Investigations into the Emergence of British Television 1926-1936

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A Critical Review submitted to Aberystwyth University in partial fulfilment of the degree of Doctor of Philosophy (PhD by Published Work) in the Department of Theatre, Film and Television Studies

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Abstract

This Critical Review discusses the significance of the author's published works and their impact on the history of the emergence of British television between 1926 and 1936. Although events in television within this period have since been well-documented, the related debates have tended to be specialist in scope and restricted to technology-centric or institution-centric viewpoints.

Within this period of complex, rapid technological change, the author's published works introduce the principle of embracing multiple disciplines for comparative analysis. The author's application of that principle opens up long-established views for further debate and provides a re-assessment of early British television within a broader context. The rewards of this approach are a view of events that not only avoids nationalistic bias and restrictions of a single institutional viewpoint, but also tackles the complex interdependencies of technology, of service provision and of content creation.

These published works draw attention to the revolutionary improvements that enabled the BBC's 1936 service and the re-definition of television, yet also emphasise the significance of the previous television broadcast services.

The most important innovation within these works has been the author's discovery and in-depth study of artefacts from that earlier period. His recovery, analysis and presentation of video recordings of historic early television from 1927-1935 is original and remains unique. It has had a significant impact on the field of Media Archaeology, where Ernst considers the book *Restoring Baird's Image* as a 'seminal' work and the overall restoration project 'a brilliant case of "Digital Humanities" research' (Appendix 2). The author's curation of content from the period 1927-1935 enhances our understanding of a time where previously no direct television footage was thought to exist.

The author extends his forensic-level investigative 'hands-on' techniques from this recovery to the analysis of the surviving artefacts from the time of John Logie Baird's claimed first demonstration of television in 1926. The results clarify not only the functions of the equipment but also the circumstances and validity of the event, and hence its true place in the history of television.

Keywords: television, history, Media Archaeology, broadcasting, video recording, BBC, Post Office, Baird, Phonovision, Marconi, EMI

Declaration: I hereby certify that to the best of my knowledge and belief this thesis is my own work and contains no material previously published or written by another person except where due references and acknowledgements are made. It contains no material which has been previously submitted by me for the award of any other degree or diploma in any university or other tertiary institution.

This Critical Review has been self-funded and is not supported by any external financial or other award. All of the author's published works were fully-funded by him, with the exception of CD/CD-ROM 'The Dawn of Television Remembered' (McLean 2005) which was partly supported by a Shiers Trust Award in 2004 administered by the Royal Television Society.

Thesis by Published Works: I hereby certify that this thesis is in the form of a series of items: this document, (with Appendix 2 by Wolfgang Ernst, Professor of Media Theories at the Humboldt University, Berlin), a peer-reviewed monograph, a CD/CD-ROM set, and two peer-reviewed articles included in Appendix 3. For all items, except the material in Appendix 2 by Professor Ernst, I am the sole author, and in the case of the CD/CD-ROM, solely responsible for authoring, scripting of the narrative, production, processing, editing and compilation.

The Published Works submitted by the author comprise the monograph *Restoring Baird's Image* (McLean, 2000), the CD/CD-ROM set, 'The Dawn of Television Remembered' (McLean, 2005), and the articles 'The Achievement of Television' (McLean 2014) and 'The Great British Broadcasting Competition' (McLean 2018).

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Acknowledgements

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In the course of establishing the significance and impact of my published works, I have gratefully received supporting comments on the relevance of my work from Professor Jussi Parikka of the University of Southampton, Dr Alex Magoun, formerly director of the David Sarnoff Library, and Dr Phil Ellis of Plymouth University. I am extremely grateful to Professor Wolfgang Ernst of Humboldt University, Berlin, for his supporting document (Appendix 2) situating my work within the field of Media Archaeology.

I have already provided thanks and acknowledgments for support for the original research in my published works, but it is worth drawing attention to the help from the staff at specific archives without which this work would not have been possible; the archive of the Royal Television Society, the Royal Mail Archive, the EMI Group Archive Trust and the archive of the Science Museum Group.

Neither the Critical Review nor my published works could have been achieved without the long-term support and encouragement from my wife, Lydia, for which I will always be grateful.

I dedicate this work to the memory of my mother, Catherine.

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1. Background

The emergence of television in the UK in the inter-war years has been covered by numerous publications and has persisted as a topic for study. Since television as a public broadcast service was entirely dependent on the successful development of the underlying technology, some histories and theses prefer to place their emphases on the engaging and complex story of the technical development that led to all-electronic television (for example, Burns 1986, 1998; Abramson 1987; Marshall 2011).

The earlier introduction of an alternative, older method of televising scenes that involved mechanical scanning complicates the history of television in this pre-war period. The core principles, such as in Bain's copying telegraph (1843) and existing inventions, such as the Nipkow disc (1884), made possible a method of television

that could be implemented in the 1920s without the need for further scientific research and with minimal technical development.

The introduction of the thermionic valve in the early 1920s, together with improvements in photocell technology, provided the capability that allowed versions of these and other 19th century inventions to be developed and incorporated into working systems in several countries (for example, Burns 1986, 1998; Udelson 1982; Schröter 1937).

Early demonstrations of television's potential using mechanical scanning (in the UK most prominently by John Logie Baird) led initially to limited and temporary broadcast television services in the early 1930s. This partly encouraged the development of fully electronic television and the establishment of broadcast television services in the UK in 1936 that evolved into present day television.

The author's published works discussed here encompass his investigations of events during the emergence of British broadcast television, 1926-1936. These works provide not only new views that add to the existing debates but introduce and describe new tools and resources that have significantly augmented our understanding of early British television from the era dominated by John Logie Baird.

2. List of the Published Works submitted by the Author

McLean (2000): *Restoring Baird's Image*, London: Institute of Electrical Engineers, 295pp, ISBN 0852967950. [Available as a separate item]

McLean (2005): *The Dawn of Television Remembered*, CD/CD-ROM[1], self-published. [Available as a separate item]

McLean (2014): 'The Achievement of Television: The Quality and Features of John Logie Baird's System in 1926', *The International. Journal for the History of Engineering & Technology, 84*(2), 227-247, DOI 10.1179/1758120614Z. 00000000048. [Included in Appendix 3]

McLean (2018)[2]: 'The Great British Broadcasting Competition: A multi-disciplinary analysis of the emergence of BBC television', *Media History*, *24*(1), 46-70, DOI 10.1080/13688804.2017.1312319. [Included in Appendix 3]

[1] CD-ROM stands for Compact Disc Read-Only Memory.

[2] This article was originally published online on 7th April 2017, subsequently appearing in print in 2018 without any changes. All references to the article in this document reflect the page numbers for the version in print.

3. Introduction to the Author's Published Works

3.1 Structure

This Critical Review commences with an overview of the contribution of the works to a deeper understanding of the emergence of British television. This period spans John Logie Baird's first demonstration in 1926 to the establishment and launch of the BBC Television Service in late 1936.

A review of prior literature for the published works submitted by the author and specific topics is followed by views on the works' significance and impact, drawing attention to their originality and to their effect and influence. The Critical Review closes with a short discussion on the research methodology used in these works and some suggestions for further work.

Appendix 1 presents a summary list of references made to the author's published works.

Appendix 2 provides an independent supporting statement by Professor Wolfgang Ernst of Humboldt University, Berlin, of the significance and impact of the works associated with early television restorations (McLean 2000 & 2005) in the field of Media Archaeology.

Appendix 3 contains the two papers from the author's published works (McLean 2014 & 2018), with the monograph (McLean 2000) and CD (McLean 2005) available separately.

3.2 Overview

The author's published works sit within a broad historiography encompassing the primary disciplines relevant to the emergence of television. By situating the actors within a business and commercial footing, for instance, whilst including socio-political and technical factors, we can more easily identify and explain issues of controversy (notably those associated with Baird).

The presentation of previously-unknown early 30-line television recordings from Baird's laboratory tests in the late 1920s and from broadcast programmes by the BBC in the early 1930s allows re-appraisal of this period.

For the 1920s test recordings, a study of the faults and features of the video material reveals previously unknown aspects of the experimental system that Baird used. Regarding the recordings of BBC's broadcast programme material from the 1930s, we now have the first instance of being able to observe and study production techniques developed and tailored by the BBC's television producer, Eustace Robb, to create the greatest visual appeal out of the 30-line broadcasts.

The author subsequently extended and applied the analysis techniques used in McLean (2000) to provide the first in-depth study of the surviving artefacts associated with Baird's first demonstration of television in January 1926. The results clarify not only the authenticity of the artefacts and how they worked but also contribute to a better understanding of the circumstances and validity of the event.

In the latest of his published works, the author developed and applied a new multi-disciplinary methodology to the commercial competition that led to the establishment of the BBC's Television Service, initially covering the London region

in late 1936. The results of this and other investigations support a more balanced appraisal of this period in television history.

4. Description of the Published Works submitted by the Author

4.1 McLean (2000), *Restoring Baird's Image* (monograph)

One of the most notable of the author's achievements in this field of study is his search for, and his discovery, recovery and analysis of 30-line video recordings made in the period 1927-1935. Prior to the author's extensive technical restoration and historical analysis of the subject, Baird's experimental 'Phonovision' recordings were largely unknown. The existence of the later off-air video recordings of BBC 30-line television was not even considered a possibility, even by those who worked for the BBC at the time.

In the course of his research and restoration, the author identified the earliest recordings (dated between September 1927 and March 1928) as being of Phonovision – Baird's attempt to develop a pre-recorded videodisc player. He also identified later recordings as being home video recordings made of BBC television sometime between 1932 and 1935.[3]

Between 1983 and 1998, the author designed, developed and built bespoke equipment, software and processes from component level. They allowed the recovery and analysis of discs that had been either ignored (the Phonovision recordings) or were previously entirely unknown (the home video recordings of the BBC 30-line broadcasts, 1932-35). A basic description of the signal and image

[3] All references to 'author' are to McLean.

processing algorithms used in recovering the Phonovision material was the subject of an earlier technical article (McLean 1989).

The author wrote this book not only to present the significance of the restorations of what remain today the world's earliest known recordings of television of any type, but also, separately, to raise awareness of a poorly understood period in television history. Whilst technical, the in-depth study of the video restorations within the book is essential in defining this new resource and describing its intersection with existing histories.

The quality and the content of the 30-line television imagery provide evidence that supports the principal arguments regarding not only television in Britain on the Baird 30-line standard but also how we should consider Baird's achievements.

Restoring Baird's Image (McLean 2000), received a special commendation as 'runner-up' at the 2001 Kraszna-Krausz Foundation book awards and has remained continuously in print.

4.2 McLean (2005), *The Dawn of Television Remembered* (CD/CD-ROM)

The author created the collection of resources comprising *The Dawn of Television Remembered* to help those seeking more information about this era: both as a general educational tool and also as a source for detailed research. It can be

considered as a companion publication to McLean (2000), as it contains the first public release of the complete set of 30-line video restorations available for study.[4]

At its simplest and most accessible level, this collection presents a two-hour audio documentary featuring recollections by key people directly involved with television. The BBC's first television newsreader, Richard Baker O.B.E., generously narrated the author's script.

For more in-depth research, the data portion of the collection includes the author's selection of eight and a half hours of unedited interviews sourced mostly from tape recordings made by BBC producer, Bruce Norman, in the course of researching his 1976 documentary, 'The Birth of Television', and his subsequent book, *Here's Looking at You*.[5]

The chief criteria for the author's selection of interviews were the interviewees' depth of first-hand knowledge and their direct involvement in television's development. To that end, the author selected two key personnel for the bulk of the unedited interviews; Thornton 'Tony' H Bridgewater O.B.E. [6] and Desmond R Campbell[7].

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[4] Though this project was largely self-funded, the generosity of the copyright holders of the material used and the Shiers Trust Award, 2004, facilitated by the Royal Television Society made this production possible.

[5] The author provides the full text of this book on the data portion of McLean (2005), with the kind permission of the BBC and the Royal Television Society.

[6] Bridgewater joined the Baird company in 1928, transferred to the BBC to operate the 30-line service in 1932, and worked in various senior roles in television engineering. He was Head of Engineering for BBC Television outside broadcasts from 1946 to 1962 (including the 1953 coverage of the Coronation), and became Chief Engineer, Television, from 1962 until he retired in 1968.

[7] Campbell joined the Baird company in 1929 and transferred to the BBC in 1932 to specialise in studio operations and television lighting, where he become known as 'the father of television lighting'.

The introduction to the CD/CD-ROM set identifies some of the issues impacting upon television history. These issues define the theme and rationale for this unique collection of study resources, as described in the booklet accompanying the set:

> The international view of how television began has been influenced by several factors including national pride, local hero-worship for lone inventors and the sheer complexity of television's history (even at the country-level). In addition, the tales of overcoming engineering challenges in long-obsolete technologies sit awkwardly in a medium that is now dominated by the art, rather than the technology, of programme-making. All of this has caused many of the early achievements to be, at best, over-simplified for our consumption and at worst, sadly lost and forgotten. (McLean 2005).

Though the collection focuses on British television, its introduction makes it clear that this could just as easily refer to any country involved in television at this time. 'A German or American, for example, would differ in detail and language, yet would demonstrate not only the same spirit of exploring something new, but also the same capability, creativity and inventiveness' (McLean 2005).

The collection is unique not just in its variety and extent[8] of content but most importantly in its generic compatibility for archive usage, as evidenced by all material still being fully accessible twelve years after it was prepared.

[8] On the data portion of the CD set are: 8h 32m of unedited interviews and other audio, 52 minutes of video, with a text-searchable version of Norman's book *Here's Looking at You* (Norman, 1984) and the full script and transcription for the documentary.

4.3 McLean (2014), 'The Achievement of Television' (peer-reviewed journal article)

A few historians have raised questions of authenticity (notably, Waddell (1986)) regarding the Science Museum's two earliest acquisitions from Baird in 1926 and 1931.

In this work, the author chose to investigate the artefacts (with kind permission of the Science Museum), using the analysis techniques from McLean (2000, pp.153-156). The additional objectives of the study were to explore and understand what the quality and features of Baird's system might have been around the time of his landmark first demonstration of television in 1926 and to determine any direct associations with off-screen photographs (Lafayette 1926) from that same period.

In the course of the research for this work, it became clear that both the contemporary publications and an absence of appropriate technical detail from Baird had created confusion among historians. The resultant article, McLean (2014), not only determined what the limitations in Baird's system would have meant for an observer of the 1926 demonstration, but also included a new analysis of existing documents. This has clarified significantly the system most likely to have been in use, and suggested the quality of the displayed television image, supporting appraisal of the significance of this event in television history.

4.4 McLean (2018), 'The Great British Broadcasting Competition' (peer-reviewed journal article)

Expanding significantly on the topics introduced in McLean (2000) (that is, of commonality of definition of what constituted 'television' and the benefit of having a broader assessment of television's development), this paper sets out a new practical methodology for assessing television histories.

The resultant methodological framework locates the observer within the main active disciplines and amongst the actors – individuals, groups or companies – involved in television internationally. The paper chose to apply the method to the competition in the 1930s between Marconi-EMI and the Baird company for the BBC Television Service from Alexandra Palace, thereby demonstrating the method's significance beyond analysing Baird, his achievements and their position in television's emergence.

Researched but not included in the paper is analysis of the work in the UK, Germany, and in the United States on cinema projection systems for television. Though Burns (1985) and West (1948) (amongst others) have reviewed the topic of 'cinema television', its commercial motivation and social implications in the UK and elsewhere have been largely unexplored.

Closest in scope to the multi-disciplinary approach in the paper is the history of television included in Briggs (1965, 1995)[9]. This is mostly due to Briggs' focus on

[9] Both 1st and 2nd editions of Briggs Volume II are referenced in this document. The 2nd edition corrects minor errors in the 1965 1st edition, including one identified in McLean (2014, p.241) that incorrectly situated John Logie Baird's first demonstration of television at the Royal Institution. This error also appears in Aldridge (2011) which only includes Briggs' 1st edition in its bibliography.

the BBC's involvement in supplier liaison, service provision and content enablement as well as policy and strategy on behalf of the UK government. However, comparison between the scope of McLean (2018) and Briggs (1965, 1995) shows the benefit of deliberately adopting viewpoints from the different disciplines and actors. In particular the business, commercial and financial issues of the two competing companies would have low relevance to Briggs' primary, institutional, perspective. The author, however, considers those supplier-related commercial and financial matters and the associated technological outcomes to be of crucial significance to the successful establishment of the BBC Television Service in 1936 and to our understanding of it.

4.5 The Need for Common Terminology

One of the central tenets of the author's published works is to seek a common language for terms, recognising that lack of definition can lead to misunderstandings. In McLean (2000), the author took the definition of 'television' to its roots of 'seeing at a distance' to locate it correctly within the exploration of its possibilities in the 1920s.

