in my hand, I had greater success. Already viewing the photos on the phone, and zooming in with a spread of the fingers, I could see that a remarkable level of detail had been recorded, as well as some exciting artefacts, which contrived to merge some objects and stretch others. The mix of fine detail and abstraction seemed like a real discovery. Also intriguing was the sense that although the image was perceptually incorrect, it was still easily readable and even appeared to have a certain innate, though not entirely discernible, logic.

The 'somehow' of this eureka moment is worth a digression: It is possible that a predisposition to its occurrence had slowly formed from my prior research and experience of time-based photography,

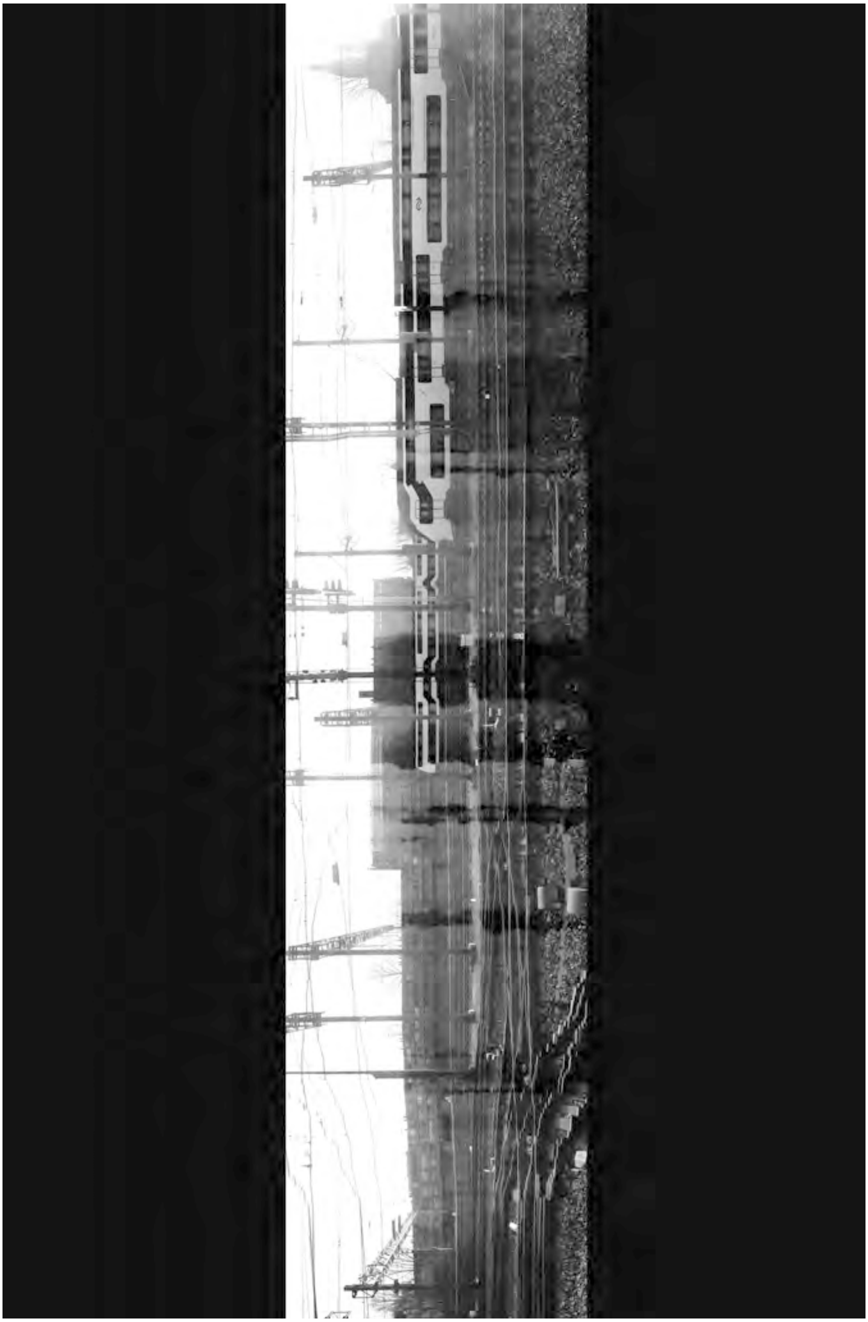

Figure 1: Amsterdam, 2016

Figure 2: Jakarta, 2015

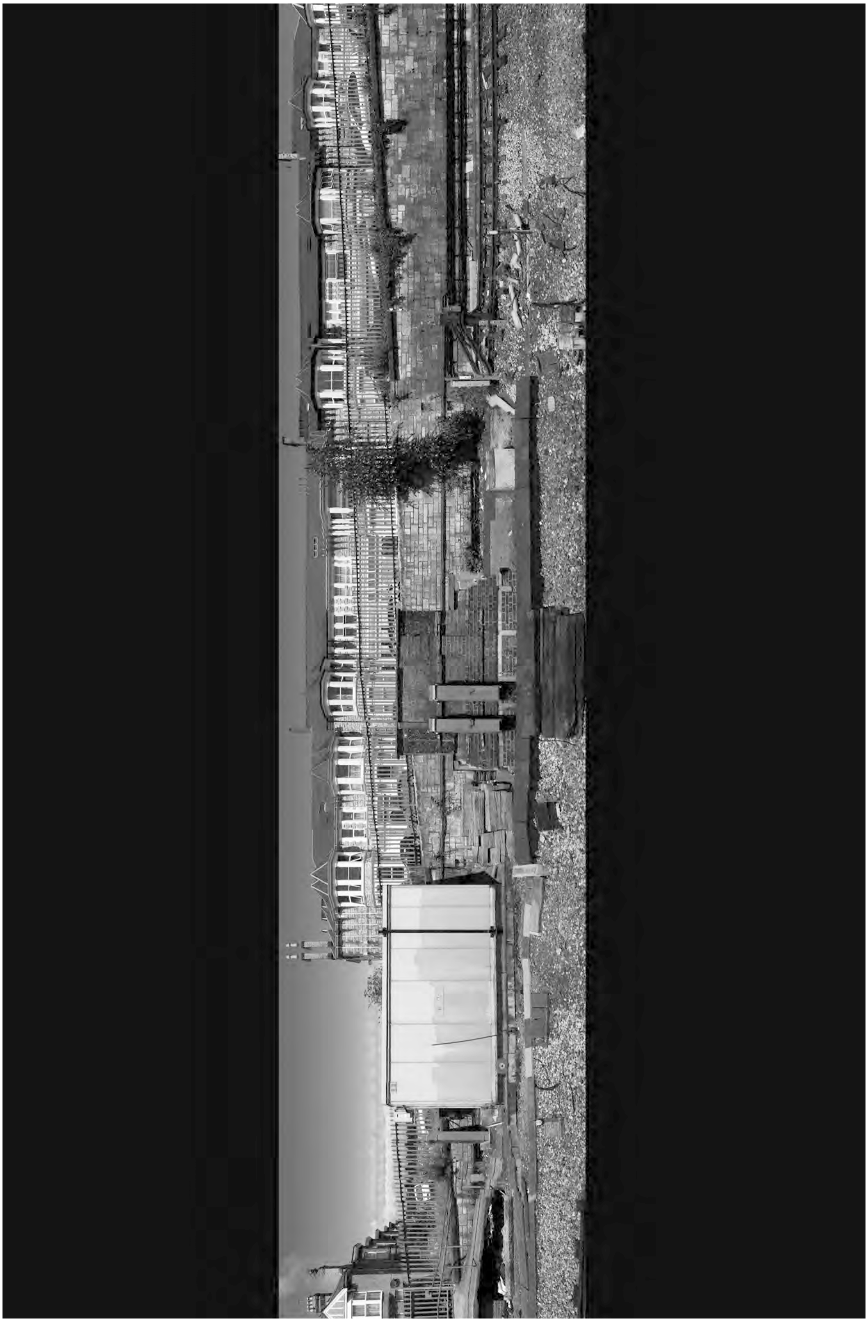

Figure 3: Plymouth, 2015

Figure 4: Basle, 2017

chronophotography and timed panoramic photography; also of the tracking shots used in motion pictures. However, it is also interesting to take note of another train-bound moving image-related eureka moment. That romantic historian of the motion picture, Terry Ramsaye, accords, apocryphally enough, not just the invention of the multiple blade film projector shutter to Albert E. Smith, the Anglo-American film pioneer and designer of the Vitagraph but the moment of its invention to Smith's journey along a railway line, bound for New York.