> But none of this – the technical, the programmatic, the social message – is strictly the original meaning of television. These are all solutions to it, implementations for it or implications from it. All these views miss the point – television is "seeing at a distance" (McLean 2000, p.10).

When we view the landscape of British television history in this multi-disciplinary way, gaps and biases in existing publications become increasingly

apparent. 'Television' is a term that can cover multiple meanings across the disciplines involved and associated with it, and that has developed and extended in scope and common usage through time.

4.5.1 Air Travel as an Analogy[10]

To help underline the importance of multi-disciplinary thinking, it may be worth considering the topic of 'air travel' as analogous to 'television'. In its early days, air travel was completely determined by the means of its technical implementation, such as the number of wings (biplane, triplane), or the type of propulsion. Indeed, the type of propulsion – piston engine versus jet engine – may be analogous to mechanical versus electronic scanning in television. As the systems improved, air travel became more affordable, creating the business of airlines (analogous to broadcasters) offering an ever-improving service to customers. This reinforces the need for definition of terms identified in McLean (2000). To the question 'who invented air travel?' the answer should be the question, 'What do you mean by air travel?', as equally correct answers are 'the Wright Brothers' and 'Sir Freddie Laker'[11].

[10] This analogy to air travel was first raised by the author in a lecture at the Centre for Media History, Aberystwyth University on 26th January 2016.

[11] The analogy is remarkably close: like television, there are different types of air-travel. Beyond a public air transportation service, air-travel became prominent in military defence (for television; imaging reconnaissance, guided weaponry, night vision systems) and in scientific exploration (the basics of television – of 'seeing at a distance' – used in remote-sensing and space probes (McLean 2000, pp.4-5)).

5. Literature Review relating to the Author's Published Works

5.1 Existing Literature

As set out in section 3, the period covered by the author's published works spans the pre-broadcast era of experimentation by Baird, through to the start of the BBC Television Service in 1936.

The earliest events covered in the author's published works occur in an environment of technical exploration and of demonstrations of possibilities. All of this is prior to television broadcasting and therefore before any practical consideration of programmes and service. With the start of experimental television broadcasting in 1929, the fledgling attempts by the Baird company and then the BBC at making and broadcasting programmes led to the competition and selection of suitable systems for the BBC's Television Service in 1936.

This emergence of television forms part of Briggs' general history of British broadcasting (1965, pp.519-622; 1995, pp.481-576) and is covered briefly both in Crisell (2006) and in Ritchie (1994, pp.24-31)). Moran (2014, pp.13-49) considers the public's view of television throughout its history and includes an account of McLean's activities for his restoration of the 1920s and 1930s video recordings (Moran 2014, pp.25-26). Winston (1998) also covers the complete period but from within a history of communications technology and that technology's interactions with society.

Detailed narrative on Baird and his achievements appears in Burns (1986, 1998) and in extensive first-hand contemporary sources, such as cited in McLean (2000,

Bibliography) and in Shiers (1997). Subsequent to publication of McLean (2000), further books on Baird included Burns (2000), Baird (2004)[12] and Kamm & Baird (2002).

5.2 The Technical Histories

One of the more balanced early articles on the history of television from a scientific and engineering perspective is Garratt & Mumford (1952). We can interpret its view of 'practical' television, there solely attributed to all-electronic television, to mean 'established and in operation'. In that sense, we can apply 'practical' across the multiple disciplines of television. We should consider this not just for *technical* practicality as set out in the article, but for its implied suitability for delivering a mature broadcast service – for programme-making and for its acceptability to the public as a domestic entertainment system.[13]

Burns (1986, 1998) and Abramson (1987) contain purely technical histories of television centred on presenting the story of the engineering development of television. Both Abramson (1987) and Shiers (1997) provide chronologies of technical achievements across this period, as chiefly collations of primary source material.

Abramson's specific views on the first demonstration of television in 1926 are discussed in McLean (2014, p.241). Abramson claims his general history content is

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[12] Baird (2004) is a revised and corrected version of Baird's 1941 manuscript autobiography, first published in 1988, by the Royal Television Society on the centenary of Baird's birth.

[13] The term 'practical' had been used for years to describe Baird's systems, but limited in meaning to technical feasibility of demonstrations.

deliberately structured (p.xiii-xiv) against criteria that he developed so as 'to present the story as authentically and truthfully to the historic record as humanly possible' (Abramson 1987, p.xiv). Abramson has evidently applied this formula to the referenced facts but does not appear in this instance to have applied it to his own views in the linking narrative. Nevertheless, his book comes across as having a broader, more even-handed multi-national scope of technical development than Burns' 'International' history (1998), by avoiding nationalistic or character bias. Burns' accuracy however is exemplary and factual errors are rare in any of his publications. Shiers (1997) is intended to be a bibliographic reference, yet the linking narrative in each chapter provides useful context.

5.3 Burns-Briggs similarities

Despite the different points of view (Burns as technology-focused, Briggs as broadcaster-focused) and despite there being no reference to Briggs (or indeed any secondary source material) in Burns' works, there is an odd similarity of structure of Burns (1986) with Briggs (1965). This similarity could be caused by each selecting the same major events and/or the same source material. However, neither include more than the extreme highlights of the broadcast programme content. Briggs (1965, pp.519-622) provides almost the same level of detail about broadcast programmes and covers almost the same programme events as does Burns (1986).[14]

[14] Burns' approach to presenting history deliberately 'follows Fahie's practice' (Burns 1986, x), basing his publications solely on referenceable facts. The 19th century technical author, John Joseph Fahie, described 'all true history' as 'scissors and paste' 'when you delete the fictions with which many historians embellish their facts' (Fahie 1899, xii). This helps explains Burns' works as appearing as collated primary sources with minimal analytical discourse and may be relevant in extending this comparison with Briggs.

Burns' and Briggs' coverage of the 30-line broadcast television content between 1929 and 1935 is minimal. (Compare Burns (1986) pp.148-243 with Briggs (1965) pp.547-566). By contrast, both Swift (1950, pp.44-66), celebrating 25 years since Baird's first demonstrations, and Ross (1961, pp.18-31), celebrating 25 years since the start of the BBC service from Alexandra Palace, provide more background in the service and programme content for the 30-line era than Briggs and Burns.

5.4 Briggs and the Briggs-Jacobs Gap

Jacobs has drawn attention to earlier criticism of the 'kind of history' exemplified by Barnouw for the USA and Briggs for the UK, 'that it privileged the broadcasting institution's own self-definition at a management level, obscuring more local decisions and developments.' (Jacobs 2000, p.8). Briggs' emphasis on the political, legislative and organisational development of the BBC and its relationship with others, based mostly on internal documents, may have been too distant conceptually from the broadcast programme content to be included. Arguably the ephemeral nature of the broadcast output together with absence of any analysis of the raw document archive for the broadcast programmes may have rendered the material too low in relevance for Briggs to consider. This may explain, as Buscombe (in Jacobs 2000, p.9) observed for Briggs' fourth volume, why Briggs provides, 'merely a listing of the major shows the BBC put out between 1945 and 1955'.

The definition of 'broadcasting' (like that of 'television') might conceivably have created too broad a topic for Briggs to extend his work to the disciplines of programme content creation, delivery and review to the degree that Jacobs expected

for his post-1936 analysis. Alternatively, we might consider the works of Jacobs and Briggs to be non-overlapping histories, operating within their own defined scope, rather than identifying any omissions in either work. As with Burns (1986, 1998), the issue with Briggs may be unintentionally down to having too broad a declared (or reader-assumed) scope.

Ritchie's book (1994) describes itself as 'an eccentric and entertaining account' and differs from the reference histories of the main characters in being a popularised story intended to be easily readable. Ritchie contains several factual errors in the detail[15], including those identified with Baird's 1926 demonstration of television (McLean 2014, p.229).

5.5 The 30-line era – Television Services or Experimental Transmissions?

By referring to the broadcasts through and by the BBC between 1929 and 1935 as test or experimental transmissions or broadcasts rather than services, there is a degree of confusion regarding how we should perceive events within this period. The author has already identified subsequent 'shifts of perception', revealing variations in how Baird's achievements have been assessed over the years (McLean 2000, pp.269-270).

Since the author's published works refer to the 30-line broadcasts as 'services', and the relative significance of the restored 30-line broadcast material may be

[15] For instance, illustrating Abramson (1987) as a source, Ritchie propagates Abramson's error (1987, p.347) in calling EMI's James D McGee, 'Joseph' (Ritchie 1994, p.29).

affected by whether the broadcasts are viewed as part of a 'service' (Burns 1986, 1998) or as 'test transmissions' (Aldridge 2012, p.48), it is appropriate to draw attention to this here.

5.5.1 The 30-line Public Television Services

The author applied the term 'service' in his published works to the 30-line broadcasts between 1929 and 1935 based on primary source material, and on what the Baird company and the BBC broadcast programmes offered; the programme-maker/broadcaster provided and promoted to the public a series of regular, scheduled programmes, for which the public purchased receivers.

Between 1929 and 1932, the Baird Company presented such an experimental service broadcast nationally over BBC transmitters. Between 1932 and 1935, the BBC controlled and operated, against the above interpretation, a broadcast television service of programmes, that were all produced and directed, planned and advertised, scheduled and documented as per sound broadcasts. Whether these television broadcasts were termed 'service' should not detract from or influence how this history should be recorded.

However, it would appear that by not referring to these series of broadcasts as 'services' they have been considered as something significantly less (as in Aldridge's 'test transmissions' (Aldridge 2012, p.48)).

Of those who consider these broadcasts as services, Shiers includes the primary source reference for the start of the 1929 transmissions where it is described as an 'experimental service' (*The London Times* (1st Oct 1929) in Shiers 1997, p.202).

Burns (1986) also refers to each as a 'service' throughout his works. Bridgewater (1992) avoids the distinction, preferring to argue for the removal of the term 'experimental' from the BBC 1932-1935 service that in his view the BBC had applied retrospectively.[16] Swift (1950) identifies the Baird experimental broadcasts as a 'service' (p.45), however Ross (1961) makes no distinction. Abramson makes no reference to either of the 30-line broadcast television services, preferring to focus on technical development. Notably, Garratt & Mumford (1952) describe the Baird and BBC broadcasts in terms of a service without stating it as such, '…in August 1932, they *[the BBC]* took over the responsibility for originating the transmissions *[from the Baird company]* in order to gain more direct experience of the problems entailed in the production of television programmes' (Garratt & Mumford 1952, p.33).

Briggs identifies both services as 'experimental broadcasts' (1995, pp.506 et seq. for the Baird 1929 service and pp.521 et seq. for the BBC's service of 1932-35). This is curious, as he quotes the Post Master General (1995, p.505), referring more than once to 'a proposed experimental service' for the Baird company in 1929.

Briggs, however, may be solely reflecting the internal view of the BBC, though whether this is the BBC of the 1960s or of the 1930s is unclear. For instance, an official public statement made by the BBC after the start of the BBC's 30-line service in 1932, stated, 'Nor must it be forgotten that England is the first country to have **a public television service**, *[author emphasis]* made possible by a British

[16] His credentials for doing so are that he was one of the few engineers operating the television studio system in Broadcasting House and later in Portland Place for the 1932-35 BBC 30-line television service. He later became BBC Chief Engineer, Television and was awarded an O.B.E. for his services to television.

invention, and any set-back would be damaging to our pioneer position in the eyes of the world' (BBC 1933). Hence the BBC's own externally-declared view *at the time* was that it offered the public a 'television service'.

5.5.2 Services as 'transmissions'

The histories of television assume various differing starting points and primary viewpoints depending on the historian's specialisation. So, for example, Jacobs (2000, p.14) considers 'early television' to occupy the period 1936-1955, consistent with his history of British television being centred on broadcast television programmes (specifically, drama productions). Jacobs' view of technical developments in general is understandably those, 'which have influenced, in various ways, the nature and production of aesthetic discourses, and the stylistic features of television drama' (Jacobs 2000, p.15).

Jacobs' reasons for 'isolating' the period to 1936-1955 do not include anything specific for considering material prior to 1936 (Jacobs 2000, p.14). His analysis of television drama commences with the 1936 service, referring to 'regular, if experimental, television broadcasts' by the BBC between 1932 and 1935 as a footnote (Jacobs 2000, p.18).

Within his overall history of British broadcasting, Crisell presents a brief overview of broadcast television between 1929 and 1935 that emphasises limitations on Baird's 30-line system, such as initial numbers of television sets only being thirty (Crisell 2006, p.77)[17]. This was however unexceptional for the start of a new

[17] This figure appears to be sourced from Baird's response to a news reporter's question referring to the sets available solely for those watching the inaugural broadcast in 1929 (with alternating video & audio every few minutes).

television service[18]. Crisell attributes involvement in the development and transmission of television in 1929 to the BBC rather than the Baird company, and describes the BBC's 1932-1935 30-line television service as 'Baird's experiments' (Crisell 2006, p.77, p.296).

Aldridge (2012) refers to what can only be the BBC's 30-line service in 1935 as 'his *[Baird's]* test 30-line transmissions' (Aldridge 2012, p.48). At that time, neither Baird nor the company that bore his name were undertaking 30-line work (other than selling receivers). In his book, Aldridge covers the period between 1925 and 1936 from four themed perspectives rather than as a chronological sequence. He refers to the 1929 and 1932 television broadcasts as 'tests' and occasionally as an 'experimental 30-line transmission' (Aldridge 2012, p.123 for the 1929 experimental service). However, he refers to specific events within these 'services', such as Baird's outside broadcasts of the 1931 and 1932 Derby races (Aldridge 2012, p.114).

For Aldridge to consider programming 'of all types' only from the post-1936 television service (that is, without Jacob's constraints of considering just television drama) is curious (Aldridge 2012, p.142). This might suggest teleological assumptions such as observed by Stokes (2013). Alternatively, this may reflect his particular approach to thematic presentation.

[18] For instance, there were only seventy receivers available at the launch of the 1936 BBC Television Service (Gander, 1961), and the BBC Choice digital service in September 1998 was publicly launched over a week before receivers were made available to the public.

5.5.3 Remarks

The evidence throughout the period 1929-1935 in the contemporary press and magazines, reveals that the Post Master General and the BBC considered the 30-line broadcasts at the time to be a form of public television service.

In 2000, the author argued the reason for subduing the 30-line services (akin to Sewell's subsequent view of 'Historical Erasure' (Sewell 2014, pp.48-50) for a similar situation in the USA) as follows:

> Those developments in electronic television led to the launch of a high definition television service by the BBC in late 1936. It had exploited the latest developments in electronics to create a service that was able to meet the demands and needs of a broadcast service for at least the next 30 years. In 1936, the scale of the change in cost, scope and systems totally overshadowed all the work that had been done before. (McLean 2000, p.269)

The author argues that broadcast television was effectively re-defined in 1936 for both the broadcaster and the public. Supporting this as a change at the time, the headline to an article in *Television and Short-Wave World* – the same magazine that had previously referred to the 30-line broadcasts as 'television services' – celebrated in their December 1936 issue 'the Opening of Britain's **First** Television Service *[author emphasis]*' (Anon. 1936).

As a result, the challenge for historians is to recognise this re-definition of broadcast television when assessing its development during 1929-1935 and after 1936.

5.6 A Comment on References in *Restoring Baird's Image* (McLean 2000)

For the discoveries detailed in McLean (2000), there was no prior awareness of either the historical significance of the surviving Phonovision discs or of the existence of original video from either of the 30-line broadcast services. Consequently, none of the secondary source publications contributed sufficiently to warrant reference. The approach adopted for McLean (2000) therefore was to refer almost exclusively to primary sources.

Both Dr Brian Bowers, formerly curator of electrical engineering at the Science Museum, and Dr Colin Hempstead of the University of Teesside peer-reviewed the book. Neither identified any shortfalls in style or process of presentation or referencing. Indeed, Hempstead reviewed the book for the IEE (now IET)[19] as follows:

> McLean's work is interesting on several levels, ranging from the representation of Baird and his work to a truly fascinating account of the discovery of and the unravelling of the content of early video recordings. This lively and engaged work presents the history of television in a way rarely seen, and introduces a new approach to an understanding of the process of invention that Baird applied. (Hempstead 2000).

The two most recent of the author's published works (McLean 2014 and 2018) include literature reviews that locate specific research and findings. The author

[19] IEE – Institute of Electrical Engineers; IET – Institution of Engineering and Technology

handled references in McLean (2000) differently in order to be compatible with the publisher's requirement. Consequently, the following literature review may be helpful in more clearly illustrating the state of knowledge prior to the author's published works.

5.7 Literature Review of Related Publications

Centred on the actions of the decision-makers in the BBC and within the associated parts of the UK government, Briggs (1995) understandably makes no reference to Baird's Phonovision. To Briggs, Phonovision may have appeared as an obscure failed invention with no relevance or contribution to British broadcasting from the BBC's point of view.

Burns, with an emphasis on technical content and a focus on Baird's systems, surprisingly only includes one sentence, 'Another invention of this year was the phonovisor, an apparatus for recording television signals' (Burns 1986, p.105),[20] and then quotes Baird's description of listening to and interpreting the sound of the vision. Despite much material devoted to the subject of Baird's achievements elsewhere in Burns, there is neither comment nor analysis of the patents associated with Phonovision. (For instance, Baird clearly intended his British Patent 324,049 to be for a self-contained domestic videodisc player.)

In Burns (1998), there is no reference to either Phonovision or television recording in general. It is not until his biography of Baird, that Burns references and

[20] The 'phonovisor' was a means of replaying Baird's pre-recorded sound & vision records rather than a recording device.

reports the work on the Phonovision video recordings, notably without further analysis or comment (Burns 2000, pp.122-127). Burns does not mention the 30-line recordings and restorations from the BBC 30-line television service 1932-1935, most likely as his book is centred on the life and achievements of Baird.

Shiers (1997), as a bibliographic reference, has extensive coverage of published material with little guidance as to the relevance of one publication over another. As such, Shiers remains excellent as an index, signposting television's scientific and engineering development with high-level commentary accompanying each chapter, and identifying the patents and reports associated with Baird's Phonovision and associated events.

Abramson refers to Phonovision as 'the first method for the recording and playing back of a television signal…' (Abramson 1955, pp.41-43). His comment is based purely on the patent, news announcements and quotations, largely sourced from Moseley & Barton Chapple (1934, pp.143-145). However, Abramson manages to deduce the general intent behind Phonovision succintly. The author identifies this as 'the first "history" book to recognise that Baird made the first television recordings' (McLean 2000, p.283).

For pre-war television programming, the collection of anecdotes in Norman (1984), (re-published in McLean 2005), and the subsequent monograph by Bridgewater (1992), provide a background in which to situate the broadcast programme nature of the 30-line material contained within the author's published works (McLean 2005).

One of the most referenced of the BBC 30-line programmes, prior to McLean (2000), is 'Looking In'[21]. The BBC broadcast the programme on 21st April 1933 and described it as 'the world's first television revue'. Both Swift (1950, p.58) and Ross (1961, p.24) reference 'Looking In'. Several contemporary magazines and newspapers also discuss and review the programme (McLean 2000, pp.212-213). The importance of the programme content is significant enough that Briggs mentions 'Looking In' amongst other notable programmes (Briggs 1965, p.565; 1995, p.523).

Very fortunately, a fragment from this programme is amongst the few surviving 30-line recordings of broadcast television. It is the only one of these recordings that the author has managed to identify from disc and locate within the BBC's written archives (McLean 2000, pp.208-211).

[21] The title is based on the name for 'viewers'. At the time, the term 'viewers' had not come into use and someone who was watching television was 'looking in'.

6. Significance & Impact

6.1 Introduction

The focus of the author's published works has been to investigate and question claims made regarding British television before 1936 with the objective of generating a clearer and more consistent historical picture of the overall emergence of television. Behind the original research into artefacts from this period, an objective for each of the author's works has been to provide evidence-based technical accuracy while achieving a balance in their context with existing works.

Wheatley identifies four areas where problems occur in covering British television history: nationalistic focus, over-emphasis on the role of the institutions, nostalgic bias influencing popular histories, and both limited access to and availability of broadcast material from within an ephemeral medium (Wheatley 2007, pp.8-12).

In fact, the author has identified these very points and addressed them in his published works, independently of Wheatley's observations. The observations on nationalistic focus and institutional bias are relevant to McLean (2018, p.48) whilst the limited availability of broadcast material is relevant to the new content and resources in McLean (2000) and McLean (2005).

One measure of the impact of the author's published works is the number of references made to them. A list of known references has been included in Appendix 1.

6.2 Significance of the Historical Aspects of *Restoring Baird's Image* (McLean 2000)

In McLean (2000), there is a discussion of the use of mechanical scanning in recent advanced applications of 'seeing at a distance', such as weather satellite imaging and multi-spectral remote sensing. Such illustrations of the validity of mechanical scanning seek to counteract the perception that broadcast television by mechanical means should be ignored or even derided, simply on the basis of using technology rendered obsolete by new advances.

A similar view, within a more general context, appears in Edgerton's *Shock of the Old.* There, the importance is placed on assessing technology by its usage rather than by invention or by being new, with Edgerton calling for consideration of 'the place of technology within wider historical processes' (Edgerton 2006, p.211).

The author believes that McLean (2000) is the first publication to take a viewpoint of, 'being able to look *back* at analogue television and see it as history' – to see analogue television as a historical method of enabling television services, rendered obsolete by advances in technology (McLean 2000, p.276). The author employs this viewpoint in the book to provide contrast with the earlier evolving negative perception of obsolete mechanical systems for television.

Sewell has since echoed the retrospective perception of mechanical television for broadcasting in the USA as 'Historical Erasure' (Sewell (2014) referenced in McLean (2018, p.63). 'Mechanically scanned television is but little remembered, and when it is, it is often subject to a way of thinking about the relationship between the present and the past that affirms the present'. (Sewell 2014, p.48).

The narrative in McLean (2000, pp.265-278) highlights the problem of techno-centricity and stability (without regard for eventual obsolescence) used to present an artificial sense of the maturity of the analogue electronic system of the 1960s. We can extend that argument to declare that all technology implementations are merely transitory solutions, systems and processes that will be replaced when superior cost-effective, more affordable, better performing and more socially-appealing solutions become available (McLean 2000, p.276).

By illustrating the weakness of assessing early television on purely technical grounds, the book opens up the 30-line television system and its broadcast services to wider historiographic analysis – to include political, social, financial and commercial issues.

The book also presents new views on Baird's achievements. One of these is the inherent simplicity behind Baird's much publicised long-distance transatlantic experiments and demonstration of 1927-1928. Thus, his use of conventional amateur short-wave radio equipment, was, '…easy to do (with the right conditions) and required very little customisation to what was by then existing technology' (McLean 2000, p.51). This contrasts with the view of ex-Baird employee, Ray Herbert, who claimed that, 'getting any kind of television image over such a distance was infinitely more difficult than…' the reception of Marconi's letter 'S' across the Atlantic in 1901 (Herbert 1997, p.7).[22]

[22] Marconi's reception of the letter 'S' in Morse code not only occurred in daylight (where transatlantic radio reception is normally unexpected across the shortwave bands), but also took place prior to electronic amplification, prior to a full understanding of selective tuning and prior to efficient aerial design. At the time, Marconi's claim generated a mixed response (Bussey 2000, pp.53-58), and has remained a controversial subject defying technical analysis and understanding (Garratt 1977).

6.2.1 A Commercial Emphasis needed for Baird

Using the restoration and analysis of Baird's Phonovision discs as supporting evidence, McLean (2000) presents a broad view for television's development, introducing the need for a better-defined conceptual language. It also extends the scope of the conventionally-offered historical context to place a stronger emphasis on Baird's commercial motivations than in Burns (1986 & 2000) and Kamm & Baird (2002).

Largely assumed to be a limitation of Baird's mechanical approach, or indeed of limitations in communications technology, the choice of 30-lines for the picture provided Baird with a rapid, low-cost route for a national broadcast television service (McLean 2000, p.39 Figure 3-11). By both minimising costs to the consumer, and by exploiting the existing BBC national radio infrastructure for medium-wave sound broadcasting, the author asserts that Baird would have achieved sales nationally of television displays almost immediately without major investment. Based on consideration of Baird's previous commercial activities as indicating financial gain as a primary motivator, the author's assertion provides a more convincing reason for Baird's activities in promoting and persisting with 30-line television as a broadcast service.

Also relevant to Baird's situation, the author discusses in McLean (2018, pp.48,64,65) the generic commercial problem for the USA and the UK regarding the problems of costs and cash-flow of starting up and delivering television services, where revenue is dependent on viewer uptake.

6.3 Significance of the Video Recordings and their Restoration (McLean 2000)

Following decades of not believing it possible to view television material from the Baird 30-line era, the availability of viewable television recordings alters the way in which we consider early television.

6.3.1 Importance of the Recorded Content

Regarding Phonovision and the viewers' off-air recordings, the historic nature of the content of the re-discovered recordings and its association with the history of television is fortuitous. We could for instance have found some scanned version of a moving picture film recorded on Baird's discs. The normal practice in testing vision for the Baird Company in the mid-1930s was to use a scanned movie loop as a source of test video (McLean 2000, p189, Fig. 7-12).

With the exception of the lantern slides comprising the 1935 Major Radiovision disc, the material from the 1920s and 30s is live content. The earliest known disc from September 1927 is a ventriloquist's dummy head. However, this is not the much-photographed dummy head in the Science Museum. A point missed in McLean (2000) was that the dummy head on the Phonovision disc had to be different from the one in the Science Museum, as Baird had already donated that dummy head, along with his 1925 'Double 8' apparatus, to the Museum in September 1926 - a full year before the date on the Phonovision disc (McLean 2014, p.231).

The author's restoration of the Phonovision discs became the catalyst for collectors to come forward with recordings suspected of containing vision

information. On two of those occasions, the author discovered genuine 30-line material from the 1930s. Until 1996, there was no consideration that any recording of broadcast 30-line television would exist; rather than ever being 'lost', the 'off-air' 30-line material was simply unknown.

In 1996, the author discovered that a recording held by a collector, David Mason, held the first four minutes of the BBC's 'world's first television revue' from April 1933. As mentioned in section 5.7, 'Looking In' is one of the most discussed television programmes from the BBC's 30-line broadcasts (McLean 2000, pp.208-213).

In 1998, the author discovered that multiple recordings uncovered during the house clearance of Marcus Games[23] were undated 30-line video recordings. He deduced them to be from the latter years of the BBC 30-line service as evidenced by the use of mirror-drum camera, large studio, excellent lighting, superb quality, and camera panning with action. The author describes those results in detail (McLean 2000, pp.203-226) and presents them (McLean 2005) as the sole-surviving video legacy of the entire period of BBC 30-line television broadcasts between 1932 and 1935, recorded 'off-air' onto early domestic audio recorders.

In these examples of broadcast television programmes, we can see the techniques in practice by the producer to gain the most out of the limited resolution offered by Baird's 30-line format. Arguably, for the fragment from 'Looking In', we

[23] Marcus Games was brother to Abram Games (1914-1996), graphics designer known for his artwork for the 1951 Festival of Britain and the first animated BBC on-screen logo in 1953.

have the first visual example of constraints in the television system influencing the production of a television programme.

Despite the limitations of the format, the producer 'offered the viewer in the disc's four minutes plenty of variety and movement that would not go amiss in a modern TV commercial advertisement' (McLean 2000, p.212). Watching the fragment gives us for the first time the opportunity to study a BBC 30-line television programme, receivable across the UK and parts of Europe[24], featuring well-known film, radio and theatre personalities in what is 'a great surprise: fast-paced entertainment, full of movement' (McLean 2000, p.208).

6.3.2 'Restoration' misunderstood

The term 'restoring' used for the 30-line recordings has been poorly understood and on occasion mistakenly likened to restoring an old movie film or videotape. The point of significance here is that the procedure involves far more than such a restoration. In this, the narrative in McLean (2000, pp.93-127) and McLean (2005), if anything, understates the scale of the problem of realising visually the material contained on the discs.

Conventionally a restoration might be the result of recovery from a 'dead media' format (such as RCA CED[25] videodisc) where the home entertainment medium has become obsolete and the playback device no longer exists. Alternatively, the restoration might be the result of a damaged recording where the mechanism to

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[24] …as opposed to the 1936 BBC Television Service which was receivable only within 80km of the transmitter at Alexandra Palace in London. The international coverage of 30-lines was sporadic and dependent entirely on the reception conditions for medium-wave transmissions.

[25] Radio Corporation of America, Capacitance Electronic Disc. A now-obscure domestic videodisc format used mostly for pre-recorded films as a television signal. Graham (1986).

replay the physical medium still exists (a hard disc backup, a damaged VHS[26] tape or more commonly, a movie film where the image has degraded with time).

In the case of these 30-line videodiscs, both negative situations above apply: the videodisc medium is unknown and undocumented (in the case of Phonovision the vision signal does not comply with any documented standard), and the playback and display devices are unknown. In addition, the damage to the recordings was complex, occurring during recording and, for the aluminium discs, also during storage.

6.3.3 Impact of the Restoration

The impact of the recovered 30-line material extends across several disciplines, including the general history of television within Science and Technology Studies, programme creation and content within Media Studies, Video Art, Media Archaeology (Appendix 2), and even from within a discussion of the educational use of videodiscs as a learning tool (Ferster 2016, pp.26, 46-48).

Appendix 1, which lists references to the author's published works, demonstrates that most citations are for McLean (2000). This may be because the book is the most extensive of the publications, has been available for study for the longest time and contains significant original historical and photographic[27] content, in addition to the information on the restoration and the presentation of its unique results.

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[26] Video Home System – a common domestic videocassette format of the late 20th century.

[27] *Restoring Baird's Image* included 40 previously-unpublished photographs from the 1920s and 1930s in addition to the author's restored imagery.

Notably, more external references are made to the historical content in McLean (2000) than to the restorations, possibly reflecting the authoritative nature of the book.

The references to the restorations are made almost exclusively to the Phonovision test recordings. This may be because the Phonovision discs contain the world's earliest-known recordings of television, or because of the popularity of John Logie Baird as a subject of study.

The absence of any reference to the restored programme content from the BBC 30-line era 1932-1935, especially the 1933 fragment from 'Looking In', is remarkable. This may be due to a predominantly technical audience for the work. However, it may more likely be due to consideration of any material before 1936 as 'test' or 'experimental' (as suggested by Briggs (1995, pp.523)). Despite this, there has been demand for the restored visual material contained in McLean (2005) in support of institutions and museums (such as the British Film Institute and Science Museum in the UK and the Cinémathèque Française in Paris, France).

6.3.4 Classifications of the Restorations

Some of the ways in which we can classify the restorations and their results are as follows:

Restoration and Forensic-level Analysis akin to an Archaeological Dig: For Phonovision, defects associated with repeating anomalies in the resultant image indicated some underlying fault in the creation of the television image, deduced to arise from building errors in and features of the scanning process in the camera.

Interpreting the results indicated the kind of equipment used in Baird's laboratory and how well it was built.

As Museum Artefacts: The surviving discs themselves were significant by association with what they contained. For Phonovision, where the discs were intended to be synchronised with the camera system, the physical disc's significance extends beyond its transcription. In 2003, the author supported the Science Museum Group in locating all surviving Phonovision discs and supervised a new digital transcription, copies of which are now held by the British Library and the Science Museum Group.

For Observing and Studying Live Content: The 'liveness', captured on disc, can transplant the viewer into Baird's laboratory, watching the image of a ventriloquist's dummy head being manipulated (Davis 2007), or at home watching BBC 30-line broadcast television in the early 1930s. The re-enactment of such programme events from the 30-line era is exemplified by the work of Dr Phil Ellis for the 1930 Pirandello play, 'The Man with the Flower in his Mouth' (Ellis 2015) [28].

For Study of Production Techniques: The video material directly reveals production techniques unique to the format that has been previously described first-hand by the original producer Eustace Robb (Robb 1934, p.243) and recalled by Bridgewater (Bridgewater 1992, p.12; McLean 2000; McLean 2005).

As Video Art: In 2001, the Victoria and Albert Museum commissioned the author to provide a continuously looping replay for a video art installation. The museum

[28] This play produced for 30-line television was unique in being the first television production by the BBC, though facilitated by the Baird Company, within the experimental Baird television service that started in 1929 on 30-lines. It was broadcast on 14th July 1930.

presented the silent restored imagery, showing the soubrette Betty Bolton singing an unknown love song, alongside five other performance and video art installations by artists including Yoko Ono (McLean 2001).

6.3.5 Reviewing Committee of the Export of Works of Art (RCEWA) (2015)

In 2015, the sale by auction of material belonging to Benjamin Clapp, Baird's first technical assistant, was suspended by a case based on the historic importance of both a Phonovision disc and Clapp's amateur radio logbook among this material. The logbook captured the on-air information exchanges leading up to (but not including) the demonstration of the display of live television images in New York, sourced from Baird's laboratory in Long Acre, London, and transmitted by Clapp's amateur radio equipment in Coulsdon, Surrey.