> As Smith regarded the New Jersey meadow landscape through the train window he noted the similarity of the screen flicker to that produced by the sweeping past of the telegraph poles. And again as the train flashed through a station he compared the slow flicker of the poles with the dancing but almost imperceptible flicker on the line of vision as he looked through the picket fence separating the tracks. This gave him the notion of dividing up the flicker of the motion picture by adding blades to the then single bladed shutter. He tried this out and found that by multiplying the flicker in fact he eliminated it in effect. (Ramsaye, 1964: 351)

Could it be, therefore, that under certain conditions a train journey can provide the right conditions for generating creative insight? My hypothesis would be that the train journey can be a source of invention in both form and content– a mobile lab for ideas and engine of creativity. In this sense, it shares crucial features with the cinema, at least the type of cinema that indulges in shots of long duration and avoids the excessive stimulation of narrative. In my experience, experimental film screenings are one of the best places to think about film, providing a free mental space that is necessarily denied during the conventional film experience. Both situations share an immobile subject exposed to a mild visual stimulus of optical flow enhanced by 'almost imperceptible flicker'.

Back in Plymouth, using an Epson large format inkjet printer, I made the first tangible extractions of the JPEG digital image files that the camera had produced. Using all the data at a print resolution of 300dpi, created an image of circa 8.5 x 36 inches, much larger than the maximum available in photo mode, which provides for an image size of 8 x 11 inches at the same resolution.[1] Printing the image out, in this case on to fine art cotton rag paper, was a definitive step. It removed it from the *dispositif* of the mobile phone and its tiny backlit screen and aligned it with a long history of panoramic photography and high quality image making which has a semi-immersive scale. The prints helped to embody the paradox of a highly-detailed photograph whose definition is nevertheless disconnected from adherence to the pro-filmic reality. They also represent a further modest rebellion against the corporate intentions of the device, which have escaped the intended loop of capture and immediate exhibition via social media and an endless proliferation of other tiny screens. Who prints photos these days, let alone photos from iPhones? And yet hidden in this *dispositif* was an enormous alternative potential. As Theo Humphries commented during the Transtechnology Research Seminar at which I presented these images, 'it makes you wonder what other joyous things they have [successfully] removed?'[2] A further aide to the development of my alternative *dispositif* was the discovery that a box existed which could contain these unwieldy prints, which, especially due to their size, were easily damaged. The box, manufactured by an archival products company, was presumably designed for vintage panoramic prints and school photographs. (*See figure 6*)

A sojourn in California, with its famous abundant light and freeways, created ideal conditions for new deviant panorama photos. I found that I didn't tire of the effect because unlike the correct use of the 'Panorama' mode the element of chance in scanning a changing landscape from a moving platform of variable speed continued to produce results that were unexpected, surprising and suggestive of new meanings. When taking the image, I chose the moment to begin but not necessarily the endpoint. While the final

1 This equates to pixel dimensions of 2472 x 10800 for panorama mode and 2448 x 3264 in photo mode.

2 'Deviating Devices: the productive misuse of technology.' Guy Edmonds and Agatha Haines. Transtechnology Research Seminar Series, University of Plymouth, Plymouth, UK, 14 December 2016.