The items had been sold for £78,500 to a collector outside the UK. Prior to completion of the transaction, a Case brought before the Arts Council with the author as one of the expert witnesses recognised the value to the nation of at least the Phonovision disc, and its association with the Transatlantic TV demonstration (RCEWA Case 1 (2015-16): Baird / Clapp Phonovision disc and ephemera, 2015). The Case included citations for *Restoring Baird's Image* (McLean 2000) which identified the disc as the world's earliest-known and discussed its possible use during the Transatlantic TV demonstration.

An anonymous benefactor acquired the collection for the nation and donated it to the University of Glasgow. The *Daily Telegraph* reported, 'Culture Minister Ed Vaizey said: "This collection will be incredibly important for the study of the history of television and I'm delighted that it will remain in the UK."' (Agencies 2015).

Prior to McLean's work (2000, 2005), there had been no association of the Phonovision disc with Baird's Transatlantic TV demonstration. Clapp had considered the disc only a curiosity. Its existence was unknown except to his close friend Ray Herbert, who was instrumental in introducing Clapp and the disc to the author.

6.4 Reviews of *Restoring Baird's Image* (McLean 2000)

The IET Publishing website lists a sample of the general reviews for *Restoring Baird's Image.* [29] The television history sections in the book have specifically received considerable praise for their balance and accuracy:

IEE Review: 'A concluding chapter, "Revising History", fits Baird into the context of his times, neither ignoring his limitations nor consigning his achievements to the waste bin of irrelevance' (Rogers 2001).

Aldridge: '…McLean's book *Restoring Baird's Image* has been a valuable reassessment of the role of Baird in the early development of television' (Aldridge 2012, p.3).

Schwarz (2001): 'The result *[of restoration]* … provides a unique and thoroughly unexpected glimpse at how television looked in its Palaeolithic era'.

Emmerson, reviewing the book for the British Journal for the History of Science:

> … *Restoring Baird's Image* does it *[clarifying the vagueness surrounding Baird]* remarkably well, covering not only Baird's contribution to television

[29] https://www.theiet.org/resources/books/history/19421.cfm

> and allied sciences but providing a conspectus in miniature of television development down to present times, while still keeping its subject within bounds. Moreover, the author's passion for his subject (and scholarship) shine clearly through, **making this book the most authoritative book on Baird's work yet published**. *[author emphasis]* (Emmerson 2001)

A few reviewers have described the process of restoration of the 30-line television recordings and the forensic-level analysis in McLean (2000) as 'archaeology':

Burns (2001) states, 'In Restoring Baird's Image, the author has given a fascinating account of his discovery of the recordings and of his subsequent treatment of their images. The latter is an outstanding example of "television archaeology"'.

Rogers (2001) states, 'The dedication with which the signals from the three categories of discs were restored is nothing short of technological archaeology. As a result, we can see the progress in 30-line quality made over its eight year life and understand the persistence of its supporters. … Read this unique book with humility and trust that a future generation will be generous to our endeavours'.

In the foreword to the book, John Trenouth, who was at the time Senior Television Curator within the Science Museum Group, states, 'for me, his work is an outstanding example of industrial archaeology' (McLean 2000, p.xiii).

The impact of the author's work on 'Media Archaeology' is discussed in section 6.9 and supported by Professor Ernst's comments in Appendix 2.

6.5 Significance of *The Dawn of Television Remembered* CD/CD-ROM (McLean 2005)

The author's CD/CD-ROM set provides an extension to the information available in McLean (2000) in both audio, video and text format. Notably, the presentation of high quality pre-rendered computer-viewable versions of the entire restored 30-line video recordings described in the book is only available on this CD/CD-ROM set. This original 30-line video material helps us understand more than any written narrative what early television between 1927 and 1935 was like.

The main subject of the publication – the audio documentary – is structured in a chronological format similar to radio documentaries in the use of short archive recollections with linking narrative. The intended audience for this documentary though is directed more towards those with a specific interest in this period of television history as it contains more detail than available in, for instance, Briggs (1965, 1995).

As is made clear on page 10 of the booklet accompanying the CD/CD-ROM, the intention is to present content that is as accurate as possible. In emphasising this, the author is demonstrating his views of the risks of reliance of factual accuracy on personal recollections of events. 'The comments made and views expressed by the people in this documentary should be considered as being more or less influenced by the ensuing circumstances' (McLean 2005, booklet p.10).

The contribution of most significance for academic research, beyond the availability of the 30-line video collection, is the unedited selection of interviews. Though the author retrieved some from the archive of the Royal Television Society,

he assembled the remainder from private collections. Of specific note, the recollection by Campbell, describing the Baird company's Long Acre studio in 1930, is the only first-hand account of the studio facilities at what was a significant time in the Baird company's existence.

The collection of material on the CD/CD-ROM provides a resource considered by Aldridge as equivalent to the extensive interview extracts in Norman (1984). In fact, the CD/CD-ROM includes the complete searchable text of Norman's book in PDF version, which the author scanned, converted and republished with permission of the BBC and the Royal Television Society. In Aldridge's view:

> Along the same lines *[as Norman (1984)]*, the material collated by Donald F McLean for his CD-ROM project 'The Dawn of Television Remembered' creates a substantial and important resource. Not only is this an audio documentary but it includes unedited interviews with some of those involved. While these are rarely referenced in this study their existence was of considerable assistance in gaining a sense of the individuals' attitudes and feelings at this crucial time' (Aldridge 2012, p.3).

The author's provision of the archive interview audio and restored 30-line video material on this CD/CD-ROM addresses in part one of Wheatley's key observations: 'the question of access to, and survival of, material that shapes our sense of television history' (Wheatley 2007, p.8).

By being self-published, the CD/CD-ROM set has had its impact constrained by only been available to those actively searching the internet for such material or to those visiting the author's web-site[30].

6.6 Significance of 'The Achievement of Television' (McLean 2014)

This journal article improves our understanding of the technical circumstances regarding Baird's demonstration of 'true television' to members of the Royal Institution at his rented facilities in Frith Street, London, in January 1926. At that time, any consideration by Baird and his business partner of television as a public service and as a business were at best commercial aspirations. The focus in 1926 was very much along the lines of demonstrating that moving pictures could be seen by wire between two rooms.

The objective for the article was to gain a reference position for assessing Baird's capability associated with this event. The assessment involved a 'hands-on' photogrammetric analysis of the Science Museum artefacts donated by Baird, using techniques adapted from McLean (2000).

The author's identification of the purpose of Baird's 'Double-8' mechanism as a crude transportable demonstrator (McLean 2014, pp.233-234) is original, deduced by analysis of the physics of the design. Since publication, construction of a working scaled replica by engineering enthusiast, Mr Peter Smith of Reading, has demonstrated that the 'Double-8' design, in any of its modes of operation, creates a

[30] https://www.tvdawn.com

significantly inferior picture to the simpler single-spiral design, confirming the author's views in the article. The author identifies that a single-spiral Nipkow disc was used for the off-screen photographs in 1926 and for Phonovision a year later (McLean 2014, 239-240).

The consistency of design techniques with contemporary descriptions for each of the two devices studied by the author (that is, the 'Double-8' and the 1926 Televisor) supports their authenticity. However, some uncertainty still remains, largely through absence of information from and removal of key parts by Baird. As a result, the only Baird artefacts that we can be sure of being original, with no possibility of subsequent modification, are arguably the Phonovision discs. The closing remarks in McLean's 2016 public lecture at the University of Glasgow were, 'with Phonovision, there is no possibility of dressing up what you see. … I would argue that the Phonovision disc ranks as being the most genuine original artefact of Baird's work at that time' (McLean 2016).

6.6.1 Reducing confusion in Assessing Baird's Achievements – McLean (2014)

Consistent with the author's other published works, the narrative in McLean (2014) establishes the need for clear, consistent definitions across the differing interpretations of the technical environment. The sources of confusion are explored – such as Abramson drawing his own conclusions based on Baird's patents, contrary to the evidence available elsewhere (McLean 2014, p.241). As the author notes, Baird's deliberate vagueness surrounding his achievements and demonstrations make any associated deductions incomplete and unreliable (McLean 2014, p.229).

The article identifies the persistence of the view that the 'Double-8' was used for the first demonstration of television in 1926, and provides the evidence against this (McLean 2014, pp.231-233).

Since the article's publication, the author discovered a plausible explanation for the association of the 'Double-8' with that first demonstration in 1926. A 1937 newsreel, 'The Anniversary of a Great Invention', shows Baird describing the two artefacts donated to the Science Museum and studied in the 2014 article (the 'Double-8' and the 1926 Televisor). The newsreel appears to have been edited on the assumption that Baird is referring to a single event, yet his words are correct and accurate for each item *as being separate*. He introduces the 'Double-8' as 'it is now 12 years since...' dating the event to around 1925. In a separate shot, Baird identifies the Televisor with the 1926 demonstration. Such errors in presentation and editing have undoubtedly added to the confusion. It seems likely that this 'first-hand' report by Baird could have been the primary reason for some historians believing that Baird used the 'Double-8' for the January 1926 demonstration (McLean 2014, p.231).

6.7 Significance of 'The Great British Broadcasting Competition' (McLean 2018)

The author identifies the general emergence of television in Britain in the period to 1936 as encompassing, '… a complex political, commercial, technical, social and cultural mix involving the UK government, the BBC as broadcaster and creative

content provider, and the companies developing state-of-the-art systems…' (McLean 2018, p.46).

The point that the author makes in this article is that the historiography should incorporate commentary from all the different disciplines involved in broadcast television, as well as including the dynamic interdependencies linking the disciplines.

To the author's statement 'This approach recognises that "television" can have quite different meanings and priorities when viewed from within each of its main constituent disciplines' (McLean 2018, p.46), Professor Daniela Zetti has stated, 'It is in my view the most solid starting point to explore television history and to understand the historical actors' motifs, arguments and discourses' (Zetti 2017).

The 2018 article presents multiple perspectives on the competition between the original suppliers for the provision of a system to enable the BBC's Television Service. Ensuring that each event is considered from multiple disciplines is a structured way of forcing the observer to understand the position and actions of each of the parties that had a direct involvement in some aspect of television. The result favours no discipline over any other.

Simon Vaughan, Archivist of the Alexandra Palace Television Society, has considered the article's presentation of the emergence of BBC television in 1936 as, 'the clearest and most unbiased view I've read' (Vaughan 2017).

For the technical historians such as Burns, the story of the development of television from a purely technological point-of-view is in itself complex, with the progressive development of components for electronic television and radio

communications sitting alongside the release of the 'log-jam' of 19th century inventions caused by the availability of electronic amplification in the early 1920s.

One of the key arguments made in McLean (2018) is that the establishment of the BBC's Television Service in 1936 was based on British systems more directly influenced by developments in Germany and the USA than had previously been believed.

Notably, McLean (2018) is the first publication to identify the close similarities of the German spotlight-scanning camera portrayed in Lipfert (1938, p.20) with the text description of the Baird company's spotlight scanning system for the 1936 service (referenced in McLean 2018, p.53).

The article presents a more complete picture of the emergence of television in Britain than elsewhere, as it not only shows a multinational element but also strong transnational cross-dependencies at engineering component level. This contrasts with the Post Office and the BBC openly showing nationalistic pride in announcing the establishment of the world's first operational Television Service (McLean 2018, pp.61-64).

6.7.1 Clarification on the EMItron/iconoscope

Aside from the new views gained from the approach, the article presents in detail the key contents of McGee's laboratory notebook that had not previously been reported (McGee 1934). This document is vital to understanding how EMI managed to develop an all-electronic system that bore such a close physical similarity to RCA's iconoscope developed by Vladimir Zworykin and his team in the USA. The author's publication of extracts from McGee's notebook significantly reduces the

controversy regarding RCA's possible direct involvement in EMI's development of an all-electronic television studio for the BBC.

In addition, previous engineering assessments of the Marconi-EMI all-electronic system have drawn attention to the similarities of the camera tubes. However, no such previous assessment has extended the comparison explicitly to the rather obvious similarity of EMI's technical studio architecture with that of RCA's prior system (such as central timing, lightweight mobile cameras with the processing electronics held in racks of equipment in a central apparatus room).

6.8 A Multi-Disciplinary Model across the Author's Published Works

The multi-disciplinary approach in McLean (2018) provides a frame of reference for historiographic analysis and assessment of early television as an engineering system, as a public service and as an industry in its general sense. The article's use of the emergence of television prior to 1936 as a case study demonstrates that such an approach can add considerable value to scholarship.

As an illustration of Wheatley's key observation regarding nostalgic bias (2007, p.8), this period in BBC Television's history has experienced more popular exposure by way of BBC television documentaries than any other. Broadcast on significant anniversaries, such documentaries fuel the nostalgia for the November 1936 start-of-service.[31] The author's article specifically avoids any such popular influences and

[31] The author was the BBC's Historical Adviser for 'Television's Opening Night' - the 2016 celebration of the 80th anniversary of the 1936 start of service.

actively dispels the use of popular anecdotes that have since been proven to be fictional (McLean 2018, pp.52-53).

Addressing the problem of excessive nationalism identified by Wheatley (2007, p.8), the framework for the author's model has no national restrictions and specifically requires the inclusion of the USA and Germany; those countries where developments influenced the emergence of the BBC Television Service and who had been assessed directly by the Selsdon committee in 1934 on behalf of the UK government. The contrasting implications of the political, economic and legislative differences in each country significantly helps to locate the development of events in Britain within an international context.

6.8.1 The Importance of Common Points of Reference

The author originally formed the principle behind the methodology in McLean (2000) out of the need to resolve inconsistencies in the histories of television believed to be caused by different context, meanings or interpretations of terms. 'Television' is shown to be too vague a term to be completely understood without knowledge of the context (as highlighted earlier in the analogy with 'Air Travel' in section 4.5.1). The argument extends to what is meant by 'invent', inferring that the answer to 'who invented television?' is meaningless out of context and requires greater specificity (McLean 2000, pp.9-10).

The chapter 'Revising History' in McLean (2000) directly attempts to address shifting perceptions and extreme views by looking at events conventionally reduced to common terms. One example given is the claim by Farnsworth of having 'demonstrated television' in September 1927. By exploring the circumstances in detail, it becomes clear that what Farnsworth demonstrated was not considered

television when the equivalent was done in 1924 by Baird. 'Farnsworth had used a "hot bright carbon arc lamp" shining directly into the front of his camera tube, with an opaque pattern on a glass slide creating a shadow' (McLean 2000, p.267).

In Farnsworth's case, the narrative supplied the information needed to reduce the argument to common terms. Something similar is at work for the study of the artefacts associated with Baird's first demonstration of television, though it requires 'hands-on' analysis to undertake the reduction to common terms (McLean 2014). The resultant observations and conclusions are a direct result of seeking a common language, albeit technical, reflecting the pre-broadcast period of television.

6.8.2 The Quest for Consistency – the Benefit of a Multi-Disciplinary Model

Throughout the author's published works, the need for consistency in the usage of terms suggests that controversies may have arisen simply from either differing interpretations of these terms or re-definition of the terms throughout television's history.

As one example, Baird's demonstration of television on 26th January 1926 is justified as being 'first' against his own definition for 'true television' as, '…the transmission of the image of an object with all gradations of light, shade and detail, so that it is seen on the receiving screen as it appears to the eye of an actual observer' (Baird 1926, p.734). This definition distinguishes his work from that of others (which might then be inferred, conveniently for Baird, to be 'not true' television). As a result, Baird was granted the recognition of having provided the first such demonstration (as discussed in McLean (2014)). However, by considering the term 'television' as experienced by a viewing audience via a *practical* television broadcast service, any such 'first demonstration of television' appears far less

significant. Such different viewpoints most likely encourage controversy when considering the significance of Baird's demonstration (as discussed in McLean (2014, p.229)).

A change in the use of the term 'practical' when applied to television has in the author's view contributed to further controversy. However, this may be more down to evolution of the meaning of 'television'. For example, in response to article by Burns (1975), where Burns claims that Baird 'won the race to be the first to demonstrate a practical system', Garratt (1975) asserted that '…Baird contributed nothing whatever to the development of practical television' and refers back to his earlier article (Garratt & Mumford, 1952). As discussed in section 5.2 of this document ('The Technical Histories'), Garratt appears to use the term 'practical' in the sense of television within the context of a service to the public that is in use and operational.

The BBC's Chief Engineer, Noel Ashbridge, employed that meaning in 1943 when he referred to the achievements of EMI as '… to all intents and purposes one firm - EMI - had created television as a practical activity in this country.' (Minutes of the Television Committee, 26 Oct 1943 in Briggs (1979, p.177)).

By contrast, the term 'practical' was in common use in the late 1920s to describe television as technically demonstrable. Hence, in a sense, both Burns (1975) and Garratt (1975) are correct within their own reference frame (that is, Burns locating his assertion in the technical development during the 1920s and Garratt locating his assertion after the establishment of the BBC Television Service), yet each present an apparently opposing view. This may be another instance that supports the author's argument (in the closing sentence in 5.5.3) for recognising that broadcast television

was effectively re-defined in 1936. Nevertheless, a more consistent use of terms from within a multi-disciplinary model may provide a better platform for such debate.

In McLean (2000), the *definition* of terms is stressed as essential to using a common language for assessing differing aspects of television. By specifying and defining those disciplines or viewpoints in McLean (2018), the author's approach not only offers a frame of reference for assessment but may also help *define* the historiographic space (and interdependencies).

6.8.3 Alternative Multi-Disciplinary Approaches

The reference viewpoints or disciplines used in McLean (2018) are arguably the most relevant for describing the *emergence* of television in the 1930s. They do not, for instance include Corner's 'television as representation and form' or indeed 'television as a sociocultural phenomenon' (Corner, 2003). Those are more appropriate for an established, mature service and hence have low relevance to the article's main case study of an emerging service.[32]

Browne's comparative study of national broadcast systems for six countries has a similar objective, based on assuming a mature, rather than emerging, broadcast television environment (Browne 1989).

Dahl, referenced in Corner (2003), reminds us that there is nothing empirically original about a multi-disciplinary approach. He uses the analogy of church history

[32] The reference to Corner (2003) in McLean (2018, p.47) is incorrectly abbreviated. The full quotation is 'it is not so much simply in the engagement with each of these aspects but in the revealing of at least some of the lines of historical interconnection between them that the greatest value for understanding television lies.'

in the 18th and 19th century with its great diversity of study objects. He identifies church history as 'an integrated field of research' and stresses the interconnectivity of the topics. However, Dahl considered that the link with media history is less clear in that, 'media history lacks … a clear thematic identity' (Dahl 1994, p.553).

6.9 Significance and Impact in Media Archaeology

One area to which the 30-line restorations has made a significant contribution is Media Archaeology, and specifically in the area of 'Media Archaeography' as defined by Ernst (2011, 2013). Here, Ernst devotes a section to 'Phonovisions: Digital Restoration of Gramophonic Artifacts' (Ernst 2011, pp.247-249; 2013, pp.65-68). Ernst references the recovery of moving pictures from Phonovision using computers as 'media archaeology as practiced by a different medium (computing)'. In support of this thesis, Ernst has provided a document included as Appendix 2. Here, Ernst considers McLean (2000) to be a 'seminal book' (p.4) for Media Archaeology and considers the restoration project as 'a brilliant case of "Digital Humanities" research' (p.2). The recognition of its relevance is in the dynamic action of processing the signal to restore and re-create the moving image from the inert physical video disc, effectively 're-enacting' the event. The practical limitations of computing power and the need to analyse time-dependent variations (bridging past and future around the current moving image) means that the restoration creates an intermediary fully-corrected version of the content, but the principle identified by Ernst remains the same.

Erdmann (2010) further notes the nature of Phonovision and its restoration. Here he discusses Phonovision's inherent nature of 'sonicity' as identified in Ernst (2016):

> This makes the 30-line images in the format 7: 3 still usable today, but only if they are 'restored' by using a computer. This was done by the physicist Donald F McLean, to whom we owe our present detailed knowledge of Baird's Phonovision. He has discovered in his research with the Phonovision discs both the procedure and its problems and results more than 70 years after the recording of the pictures. *[Translation by Google]* (Erdmann 2010)

The editorial by Fickers and Weber (2015) notes that both Ernst and Kittler have a similar 'materialist' approach to Media Archaeology recognising that 'technological things, defined as non-human agents, create meaning and thus, historical agency' (2015, p.2).

Elsewhere in Media Archaeology, reflecting the interest in 'hands-on' media history through re-enactments, the video content contained in McLean (2005) partly influenced the work of Dr Phil Ellis of Plymouth for his re-enactment of the Pirandello play 'The Man with the Flower in his Mouth', first broadcast as a BBC/Baird co-production in July 1930 (Ellis 2015).

The area of 'liveness' is particularly of interest to Dr Wendy Davis and reflected in her focus on the images from the earliest of the Phonovision discs (Davis 2007). Using a close study of the appearance, movement and 'liveness' of the earliest example, Davis '…argues for the need to include some consideration of television's experimental period in contemporary television and media studies' (Davis 2007,

p.36). Recognising that the rarity of the early material can be a factor in elevating its significance, '… television scholarship remains an incomplete project if it fails to account in some way for this early period of the technology's history' (Davis 2007, p.38).

There is a complex link between perceptions of the 30-line television recordings and Media Archaeology. The various points of contact can be in terms of its creation by and retrieval from mechanical devices, in terms of the appearance distorted by noise and degradation of the physical disc medium, in terms of the imagery being 'lost' and then unearthed, or in terms of the content having an artistic presence – a 'liveness' captured on a medium that is alien to the visual format.

This echoes in part the complexity of live imagery converted for electrical communications purposes into a single time-variant electrical value. The two-dimensional surface dimensionality of the scene at the camera is converted into a time-sequence of continuously varying voltage (Ernst's 'one-line scanning') for communication by wire, by radio or captured onto records, with some means of faithfully reconstructing the two-dimensional view on reception in ideally perfect synchronism with the camera.

7. Research Methodology

The nature of the research in the author's published works is complex, involving expertise across apparently unconnected capabilities, applied to create a unique set of studies of early television history. Specifically, in consideration of McLean (2000), others have described the work as 'industrial archaeology' (McLean 2000, p.xiii), 'technological archaeology' (Rogers 2001) and 'television archaeology' (Burns 2001) – as detailed in section 6.4.

The principle of embracing multiple points of view stems from McLean (2000) as an outcome of the need for common definitions of terms. The narrative demonstrates that this approach can suppress the bias that is all too prevalent across Bairdian historiography. Initially applied directly by the author in talks presented on Baird,[33] the author developed the method to improve understanding of the broader topic of the competition for the BBC's studio systems for broadcast television (McLean 2018). In the article, the author demonstrates that the new methodological framework is of value in defining and locating relevant viewpoints, and in exploring the interdependencies from which a more comprehensive contextualised history can be identified.

Much of the author's work is based on his deep understanding of the many different disciplines relevant for early television. The span of its complex historical development in this period, framed contextually with operational usage for programme-making and broadcast services, belong methodologically to Science and

[33] Aberystwyth University 26 January 2016; Glasgow University, 14 April 2016; Royal Institution, 27 January 2017; Cinemathéque Française, 16 June 2017

Technology Studies. However, the content and its contextual position within television history contribute to a greater appreciation within more general programme studies.

These approaches collectively describe the author's methodological focus for investigative research that strives to resolve disparities and anomalies (such as claims for primacy of invention and of introducing broadcast services), to recognise and minimise bias (such as nationalism and over-emphasis on institutional focus or individual endeavour), and to extend the gamut of likely causes and reasons for key aspects within the emergence of television in Britain.

8. Future Research

The multi-disciplinary approach to considering television history, defined in McLean (2018), has been – as mentioned earlier – built on views 'that "television" can have quite different meanings and priorities when viewed from within each of its main constituent disciplines' (McLean 2018, p.46). The resultant methodology, applied as a framework aligned to the needs of the field, can provide a solid, definable foundation for future research in the review of existing publications and in the exploration of new topics.

Within the period covered by the author's published works, there remain many topics where such an analysis could yield a more comprehensive view of history. Here are just two examples:

8.1 Exploring the Controversies surrounding Baird

The author considers that the large number of books written about Baird, relative to other such television pioneers, are not just a reflection of his fame, but of the level of controversy surrounding the person and his achievements, and the various writers' reactions to those controversies.

If a study were to be undertaken along the lines of that in McLean (2018), there would be a likely reduction in the significance of the controversies through greater emphasis on a broader assessment, especially through exploring Baird's commercial motivations. Nevertheless, Baird's achievements will remain a difficult subject to assess in a balanced fashion due to the vagueness surrounding those achievements

and to the sharp business practices associated with the Baird company (Briggs 1995; Burns 1996, 1998, 2000; Kamm & Baird 2002).

8.2 Extending the Methodology: the emergence of French Television

Applying the multi-disciplinary approach to the history of the development of television in France would allow assessment encompassing socio-political, commercial and business imperatives as well as technical progress.

Burns, for instance, discusses French developments, in relation to the USA, Germany and the UK:

> 'A comparable French industrial research programme did not exist. Indeed, French television work during the early years of the 1930-1940 decade was unremarkable in its achievements. It lacked the excellence of the corresponding mechanically scanned television schemes being developed in Germany and did not advance the principles, or the engineering implementation of the principles, on which television is based.' (Burns 1998, pp.279-280)

Although factually correct, the context of the view is uncertain and differs from the published capabilities of Barthélemy, de France and Chauvierre (Chauvierre 1989). From Burns, we might infer a negative view relating to French inventive or engineering capability. The issue with French development appears, however, to be partly attributable to instability within the French government in the early 1930s,

with some officials within the governing PTT[34] only staying in post for a few months (Amoudry 1997; Tichit 2017). The socio-political viewpoint is unexplored in Burns and a broader comparative analysis may identify other such obstacles to French television development.

[34] 'Postes, Télégraphes et Téléphones' – the French government administration for all communications.

9. Summary & Concluding Remarks

The investigations contained within the author's published works have resulted in clarification of confusions and controversies in the period between Baird's first demonstration in 1926 and the start of the BBC Television Service from Alexandra Palace in 1936.

The published findings provide a positive influence on how we perceive this pre-1936 era. This period has been overshadowed and rendered obscure by a re-definition of television through the technical advances of the BBC's all-electronic studio system that significantly enhanced programme-making and the viewer-experience (McLean 2018).

The collection on CD and CD-ROM of first-hand verbal accounts from this period remains a unique and useful resource, providing a readily-accessible archive collection of interviews and supporting material, including the complete collection of restored 30-line television material from discs (McLean 2005).

These restorations are themselves a first-hand unique resource of original pre-1936 television content that can be applied directly to support television studies. The principal scholarly interest in McLean (2000) appears to be in Baird's Phonovision recordings of 1927-1928. Of greater significance to broadcast history and largely unexplored in subsequent works are the 'off-air' recordings of BBC television from the early 1930s. The opportunity therefore remains for broadcast television during this period to be re-evaluated.

The most evident impact of the recorded material restored and curated by the author is in Media Archaeology. Here the restorations provide a different, experiential

connection. The perception is of ephemeral 'sonicistic' imagery captured in time and continually 're-enacted', or in the author's view, 're-experienced' through the action of digital playback. Viewing the broadcast material creates an almost magical engagement that transcends the mechanisms and processes rendering the playback possible. Correcting the damage of an unsuitable recording medium and converting the one-dimensional movement of a needle in a groove into, say, the experience of recognising the fluid motion of a singer or the face of a woman blowing a kiss to the viewer generates as strong an emotional impact as a work of art. Such a positive impact triggered the request for the author's 30-line material to appear in an exhibition of video art (McLean 2001).

In the latest of the author's published works, he develops and applies a new multi-disciplinary approach to the complex story of the competition for the BBC's studio system in 1936 (McLean 2018). The result encourages a multi-national view of the emergence of British television and extends the institutional focus of the traditional history to include a new exploration of the strong commercial influences on the suppliers. By situating the problem within a multi-disciplinary view, it provides a new explanation of why the BBC can consider its service the 'world's first', a status which had previously been argued unconvincingly solely on its technical merits.

The strength of the author's multi-disciplinary methodology is in providing a flexible, practical, reference historiographic framework for researching new topics against agreed, or if possible, defined perspectives. It has the potential to go beyond simple classification of views to be an active tool for directing future study and research.

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Appendix 1: References made to the Author's Published Works

List of the Author's Published Works

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McLean (2005): *The Dawn of Television Remembered*, CD/CD-ROM[35], self-published.

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Categories for References

This appendix lists all known references made to the author's published works listed above as well as to the earlier body of work that supports the author's published works.

[35] CD-ROM stands for Compact Disc Read-Only Memory.

The majority of the references to the author's published works are for *Restoring Baird's Image* (McLean 2000). This book comprises not only analysis and background detail on the restorations, but a revised history of this period in the author's investigative style. To help illustrate the respective impact, the author has separated the references to the book for the 'Historical Context' from those made for 'The Restorations'.

Referencing the Body of Work supporting McLean (2000)[36]

Burns (1999): p.208 (Review of the author's lecture covering the subject material in McLean (2000) on 11th Apr 1999 at IEE Savoy Place, London)

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Cooper (2006): (Reference generally to the author's work as described in McLean (2000)

Davis (2007): p.43, 49, 50 (Reference to the author's website at www.tvdawn.com)

Donnelly & Ross (1997): p.131, (Reference indirectly to Ross's online article on the author's work at www.mediahistory.com)

Erdmann (2010): pp.10,12 (References to McLean (2000c)

Herbert (1997): p.11 (Description of the author's work without citation)

Koszarski (1998): p.136 (References to McLean (1985) and the author's website)

[36] Included in the 'Body of Work Supporting McLean (2000)', is the author's website www.tvdawn.com, prior versions of the website, and all publications prior to the author's published works.

Lewis & Cosier (1997): p.68 (References to McLean (1985) and the author's website)

Magoun (2009), p.191 Bibliographic reference to the author's website

Nawrocki (2007): p.27 (Reference to p.2 of article McLean (2000b))

Yuste (2008), pp.65-82 (Reference to McLean (2000c)

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Aldridge (2008): p.137 (Reference to p.37, regarding Fox's recollection of Baird);

Aldridge (2012):

- p.14 (Reference to pp.267-274, 'McLean's discussion of the change in attitudes towards Baird over time'),
- p.18 (Reference to p.27, regarding the history of the Nipkow disc)
- p.21 (Reference to p.38, regarding Baird's first demonstration of television)
- p.35 (Reference to p.51, regarding Baird's long distance TV transmissions)
- p.35 (Reference to p.45, regarding Baird's use of basic technology)
- p.58 (Reference to p.193, regarding poor usability and quality of the Baird system in 1936)
- p.67 (Reference to p.131, regarding the Columbia Graphophone Company)
- p.84 (Reference to p.182, regarding the opening of BBC 30-line TV in 1932)
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- p.111 (Reference to p.37, regarding Fox's recollection (as Aldridge (2008)))

Ellis (2015): p.74 (Identification of the correct location of Baird's studios in Long Acre from Figure 7-6 on p.179)

Given (2011): p.223 (Reference to pp.241-242 regarding the history of audio recording and EMI

Hadziselimovic (2012):

- p.23 (Reference to p.41, first photograph of a television image)
- p.24 (Reference (no page number) to Taynton as 'first face on television')

Harrison (2003): p.3 (Reference (no page number) to Baird's cinema television projection)

Hellman (2004): p.230 (General reference to British television history (no page number))

Hempstead & Worthington (2005): p.825 (General reference to British TV history)

Kamm & Baird (2002):

- p.80 (Reference to p.69, regarding Baird's 'Falkirk transmitter')
- p.84 (Reference (no page number) regarding surviving 'off-air' recordings)
- p.88 (Reference to p.69, regarding Baird's 'Double-8' transmitter)
- p.105 (Reference to pp.52-54, regarding flying spot quality improvement)
- p.281 (Reference to p.191, regarding viewers for the 30-line transmissions)
- p.296 (Reference to p.194, regarding Baird's airborne reconnaissance)

Marshall (2011): p.51 (Reference to pp.12-13, regarding the first consideration of television)

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Ferster (2016): pp.46-48: (Reference to pages xvi, 26-53 regarding the story of the restorations)

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Lax (2009): pp.64-65 (Reference (no page number) to the author's video restoration)

Marshall (2011): p.35 (Reference (no page number) to the recovery of the early TV recordings)

Martin (2005): p.47 (Reference (no page number) to recording television onto audio disc)

Moran (2014): pp.25-26 (Reference (no page number) to McLean's story of the restorations)

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Referencing *The Dawn of Television Remembered* (McLean 2005)

Aldridge 2008, pp.23, 90

Aldridge 2012, pp.3, 35, 58

Ellis 2015, pp.74, 76

Referencing 'The Achievement of Television' (McLean 2014)

Schubin (2016): p.40

Referencing 'The Great British Broadcasting Competition' (McLean 2018)

None.

Appendix 2: Comment from Professor Wolfgang Ernst

The following text was generously provided by Dr Wolfgang Ernst, Professor of Media Theories at the Institute of Musicology and Media Studies at the Humboldt University, Berlin, Germany.