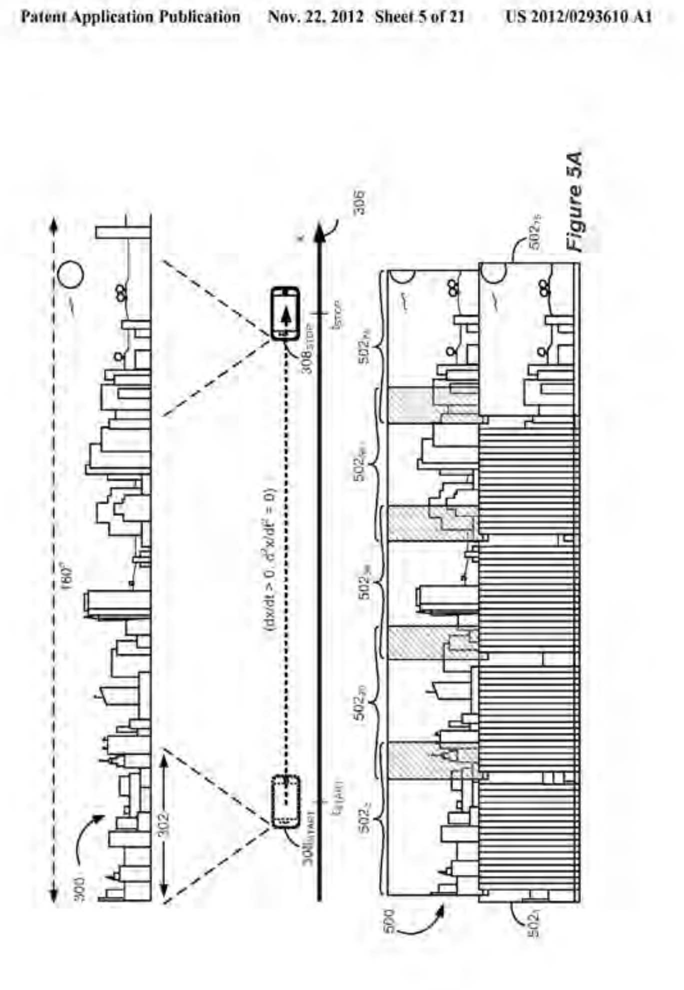

Figure 5: A page from Apple Inc.'s patent (US020120293610A) for Intelligent Image Blending for Panoramic Photography.

Figure 6: The author demonstrates the scale of the panoramic photographs and their box

result is a still image, during its creation the image is a live video which, as user, one can see unfolding. The iPhone camera blurs the traditional distinction between the two media and in 'Panorama' mode effectively produces hybrid film-photos. It takes regular time slices and compiles them over a varying duration, anything between 5 seconds to potentially minutes long, depending on the speed of travel. As creator, therefore, one is taking a back seat, choosing only a moment in which to initiate a process, resigning some creative agency to the device. One can imagine Henri Cartier-Bresson becoming rather frustrated by such indecision compared to the finely tuned and efficient mechanism of his Leica that was an extension of 'the brain, the eye and the heart' (Cartier-Bresson, 1999: 24). On the other hand, however, the cultural philosopher Vilém Flusser, has claimed a greater degree of agency for photographic devices than that with which they are normally credited, especially when, as in the hands of such hero-photographers as Cartier-Bresson, the photographer's fame obscures the role of the apparatus. Indeed, Flusser's apparatus-centric analysis seems especially applicable to the case of my iPhone panorama photos.

> The camera is not a tool, but a toy, and the photographer is not a worker as such, but a player: not "homo faber," but "homo ludens." Except: the photographer does not play with, but against, his toy. He crawls into the camera in order to discover the tricks hidden there. The pre-industrial craftsman was surrounded by tools, and the industrial machine was surrounded by workers, but the photographer is within the camera, intricated in it. This is a new kind of relationship, where man is neither the constant nor the variable, but one where man and apparatus form a single function-unit. This is why the photographer should be called the "functionnaire" of an apparatus. (Flusser, 1984: 19)

However, despite this apparent lack of control, my ludic 'functionnaire' self wrestles back some influence at the editing stage, in fact not unlike Cartier-Bresson, who took many more photos in the temporal vicinity of his iconic 'decisive moments' (Cartier-Bresson, 1952) than is often acknowledged. My method has a very high shooting ratio, which I am quite unused to with analogue photography projects. I would estimate that at least half are deleted immediately while still on the phone. Of those that bear further investigation, I have saved 600 of which only 20 have been selected for printing. Many immediate losses are due to bad focus or over or under exposure, these values being fixed at the start of what one might call the 'long moment' of picture taking. Ultimate selection for printing is determined by my subjective assessment of the semi-found photograph's composition, subject and overall effect. I particularly value a balance of messy and formal qualities in these extractions of reality.

Camera with a brain

After some reflection on the printed photographs and the process of making them, it perhaps belatedly occurred to me that their significance lay in them having been produced by a camera with a brain. That, in effect, there were two brains in this operation as my traditional-style brain had been augmented by an extra dollop of cognition provided by the software controlling the device.