This document is offered in support of this Critical Review as comment on the author's published works. It situates the author's restoration of original 30-line television recordings from the 1920s and 1930s (McLean 2000, 2005) in the field of Media Archaeology. Professor Ernst supplied the document on 30th September 2017.[37]

A MODEST COMMENT ON WHERE DONALD MCLEAN'S WORK SITS WITHIN THE VIEWS OF ("RADICAL") MEDIA ARCHAEOLOGY

a) Some notes on Media Archaeology as research method and on Media Archaeography as mode of representation

b) Further modules (sub-chapters) which discuss the McLean research in two pdf files accessible on the academic website of Wolfgang Ernst www.medientheorien.hu-berlin.de, section "Ernst in English"

a) Some notes on Media Archaeology as research method and on Media Archaeography as mode of representation

- There is a "soft" version of "historical media archaeology" as practiced by academic scholars like Siegfried Zielinski (calling it "variantology") and Erkki Huhtamo, which is rather about bringing "dead media" back to consciousness again in the so-called digital media culture; on the other side, the "Berlin school" of Media Studies (Kittler, Ernst et al.) rather differentiates media

[37] The author has corrected only a few minor typographical errors in Professor Ernst's document.

archaeology ontologically from experimental forms of (still writing) media historiography.

- Donald McLean's achievements in "restoring" Baird's early television recordings can most appropriately be situated within the media archaeological field. Media archaeology as research method deals with technological artefacts, in the present and / or as "past-continuous-present" (to borrow the title of Dan Graham's notorious video art installation based on magnetic tape-delayed signal feedback). Media archaeology consciously isolates technological evidence (at least for a moment) from social, discursive, cultural, historical contexts, to let it speak in its own language, as monument in itself rather than document for external circumstances (Michel Foucault, *Archaeology of Knowledge*, "Introduction").

- Media archaeology as a method is understood in another sense as well: making technologies themselves become archaeologists of signal evidence, such as measuring devices analog (oscilloscope) or digital (filter algorithms); to quote the signal epiphany in McLean's research: "The green flicker of the oscilloscope trace was difficult to decipher. I was looking at what was supposed to be a video signal. I could see that the waveform repeated in a slowly changing pattern every 80 milliseconds, and another pattern repeated within it. This was undoubtedly a signal from out of history: a 30-line television signal with a picture rate of 12 1/2 per second" = McLean 2000: xvii

- McLean's research practice is closest to media archaeology as possible in the sense that McLean made technological media themselves the real "archaeologists" of past media signal events.

- Even more media-epistemologically relevant, McLean's successful restoration of early 30-line television recording brings out what looks almost oxymoronic at first sight: only with digital analytics (Digital Signal Processing) the hidden or obscured analog signals could be re-presenced. Current computing therefore time-tunnels the "historic" gap which has separated the present from such past recordings so far: "If it were not for computer technology, Baird's *gramophone videodiscs* would continue to be curiosities that merely hinted of a time before television as we know it. Their latent images would remain unseen and the information imbedded in them would still be completely unknown" [McLean 2000]. The media archaeological key operation is no metaphoric "digging" but a techno-mathematical procedure: analog-to-digital conversion, sampling. *Sample-and-hold* means first of all the time-discrete

sampling of the time-continuous analog signal, which allows for its quantisation, that is: symbolical numbers, a translation (or even "trans-substantiation" in terms of Christian liturgy) into the digital, that is: the mathematically calculable, transforming time into frequencies. A media philological act "to transcribe them" - sc. the distorted, barely readable signals - "in a controlled fashion" [McLean ibid.]. "Taking samples of the voltage at regular intervals gives us a sequence of stable voltage values that we feed to the converter hardware. Each stable voltage value is converted into a number, represented in binary notation" [McLean 2000: 108].

- A focus of media archaeological research is so-called time-critical media. Decisive is the so-called Shannon-Nyquist theorem: "The frequency for sampling a signal should be a minimum of at least twice the maximum frequency within that signal" [McLean ibid.], enabling a high-fidelity reconstruction of the signal event. The signal-to-noise ratio is not only the core question of communication engineering (Shannon), but as well for academic discourse analysis: "Message or bruit?" is the title of one of Michel Foucault's notorious lectures (author of *Archaeology of Knowledge*, French original Paris 1969).

- This kind of media archaeology of the 30-line television makes McLean's project a brilliant case of "Digital Humanities" research in a more precise sense than commonly (mis-)understood (reduced to "open access to "big data"). - "digital humanities", in the media-archaeological sense, means "algorithmic hermeneutics": applying computational software as active archaeologist of cultural knowledge hidden within techno-physical signals. But this is not only relevant for harvesting "bid data", but for close analysis of material technology.

- In a parallel way applied to media archaeology of the sonic, Patrick Feaster succeeded in re-playing Léon-Scott's "phonautographic" diagram of the children song *Au Claire de Lune* from pre-Edison times of 1859. Again, such media-active archaeology of acoustic recording has been possible only through highly sophisticated algorithmic filters performing signal intelligence; see as well for the earliest remaining sound recording from Norway, the Sound Archive Project at the School of Engineering Sciences in the University of Southampton attempted a digital restoration

- Just as video artist Bill Viola once defined the electronic image as "Sound of one-line scanning", sonification of the recorded television image (signal) has been an analytic tool for John Logie

Baird already: "In testing out the amplifiers I used to use headphones and listened to the noise of the vision signal made. I became very expert in this and could even tell roughly what was being televised by the sound it made. I knew, for example, whether it was the dummy's head or a human face. I could tell when the person moved, I could distinguish a hand from a pair of scissors of a matchbox, and even when two or three people had different appearances I could even tell one from the other by the sound of their faces. I got a gramophone record made of these sounds and found that by laying this with an electrical pick-up, and feeding the signal back to a television receiver I could reproduce the original scene. <...> If the cinema had never been invented the 'Phonovisor', as I christened the device, might have been / worth developing; it was certainly an intriguing process. Vision into sound and sound back into vision" [Television and Me. The Memoirs of John Logie Baird, ed. Malcolm Baird, Edinburgh (mercatpress) 2004, 64 f.]. "The mental leap here is thinking of the flat two-dimensional picture, in space, converted to a one-dimensional electrical signal, varying in time" [McLean 2000: 96].

- Media archaeological practice-based research results in "virtual reality" in the double sense of techno/logy: on the one hand it is about restoring the materiality of the mechanical or electronic device, but in order to restore the signals, it nowadays deals with mathematized meta-realities as well. Computers and algorithms themselves here become active agencies of media archaeology.

- Media archaeology reveals the material and logical, therefore: techno-logical principles (ancient Greek *archai*) that drive signal transduction and data processing in the architectural hardware and archival textural software of computing. This necessarily includes analysis of its operativity, that is: truly processual media-archaeology, revealing temporal and time-critical patterns of the medium - just like contemporary archaeology as such nowadays shifts the focus of analysis from the distant past to the "production of presence" (Gumbrecht, Shanks): The past *is* present *in* its traces and is *made* present *through* re-enacting its traces indeed.

- Past media can be "re-presenced" (Sobchack) not only by sheer materiality; they rather require operative re-enactment, operative presence (which is the ratio for assembling techno-epistemological "toys" in the Media Archaeological Fundus and the Signal Laboratory at Media Studies, Humboldt University, Berlin).

- An internationally leading figure in Media Science, Jussi Parikka (Winchester School of Art) suggested McLean consider "Media

Archaeography" as being the right association for the material. Indeed, the technical term media archaeography implies that instead of writing "about" past technologies (that is, intransitively) in a language which itself is foreign to the circuitry (textual description / narrative), it rather aims at *writing the media diagram* (transitively), akin to the circuit diagram (analog) or the source code (digital).

- For media archaeological research derive consequences for communication with technologies from the past. Instead of "historicizing" in its epochal context (which is necessary but concerns rather cultural historical interests), media archaeology aims at "re-presencing" inherited technologies; see Vivian Sobchack, Afterword. Media Archaeology and Re-presencing the Past, in: Erkki Huhtamo / Jussi Parikka (eds.), Media Archaeology. Approaches, Applications, and Implications, Berkeley / Los Angeles / London (University of California Press) 2011, 323-333. This approach is based on the media-theoretical assumption that a technological artefact (be it recordings or the actual player) is in a "media" state only when signal processing (or rather: signal transducing, in the "analog" electronics case). Therefore, different from most other artefacts in the museum ("archive") of cultural history, such archaic technologies need to be "re-enacted" (historian Collingwood's term for negotiating evidence from the past, though textual in his case).

- McLean's seminal book has occasionally been referred to as ‘industrial archaeology’, ’technological archaeology’, and the author as a ‘television archaeologist’. In terms of Media Science, McLean's methods of artefactual research is "more like a forensic-level investigation" (McLean); this relates to the "twin" method of media archaeology which is media philology indeed: paradoxically, only from critical, "forensic" signal analysis results true media-philological insight (not traditional philological criticism related to the con/textual metadata); see Kirschenbaum's "forensic" analysis of the computer hard disc: Matthew Kirschenbaum, Mechanisms. New Media and the Forensic Imagination, Cambridge, MA (The MIT Press) 2008

- Against the media-phenomenological approach which is primarily oriented at what humans actually / affectively perceive, media archaeology aims at creating sparks of knowledge from within technology itself - even if unremarked by human consumer senses, but relevant for scientific research which is most interested in events which sur- oder underpass direct human perception.

- Donald McLean's achievements in "bringing these images to light and unearthing the back-story from the video faults" (his e-mail communication from 5 September, 2017) at first glance may look like an archaeological metaphor, but calling the signal restorations ‘archaeology’ is not misleading at all but both a method and an aesthetics of practicing media criticism. Against archaeology as metaphor borrowed from the classical academic archaeological discipline related to the act of unearthing material artefacts underneath the ground, media archaeology is understood rather in Michel Foucault's sense who in his *Archaeology of Knowledge* defines archaeology as foregrounding the conditions of possibility for perception to happen at all (the *a priori* in philosopher Immanuel Kant's sense); this corresponds to the non-phenomenological inquiry into archaic 30-line television: "What few have referred to is that the investigation surrounding the Phonovision restoration revealed the details and flaws in the methods and mechanisms by which the material was originally recorded. So there was far more than just the visual imagery as output from this research" (McLean's e-mail from September 5, 2017) - indeed.

- Inbetween archaeology as misleading metaphor (regarding technological forensics) and active media archaeology indeed: magnetic prospection methods in archaeological field research as part of *imaging science*

- Chronopoetically, media time is time of archaeological latency (more precisely: delayed transfer, *Delta-t*). Therefore, Baird's *Phonovision* is not "dead medium" (in Bruce Sterling's sense), but an aggregation, waiting to be re-processed in order to become a true medium (in operation) again - an existential temporal form which, in this case, coincides with the technological act of induction itself.

- Donald McLean intends to deposit the restored material (amounting to 15 minutes of Phonovision and about 16 minutes of BBC 30-line restoration, including all surviving 4 minutes of the April 1933 ‘Looking In' TV revue), with the British Film Institute, to make and institutionally keep this material available in full. As a "monument" the Baird Phonovision recordings have become part of the archive (by inventorisation and curatorial preservation) such as any other classical paper record. The difference is operative: as a "document" it comes only into being (i.e. "readable", recognizable for the eyes) when being processed / played a) by a technical medium (first the Phonovision electro-mechanical Baird equipment, now the digital restoring computer) and b) when kept

operative by an on-going medium, which requires the archival artefact to be processed; see http://www.tvdawn.com/silvaton.HTM, © D F McLean 1996

b) Further modules (sub-chapters) which discuss the McLean research in two pdf files accessible on the academic website of Wolfgang Ernst (chair of Media Theories) www.medientheorien.hu-berlin.de, section "Ernst in English":

- '**Radical Media Archaeology**', sub-chapter, 'Media themselves as archaeologists (archaic video recording)'; Lecture at Universitat Oberta de Catalunya, Barcelona, Dec 1, 2017.[38]

and

- '**Operative Media (Art) Preservation. Adopting to the technological time regime',** sub-chapter, 'Materiality matters: electronic media art (esp. video)'; Lecture at Media Art Preservation Symposium, March 23/24 2017, Museum of Contemporary Art (Ludwig Museum), Budapest.[39]

> 'Media-active archaeology is time-reversed, such as the restored wonders of original recordings from the dawn of television technology, made in the era of mechanically-scanned television by means of algorithmic signal detection and filtering software. "Not until the computer era came on us could we study these images" (McLean 1998, http://www.tvdawn.com/index.htm; accessed 15 March, 2008. This makes all the difference to media artistic play such as the *VinylVideo* project, which Gerhard Sengmüller calls a "piece of faked media archaeology" (see visomat inc., asciiVision, in: Thomas Y. Levin, Ursula Frohne / Peter Weibel (eds.), CTRL[SPACE]. Rhetorics of Surveillance from Bentham to Big Brother, Cambridge, Mass. (MIT) / Karlsruhe (ZKM) 2002, 372)'

[38] PDF retrieved on 1st May 2018 from https://www.musikundmedien.hu-berlin.de/de/medienwissenschaft/medientheorien/ernst-in-english/pdfs/medarch-radical-barcelona.pdf

[39] PDF retrieved on 1st May 2018 from https://www.musikundmedien.hu-berlin.de/de/medienwissenschaft/medientheorien/ernst-in-english/pdfs/medarch-re-enact-budapest.pdf

Appendix 3: Published Works submitted by the Author - McLean (2014 & 2018)

The following pages (with original page numbers) include the published articles:

McLean, D. F. (2014). The Achievement of Television: The Quality and Features of John Logie Baird's System in 1926. *International Journal for the History of Engineering & Technology, 84*(2): 227-247. DOI 10.1179/1758120614Z.00000000048

McLean, D. F. (2018). The Great British Broadcasting Competition: a multi-disciplinary analysis of the emergence of BBC television. *Media History 24*(1): 46-70. DOI:10.1080/13688804.2017.1312319

Note that **McLean (2000) and McLean (2005)** are available as a physical book and a CD/CD-ROM set respectively and hence are separate to this document.

INT. J. FOR THE HISTORY OF ENG. & TECH., Vol. 84 No. 2, July 2014, 227–47

The Achievement of Television: The Quality and Features of John Logie Baird's System in 1926

DONALD F. MCLEAN
Independent Historian, UK

In January 1926, John Logie Baird gave what was considered at the time to be the first public demonstration of television. The image quality that people experienced can only be guessed; no details were released of the equipment and published reports were vague and inconsistent. Historians since then have been unable to add to the understanding and occasionally have confused the story through assumptions that are inconsistent with the available facts.

This paper explores the period around Baird's first demonstration in detail using a new in-depth analysis of the original Baird equipment now in museums, and a new contextual analysis of the original published material. It describes the most likely status of Baird's television system in use in early 1926 and the likely quality of what people experienced.

KEYWORDS John Logie Baird, television, opto-mechanical, televisor, BBC, Science Museum, Royal Institution demonstration, Nipkow disc

In the years that followed the discovery of the light-sensitive electrical properties of selenium in 1873, many ideas were proposed for a means to transmit still images across distances by telegraphy and early successes were encouraging. Some extended the thinking to allow seeing at a distance by electricity (referred to more commonly as 'television' after 1908) and several optical and mechanical means to do so were put forward.[1]

The principle in this early form of television was that an optical image of the scene was swept ('scanned') across a light-cell mechanically. At any one time only a small part of the image fell onto a single stationary light-cell. The varying brightness of the light generated a varying electrical signal that could be sent by wire to a receiver. There, a similar arrangement using a fast-reacting light source reconstructed the image. In order for the viewer to see a moving picture, the scanning of the scene needed to be done many times a second. Although many techniques for opto-mechanical

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scanning had been invented in the mid- to late-nineteenth century, there was at the time no means of getting a signal from the light-cell that was suitable to drive a display.

By the 1920s, the advent of valve-based electronics provided the means to amplify faint electrical signals from such light-cells. Several inventors (most notably Jenkins in the USA[2] and Baird in the UK) sought to adapt and develop the earlier opto-mechanical methods to create a practical camera and display. The encouragement to do so was the social acceptance and commercial success of audio broadcasting. The nineteenth-century concept of television was that of a camera converting a scene to an electrical signal, which was sent down a wire to a display where the signal was converted back to an image of the scene. Hence the examples of television given at the time were typically that of a telephone with live pictures as well as sound — an extension of telegraphy and telephony.

Radio broadcasting opened up new possibilities for television. If the radio communications technology could be extended to include vision, then there should be a market for radio receivers that would allow people to see as well as hear broadcasts. However, in the 1920s the limitations of the electronic components and the infancy of electronic design techniques placed serious constraints on making the television display and especially the camera system work. Even crude impressions of a scene proved difficult to achieve.