As a photographer and filmmaker using predominantly analogue technology, I use a number of different cameras, which are capable of imparting subtle distinctions to the images that they produce (Edmonds, 2016). However, only the camera that is also a phone has the ability to further process the image after having captured it. During the picture making operation, one can even see the camera engage in what looks like thinking or deliberation. The live video view shows the image within the camera's line of sight and only moves to the next image when it has decided to accept it into the gradually forming panorama. Sometimes it hovers in deliberation and it is possible to see images that are then discarded before ever having the chance to be woven into the final result. A program which analyses the data arriving from the imaging chip and which decides whether one set of data is a sufficient match to the previous presumably drives this process, although such an operation is never explicitly part of the interface. The speed of travel is critical to the camera's ability to process, and is therefore somewhat analogous to human vision, which also has limitations bound by the requirements of processing so much visual data. There are parts of reality that we ignore or gloss over either because they exceed the processing ability of our visual system or because they are considered unimportant at a cognitive level.

The traditional photographic camera has often been co-opted as a fallible model of visual perception and it is tempting to similarly assign notions of thinking and cognition to the camera-phone with live image processing. In such a system, the percept is not just received and recorded; it is subjected to the application of prior knowledge. Such a move, from camera/eye to camera/brain, while failing to avoid the drawbacks of any metaphor, at least empowers a more extended model of visual processing, much of which we now know takes place in the brain. The very ocular-centric notion of kino-eye, from the 1920s Soviet movie-making avant-garde, becomes rather, kino-brain, and corresponds with recent work in film studies which has acknowledged the role of the entire nervous system in the cinema experience.

Black box resistance

The import of such a development would seem substantial, however, what is interesting about such a move is that it is hidden away, by the device itself and its makers, by the designed interface, and only revealed when subjected to abuse. Only by deviating from common usage and forcing an error is the device revealed as a thinking device, a camera with a brain, or indeed a smart camera. Using it as intended masks the fact that it is not just taking an accurate representation of spatial reality, but also engaging in processing that reality. It pretends that it is still only a camera along the lines of a camera obscura or film camera, with no greater ontological claim. The operation of a 'brain' is masked by the non-brain label of 'Panorama'. There was perhaps the careless assumption that the phone was 'smart' because it also had a camera not because the camera was also 'smart'. There is a further subterfuge worth noting, one already enacted by most panoramic photography, which denies the time-based nature of the practice. Historic panoramic photographs ostentatiously declare their wish to expand space but rarely, with the exception of the schoolboy trick of racing to the opposite end of the benches during the exposure of the posed class photograph, do they acknowledge their incidental ability to expand time and record duration.

The iPhone camera hides its virtuosity behind a virtual button called 'Panorama'. It follows Eastman Kodak's mass-market amateur photography tradition of 'you press the button, we do the rest' (Harding, 2005), although 'the rest' occurs almost instantaneously and remains inside the black box. The implication of such systems is that there is no need to know how it works because it does so perfectly. The technology is almost invisible and offers no resistance. By contrast, it is an artistic strategy to employ the creative potential of material resistance whether it is the physical substance of a block of Carrara marble for Michelangelo or a specific process such as analogue filmmaking, as described by Tacita Dean.[3] In the case of making these panoramic photos the productive obstruction was provided by the resistance of the black box of the camera's design to penetration. Or, as Flusser would have it, playing against the toy. It is a kind of fight or tussle mode of artistic operation because doing what it wants you to do is immediately boring and already done by millions of other users. In that sense, the eureka moment was actually an 'aha, I've found it *out*, it's not perfect after all' – perfection was never interesting anyway. For me, this experience has also provided an entry point into using digital photography: when I realised that it could be broken, it became interesting and paradoxically a more productive tool.[4]

Productive misuse

The practice of deviating devices can be seen as an extension of the concept of what are known as philosophical toys. These 18th and

3 "The value of any medium is that it can act independently of the artist: Not every action is deliberate; not every gesture has intent, as any painter can attest. Film as a medium brings qualities to the work, some that the maker never intended-characteristics integral to its chemistry and to its internal disciplines and material resistance." (Mazzanti, Dean, & Taubin, 2015, 294)