The first demonstration of 'true' television

After three years of development work and demonstrations to the public, John Logie Baird achieved an improvement in his television system on 2 October 1925 that allowed him to meet the basic criteria for 'true' television; immediate viewing of a remote illuminated scene (notably the face of office-boy, William Taynton) reproduced in light and shade.[3] In the following few months, Baird gave demonstrations to groups of potential financial backers and interested parties. In late January 1926, generally believed to be 26 January, he demonstrated television at his premises in Frith Street, London, to about forty people including members of the Royal Institution (referred to here as the RI). *The Times* was the only newspaper invited, and its reporter published the story on 28 January.[4]

With very little money, few resources, only commercially available technology, a forty-year-old technique for scanning a scene and 'almost superhuman determination',[5] Baird achieved what others had not. His innovation was in configuring and adapting existing methods and technology. His subsequent achievements were in pioneering and promoting wide-ranging imaging applications and, more through inspiration than invention, accelerating the development of broadcast television in Britain.

The 1926 demonstration was a pivotal event in Baird's life, marking the transition from his existence as a poor garret-flat inventor to global recognition for achieving television, and coming at a time of strong social interest in new media communications as the public acceptance of radio broadcasting matured.

A lucrative industry had already developed for the sale of audio broadcast receivers ('radios'). Baird, who had a history of attempted money-making ventures and a background in engineering, saw a similar opportunity with television and, at the January

1926 demonstration, announced his intention to sell television receivers to the public.[6]

Over the remaining years of his life and long after the need for commercial secrecy had passed, Baird did not disclose any detailed information of the equipment used for the January 1926 demonstration. Despite the commercial sensitivity of his work, Baird was consistently a poor documenter; a point supported by comments from his secretary, Dora Caffrey.[7] Throughout his life, he considered his next idea more important than documenting his current or previous ones. However, if Baird had disclosed details, this would have allowed technical comparison with subsequent, demonstrably better-resourced approaches in the USA and elsewhere. In the demonstration in January 1926, Baird with minimal finances and resources had after all achieved what others with far greater resources had not. That lack of information, even long after the event, has kept historians guessing, with the result that there remain conflicting views that this paper attempts to address.[8]

Existing publications

The events surrounding this first demonstration of television have been published extensively, with some material currently in print.[9] Due to the archaic and at times arcane technical element of the story of television's development, it can be difficult for non-technical historians to maintain consistency with the language and meaning of the published material. This can result often in conclusions being drawn that may be plausible, but are not necessarily the most likely, or an explanation given that may not be strictly accurate. In general though, there is considerable variation in the accuracy of documenting this event. For instance, Ritchie, a film director, has several minor factual errors surrounding the 1926 demonstration (dates, type of event, sequence of events).[10]

Whilst many of the early television historians (such as Burns) have included the 1926 demonstration as a key event, some have not even referred to it. This may be due to perception of a lack of a technological breakthrough, as evidenced by parallel developments in the United States, elsewhere in Europe, in Russia and in Japan. After all, Baird's achievement had been in successfully configuring existing components to produce the first demonstration of 'true' television.

It may also be that some authors have judged opto-mechanical systems to be less relevant than the later electronic systems, emphasizing the later thermionic valve-based systems (such as RCA's iconoscope). By the late 1930s those valve-based all-electronic systems were to become the mainstay of broadcast television for decades to come.

Oliver Hutchinson, Baird's business partner, strongly promoted Baird's television work, and at times overstated its capability and readiness. In a few instances, this operated as a negative influence on Baird and his achievements. Notable among the critics of Baird was Swinton, the proponent of all-electronic television. Between 1928 and 1929, Swinton severely and openly criticized Baird, the Baird Company and mechanical television in general. However in late 1929 his critical view was tempered when he saw a Baird television demonstration at the BBC. 'The television was very successful, and I was able to recognize a moving picture of the Prince of Wales'.[11]

De Forest makes no mention of Baird's 1926 demonstration, giving credit to both C. F. Jenkins and Baird for the first television transmissions of 'shadowgraphs' in 1925.[12] More recently, Winston makes no specific reference to Baird's 1926 demonstration, preferring to address the demonstrations of Bell Labs and General Electric in 1927 and 1928 and to consider Baird's work as a 'partial prototype' in his terminology, referring also to 'the curious persistence of Baird's reputation in British consciousness up to the present'.[13] However, Shiers in 1981 considered the 1926 demonstration as a landmark event stating that, 'Demonstrations by Baird in January 1926 marked the end of the long and speculative search for ways to see by electricity and the beginning of a new era in telecommunications'.[14]

Outline of Baird's approach

In Baird's television system, the scene being televised was scanned progressively using the Nipkow disc, patented by Paul Nipkow in 1884.[15] In its simplest form, this was a disc that scanned one image on each rotation, the lines of which were created by having apertures (holes or lenses) distributed equally around the outer part of the disc, with one line per aperture. So, in this simplest form, for a 30-line TV picture (as commonly used in the UK between 1926 and 1935), there would be 30 apertures around the disc, spaced 12 degrees apart for the full circle of 360 degrees. The scanned area was small; the length of a line was the 12 degree arc-length around the circumference and the width of the stack of lines was set by the number of lines and the radial spacing between them. The sweep of the disc meant that, at any instant, only the light from one tiny part of the scene was being converted to an electrical signal. This action had to be repeated many times a second to refresh the image and to give the impression of smooth movement.

Most available light-cells in the early 1920s were not only insensitive to small changes in light for television but also slow in response time. The electronics needed to amplify the faint signal were in their infancy. Though many differing methods for achieving television had been suggested and even patented since the late-nineteenth century, practical results had remained elusive.

Jenkins in the USA followed by Baird in the UK had achieved what were called television 'shadowgraphs' prior to 1926. The poor sensitivity of the available light-cells meant there was no tonal detail in the shadowgraphs, hence only the shadows or shapes of the subject could be viewed reliably. For the Jenkins broadcasts, just the novelty of receiving and seeing recognizable moving shapes by radio was exciting.

Baird stated that 'true' television had to display a normally lit scene in full tonal range from bright to dark.[16] Seeing a silhouette of a head came a poor second to being able to see facial expressions. To show tonal variations in the image of a face was technically demanding; instead of handling a subject with strong backlighting, the camera system had to deal with only the much fainter light that was reflected off the subject. The vision signal from the camera had also to follow the rapid changes in brightness to reproduce detail and texture faithfully.

In 1925, Baird had improved his system such that he was televising an area the size of a face at a short fixed distance from the camera in reflected light. His light-cell and electronic amplifier were not yet good enough to resolve any detail within the image.

Yet Baird demonstrated this type of quality in 1924 and 1925 as part of promotional activities to raise awareness and funds. People claiming to have been televised by Baird before October 1925 were likely to have been scanned in this way.

The surviving artefacts

To provide evidence of his achievements in 1926, Baird arranged with professional photographers to capture images at his workplace of the equipment he was using, as well as long-exposure off-screen photographs of his 30-line image. Two photographs by Lafayette's from different sessions are reproduced here. Baird also arranged for items to be donated to the Science Museum: a television display device (which he called a 'Televisor') reportedly from the 1926 demonstration, and earlier equipment that is described below. A second version of this earlier equipment was later discovered in Falkirk, Scotland, comprising the camera system only.[17]

The Double-8 equipment

The first equipment donated to the Science Museum was a combined camera and display built around an unusual arrangement of lenses and apertures on the Nipkow scanning discs. Rather than a single spiral on one complete turn, the Nipkow camera disc on this equipment contained two spirals of 8 lenses on each revolution of the disc (shown in Figure 1 with a white display disc having 2:1 shaped rectangular apertures, suggesting intended 16 or possibly 32 lines per image operation). For simplicity, the equipment using this type of Nipkow disc arrangement is referred to here as the 'Double-8'.

On 6 February 1926, notably within a few weeks of the first demonstration of television to members of the RI, Hutchinson offered one of Baird's Double-8s to the Science Museum (Figure 2: note that the white Nipkow display disc has been removed from the disc at the right. The spiral-slotted disc is mostly obscured, above the 'E' and below the central motor. The belt drive and pulley-gear for it is to the right. 'C' is a light chopper disc on a separate motor, which Baird eventually discarded as obstructing too much light.). This was delivered and accepted in September 1926.[18] According to the Science Museum registry entry made at the time, Baird's Double-8 equipment 'effected the first public demonstration of wireless television' (shadowgraphs) in 1924. The Double-8 equipment was capable of creating and displaying an 8-line image from the lens disc alone (assuming each of the two spirals of lenses was identical). It could also generate an image of 32 lines, when the lens disc was used in conjunction with the spiral-slotted disc. As a report written later in 1926 mentioned a 32-line system in use at that time,[19] the Double-8 equipment has been considered by some to have been used for the 1926 demonstration.[20]

Baird himself indirectly referred to the Double-8 being used for the October 1925 imaging of Taynton by stating 'the original apparatus and the dummy's head' were at the Science Museum.[21] As a lesser achievement is recorded in the Science Museum registry for the Double-8 equipment, and as Baird dictated his book from memory in 1941, there should be caution in accepting that the Double-8 was used for the October 1925 session.

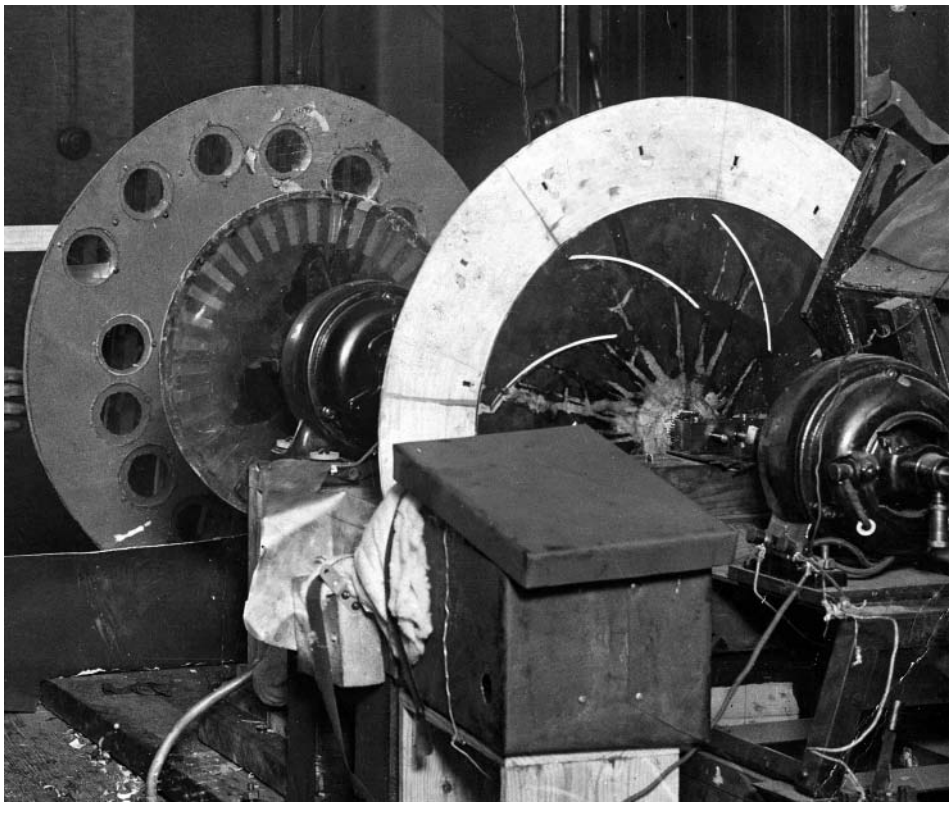

FIGURE 1 The Double-8 equipment with double-spiral Nipkow lens-disc. *Royal Television Society [RTS36-07].*

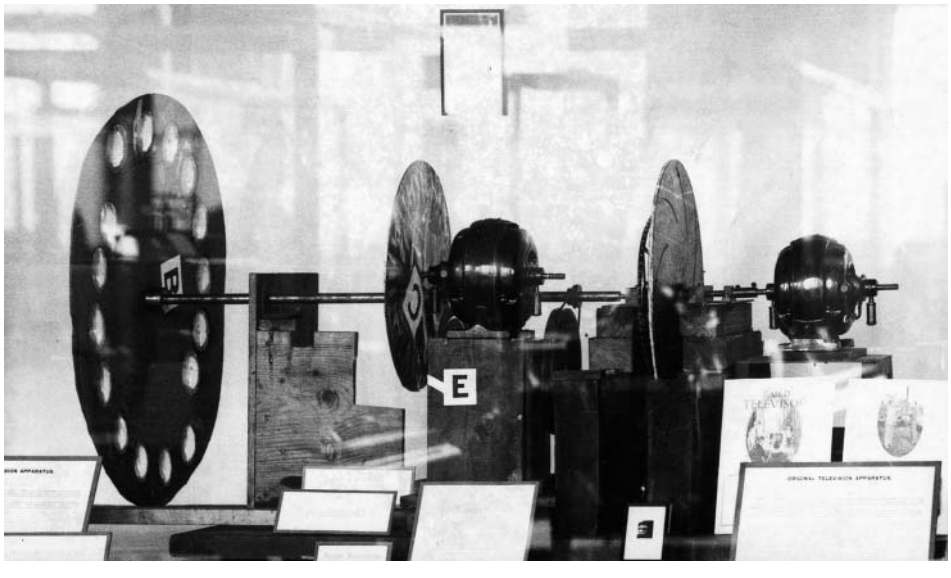

FIGURE 2 The Double-8 equipment as exhibited at the Science Museum. *National Media Museum [RTS36-19].*

A few months after the donation, Baird openly described how the Double-8 camera and display system worked.[22] As the equipment could now be studied by anyone, there was no need for commercial secrecy. However, the Science Museum equipment was missing certain parts, including the light-cell and its electronic amplifier. Baird was most likely protecting his commercial position but, without those components, the system could not be technically assessed to get an idea of how good the image quality had been.

A comparison of Figure 1 (in Baird's offices) with Figure 2 (at the Science Museum) shows the rear light-coloured Nipkow display disc had been removed before its donation to the Science Museum. The combined rear radial and spiral disc on the equipment (currently at the National Media Museum) may have simply provided rigidity to the missing Nipkow display disc and consequently performs no purpose now other than to confuse the researcher (Figure 2).

In November 1926, an article in the *Electrical Review* covered details of the Double-8 equipment used for demonstrations at Selfridge's department store in London in 1925.[23] This described the combined action of the two connected scanning discs for the camera: the Double-8 lens disc and a smaller spiral-slotted disc (Figure 2). Both Baird and Dinsdale stated that the lens disc turned at 800 rpm, four times faster than the spiral-slotted disc which turned at the image refresh rate of 200 rpm (or around 3 images per second). Dinsdale caused confusion in the second edition of his book by both referring to it as both the Selfridge's system for outlines and saying that it gave 'true television'.[24] Dinsdale's and Baird's descriptions are similar and misleading, suggesting Dinsdale simply repeated Baird's description and error.

As the lens disc was a double spiral, in theory it only needed to turn twice (rather than four times) as fast as the image rate for a 4:1 interlaced 32-line image.[25] The small spiral-slotted disc (Figure 2) that created the interlacing, rotated at the image refresh rate. The lens disc with two spirals of 8 lenses had to turn precisely twice for each image to give a 32-line image.

In practice however, both existing Double-8 systems feature pulley-belt gearing to drive the spiral-slotted disc rather than more precise mechanical gearing. A physically separate arrangement of camera and display would be completely impractical. Not only that, the gear ratio is substantially higher than needed. However, if the spiral-slotted disc were on the same drive shaft, and the gear ratio reduced to 2:1, then a Double-8 system could theoretically generate and display a type of 32-line image.

Transportable demonstrator?

There is an inherent design weakness when operating the Double-8 equipment assuming that it operated to generate 32 lines per image. This concerns the maximum safe rotational speed of the thick cardboard Nipkow lens disc. From basic physics, the centrifugal force acting on the lenses increases by the square of the rotation speed, yet only proportionately with the radial distance of the lens. What this means is that, for a specific image refresh rate, the lens mountings on the thick cardboard disc in the Double-8 suffer twice the stress as those on an equivalent 32-line single-spiral disc. Not only that, there is an adverse impact on image quality from the additive errors of having two mechanically linked and hand-made scanning discs.

Although these appear to be straight design flaws, there may be a deliberate overriding reason for building such a complex system: the Double-8 equipment is far more easily transported than a single-spiral equivalent. A camera and display system using a 1-metre diameter Nipkow camera disc would be much easier to move to, say, Selfridge's department store, than one with a 2-metre diameter disc.

For studio demonstrations in late 1925 and 1926, there was every reason for Baird to discontinue using the Double-8. Just by using a single spiral disc for the camera with the same size of lenses and numbers of lines, Baird would have created a substantially better image. Compared with the Double-8, this would have reduced the curvature of the image, simplified both the mechanics and the optical path, and most importantly allowed a higher image refresh rate, as the disc could turn faster for the same centrifugal force. The latter point alone would have significantly improved the quality of the displayed image.