4 The glitch, the visible sign of a broken system and a telling moment of truth in the increasingly pervasive digital environment has itself become a design trope as well as an object of artistic research, see (Grundell, 2016)

19th century optical toys were simple hand-holdable devices which exploited and made palpable features of our visual system that consequently gave rise to philosophical challenges to our common sense of reality. They were both means of scientific enquiry and parlour games. Once deviated the iPhone is a perception device that both mimics our way of seeing and leads one to imagine alternative ways of seeing. These images ask, how do *we* see, actually? What are the different ways of seeing, machine and animal? They can refer to pathologies of vision such as akinetopsia (cerebral motion blindness) (Zeki, 1991) or theories of vision such as segmentation and chunking (Zacks, Speer, Swallow, & Maley, 2010). They can address the still unsettled scientific debate as to whether our perception is achieved through a continuous or intermittent sampling of reality (VanRullen & Koch, 2003). They can also refer to the experiments of the film and photography pioneers, in the sense that doing it wrong is a way of getting back to doing it first, but in this case, there is no ambition to perfect the errors but rather to error the perfection, to reintroduce the potential for creativity which the errors signal.

Aside from provoking questions about our faculties of perception, these images also have an expressive function. Despite their materially two-dimensional state, they are readable or at least evocative of four dimensions. They are films that are viewable as still images. Portraying more than just a moment, they are a gaze rather than a blink, an encounter rather than a frisson. Having now taken many hundreds, and possibly shifting my perception accordingly, they now feel more experientially valid to me than a conventional photograph, a better record of the *experience* of travelling on a train in Switzerland or being in a car in a traffic jam in Jakarta than is afforded by a snapshot or even a film clip.[5] Operating in the intriguing space between film and photography, the effect is perhaps similar to the short bursts of frames making up Oskar Fischinger's 1927 film, *Walking from Munich to Berlin*, an anomalous experiment even within his own experimental film oeuvre, in which vivid

5 The practice does not require an exotic location per se, as these examples may suggest. Images taken locally in Plymouth and Ivybridge have the effect of transfiguring and seeing anew familiar landscapes.

moments occurring during a walk lasting three and a half weeks are condensed into a screen time of three and a half minutes.[6]

Through misusing this device, I have also felt a shift in my perception of the built environment. It is as though I have unwittingly trained my perception to appreciate or at least identify a new architectural idiom. These images seem to provide evidence for a tendency in modern architecture in which architectural elements have passed through a digital tool box of copy and paste and self-conscious pixellation, before being subtly or not-so-subtly recombined. Although the effect is almost universally available in modern townscapes, a good example is offered by the redevelopment of the BBC's Portland Place building where the new extension of the iconic 1930s modernist structure appears as an over-restored digital copy of the original (see figure 7). Given the technological revolution occurring in the broadcasting industry over the last decade this seems entirely appropriate and offers a persuasive institutional narrative, which is made use of in shorthand form in the corporation's idents and overall branding. In short, it would seem that architecture perhaps more so than photography and film has reacted against the digitization of its practice not by a reversion to analogue techniques but by seeking out the productive mistakes, and playful errors present in the new technology. Whether such glitches are literally incorporated into the fabric of buildings such as at the House of Electronic Arts in Basle or rather treated allusively as at the BBC or in the plans for Google's new London headquarters, lining the railway tracks at King's Cross (see figure 8), these experiential slices of urban landscape seem to provide the missing link as to how our perception itself has been remodelled and rendered digitally sliced and diced.[7]

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6 For a detailed discussion of the film's "utterly original" hybridity, see (Frederick, 2013)

7 Concerning the House of Electronic Arts building, see (Voon, 2015). BIG and Heatherwick's design for Google shows "an exterior that takes its cue from the somewhat po-faced regularity of office blocks around it, and from the repeating lines of the railway tracks down one side. These rhythms then get jiggered, as if the internal energy can't be contained any longer." (Moore, 2017)

Figure 7: “BBC Radio 4 Broadcasting House” www.bbc.co.uk

[Removed due to copyright restrictions]

Figure 8: “Google, King's Cross by Thomas Heatherwick” www.hayesdavidson.com

[Removed due to copyright restrictions]

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