Understanding the mechanisms for opto-mechanical television is difficult enough without the poor quality of contemporary understanding and reporting. These have hindered determining what the most likely system for the 1926 demonstration was. For instance, Larner discusses a 32-aperture disc for the 1926 demonstration, stating: 'The apparatus used in the first of these demonstrations is now in the South Kensington Science Museum, and consists at the transmitting end of a roughly constructed disc of cardboard containing 32 lenses in a staggered formation'.[26] The illustration shows a single spiral of 32 lenses, and yet he has just described, incorrectly, the 16-lens Double-8 equipment; the only such system at that time provided to the Science Museum. The rest of the description is similar to that of Dinsdale and Baird for the Double-8 equipment.

Image quality

Visible on both Figures 1 and 2 is a motor and disc with radial slots (labelled 'C' on Figure 2). The motor is free-running and not physically connected with the rest of the equipment. This disc, which Baird in his memoirs refers to as a 'light chopper',[27] was an attempt to gain more signal from a selenium light-cell, which naturally suggests that the camera part of the Double-8 was also based on a selenium cell. Baird abandoned the light chopper as it produced interference patterns and cut the average light falling on the light-cell considerably.

To combat the distortion caused by the response of selenium to light, Baird tried a simple electrical filter that emphasized changes in light. He claimed that this led to success in the October 1925 session with Taynton, and by extrapolation, success in the January 1926 demonstration.[28] However to say, as Aldridge has done,[29] that Baird had achieved 'proper variation of greyscale' with such a filter would be an overstatement. In signal processing terms, a differentiating filter as Baird described would not only tend to over-emphasize texture and detail but also incur phase errors distorting the tonality of the image.[30] In fact this over-emphasis was a feature of the 1926 Lafayette images (Figures 3 and 4) and also all of the surviving video recordings Baird made between 1927 and 1928 (captured in a process he called 'Phonovision').[31] Though in the case of Phonovision there may be other reasons for the distortion, there is a distinct possibility that the Lafayette images reveal the effect of Baird's electrical filter.

FIGURE 3 Oliver Hutchinson — subject of the earliest photograph of a television image, early 1926. *National Media Museum* (for image on right).

Burns believed that the improvement in October 1925 was helped by Baird developing a colloidal selenium cell, giving greater sensitivity than the standard selenium cell.[32] In his paper of December 1926, after describing the Double-8 scanning method, Baird states in reference to the remodelled light-cell and electronics, 'at the present time, owing to the patent situation, I am not at liberty to give technical details of the device finally developed', suggesting something new beyond that used for the Double-8 equipment.

Remodelled equipment

Elsewhere in his December 1926 paper, Baird stated that, after a series of public demonstrations at Selfridge's department store in London in early 1925, 'The machine went back to the laboratory at Frith Street and was entirely remodelled, the optical system was improved, and the mechanical imperfections as far as possible eliminated'.[33] The extent of this 'entire remodelling' was not described, yet Baird referred to an off-screen photograph of Hutchinson as 'one of the first images seen on the Televisor' (Figure 3). A study of this photograph shows it is without any doubt an

FIGURE 4 One of a series of off-screen photographs dated 14 July 1926. *Victoria and Albert Museum.*

image from a 30-aperture Nipkow disc with its apertures arranged in a single spiral. If Baird's association of the re-modelled system was accurate, then he was effectively saying that the system used 30 lines progressively scanned, which the Double-8 equipment could not do.

Further evidence for a 30-line system at the time of the January 1926 demonstration appears in a report on a visit to the Baird laboratories published on 6 February 1926.[34] Here there is a clear statement: '[. . .] while in the transmitting-room a huge 5 or 6 ft disc with 30 lenses arranged round its circumference, arrested the attention of the observer'. This may be significant, as it is the first mention of a single spiral 30-line camera disc. Subsequently, the 30-line system became the basis of his and the BBC's television broadcasts until 1935. All the surviving off-screen photographs commissioned from Lafayette in early and mid-1926 show a 30-line image from a single-spiral disc (Figures 3 and 4). The Science Museum 1926 Televisor has a 30-line display disc with the same image shape, or aspect ratio, as the photographs (Figure 5 is a double exposure of the Science Museum's 1926 Televisor display, showing the line pattern and the square apertures for lines 1 and 30 — the fine dark and light lines are caused by slight differences in radius between adjacent apertures). As the Rogers article was published around a week after the January 1926 demonstration, it provides support for Baird's remodelled system to be a 30-aperture single-spiral

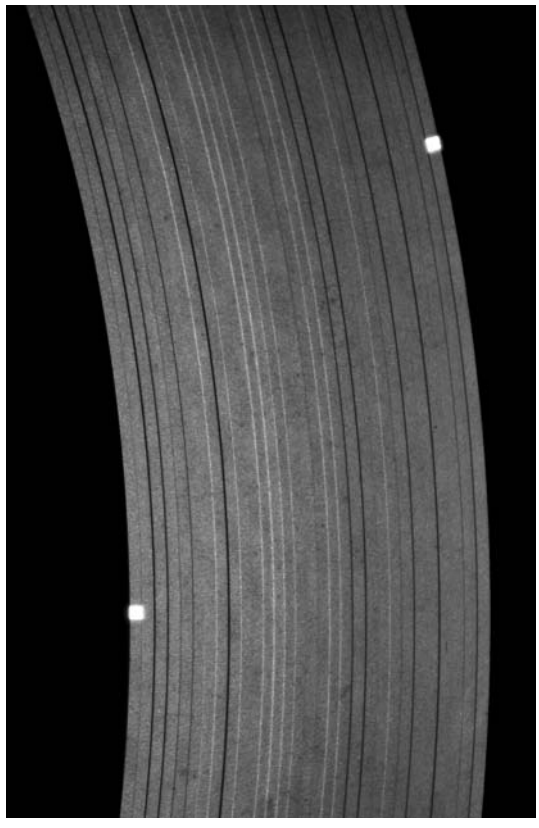

FIGURE 5 Aperture and line structure of the Science Museum 1926 Televisor display. *© D. F. McLean.*

disc with simpler optics and mechanics, larger lenses and enhanced light-cell and electronics.

The 1926 Televisor

On 24 November 1930, the Science Museum received a letter offering the loan of 'the original model of Mr Baird's "Televisor" used in the demonstration given by him to Members of the RI and others in January, 1926'.[35] The Museum staff exercised considerable caution, but on 25 November, O'Dea of the Science Museum confirmed the authenticity, saying

> I have examined the apparatus which proves to be part of that used in 1926 before the Royal Institution in the first public demonstration of true television. It is a development of that which we already have in exhibition and I recommend its acceptance as the original Baird apparatus we have (that is, the Double-8 equipment) only relates to outline transmission.

The Science Museum received the 1926 Televisor on 7 February 1931 (Figure 6).

It is not known why over four years elapsed before Baird offered the 1926 Televisor to the Science Museum. Possibly it was to preserve commercial secrecy, as no photographs of it and no details of the demonstration had been published. Some

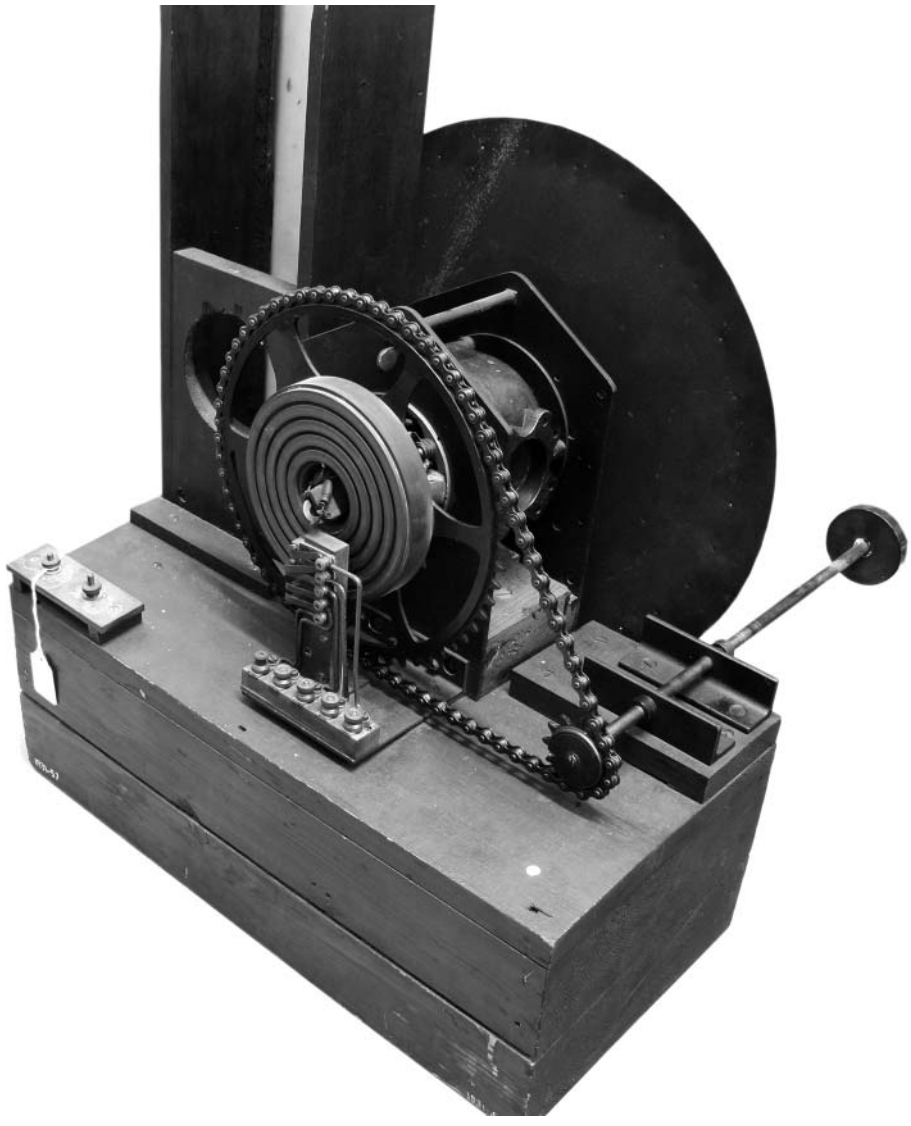

FIGURE 6 The rear of the Science Museum 1926 Televisor. *© D. F. McLean.*

question as to its authenticity appeared in the 1980s triggered by a private letter from W. C. Fox.[36] Ray Herbert also questioned its authenticity, based on the belief that it was a copy or model. He referred to an article that described the same device at an exhibition in 1931. 'This display included a model of the first "Televisor" receiver, and which, by the way, is shortly to be placed in the South Kensington Museum'.[37] However the word 'model' in the 1931 article, in a 1931 book[38] and also in the Science Museum registry entry (above) is taken to mean 'apparatus' and not a copy.

The 1926 Televisor was driven by a synchronous motor assembly that would have been electrically connected to a compatible generator on the camera. This would have

ensured that the display would be turning at exactly the same rate as the camera's lens disc. As there was no method for automatically aligning the start of image and line, the entire motor assembly was manually turned using a bicycle-chain gear arrangement (Figure 6) to align the displayed picture with that from the camera. The use of a synchronous motor is fully consistent with the methods Baird described and used in 1925 and 1926.[39]

The display was generated by a neon tube, fed by the vision signal. The neon shone through a diffuser onto a 30-aperture single-spiral Nipkow display disc. Currently missing from the 1926 Televisor is the rear reflector to concentrate the faint light. The disc provided an image in the ratio 4 horizontal to 5 vertical. The apertures are square, creating even illumination across the width of the line and along each line. This is consistent with the format of the 1926 Lafayette photographs.

The 1926 Televisor and the Lafayette photographs

The author studied the 1926 Televisor at the Science Museum in 2007 to determine if it had been used to create the Lafayette photographs from 1926. Measuring the positions of the 30 apertures (one per line) gave circumferential errors (that is, along the line direction) no greater than 1.5 per cent of line length and typically less than half that. The radial errors (across the width of the image) show up best on a long exposure photograph (Figure 5). Here a pattern of fine light and dark lines is caused by the paths of consecutive apertures not in perfect alignment. Bright lines indicate the radial gap is too small and black lines indicate the gap is too great.

Figure 4 shows one of the Lafayette photographs taken at Baird's premises in Motograph House in July 1926. The repeat image pattern is a feature of the Nipkow disc. The flattened appearance suggests the camera had a narrower aspect ratio than the display).[40] Analysing the photograph of Figure 4 reveals that its display disc had much better positioning of the apertures than the 1926 Televisor, with residual errors of about 0.5 per cent of line length. Comparing this with the other photographs in the Lafayette Collection[41] shows the same pattern between lines. However the pattern is different to both the earlier Hutchinson photograph (Figure 3), and also to that of the 1926 Televisor. That means the Nipkow display used for the earliest off-screen photograph, the one used for the sequence of photographs dated 16 July 1926 and the 1926 Televisor were all different.

Decoding the Lafayette photographs

The earliest photograph of a television image (Figure 3) was published on 25 June 1926.[42] In his December 1926 paper, Baird described this photograph of his business partner, Hutchinson, as 'very imperfect, but it is the first of its kind'. It subsequently appeared in the US magazine, Radio, in August 1926 alongside a remarkably similar still photograph of Hutchinson (Figure 3).[43]

All off-screen photographs at this time show an odd feature of Nipkow display discs; the displayed image is repeated around the disc (Figures 3 and 4). For a single spiral of apertures, each successive image round the circumference will be shifted left or right by one line. On the Lafayette photographs, this shift direction means that the

spiral of apertures moves outwards going anti-clockwise. However, on the 1926 Televisor, the spiral moves inwards going anti-clockwise, suggesting that the Nipkow disc on the Televisor may have been mounted back-to-front at some stage.

In the Hutchinson photograph (Figure 3), there is a vertical step in the image between lines 11 and 12 counting in from the right. On the next image going clockwise, this step has moved one line to the left. If the step had stayed on the same line, then the fault would have been on the display disc. As it shifts with the image, the fault is embedded in the signal driving the display and is therefore caused by an error in the camera disc.

One of the lines is occurring slightly early or late, explained simply by the relevant lens for that line on the camera disc being slightly out of position. The measured amount is about 3–4 per cent of line length and is equivalent to similar errors the author has measured on Baird's earliest surviving Phonovision recording from September 1927.[44] As the same pattern is showing up on all lines, the errors in the camera disc are significantly greater than on the display disc. This is to be expected, as positioning lenses would be less precise than punching out holes.

The faces in the later Lafayette photographs (Figure 4) also look too wide, suggesting the camera disc had a narrower aspect ratio than the 4:5 of the display. Baird changed his aspect ratio from the 4:5 aspect ratio of the 1926 Televisor and the Lafayette photographs, to a narrower 3:7. It looks from the Lafayette photographs that he started making that change during 1926 as the wide faces on the photographs are most likely caused by him using a 3:7 aspect ratio camera. A change in aspect ratio is consistent with Tiltman's observations that improvements to Baird's system allowed the field of view and aspect ratio to change from just a head in early 1926, to head-and-shoulders a year later.[45]

The Hastings Nipkow Disc

In 1999, the Hastings Museum acquired a set of Nipkow discs that may have been associated with Baird. One of the discs has a 32-hole single spiral and was believed by Kamm and Baird[46] to be the one used for the 1926 demonstration. When discovered, the collection of Nipkow discs had only circumstantial provenance. In 1996, Ray Herbert claimed that 'positive identification is not possible', though he believed the discs could have originated from Baird's laboratory.[47] The source of the view that the Hastings disc was used at the January 1926 demonstration may have come from an earlier report by Herbert in 1993 that states, 'The original receiving disc [for the RI demonstration] turned up in a Hastings junk shop some years ago', and describes the same disc.[48] Though superficially similar to the Science Museum's Televisor disc, the 32-hole disc cannot fit on the 1926 Televisor and, more significantly, has drilled round holes for the apertures instead of punched square holes. Round holes give a decidedly inferior image to square holes and are inconsistent with the square holes on the display used for the Lafayette photographs, with those on the 1926 Televisor itself and with the rectangular holes visible on photographs of the Double-8 display disc (Figure 1). This strongly suggests that the Hastings disc is not contemporary with the January 1926 demonstration and is inconsistent with Baird's practices from 1925 onwards.

Flying-spot versus floodlight

Baird lodged a patent for the flying-spot technique just a few days before the January 1926 demonstration.[49] As a direct result, the US historian Abramson believed that Baird implemented the flying-spot technique from October 1925 up to and including the January 1926 demonstration.[50]

The flying-spot technique is effectively a reversal of light-cells and lights in televising a floodlit scene. The 'camera' sprays a rapidly moving pencil-beam of light across the subject in a fully darkened room, scanning the area to be televised — hence 'flying-spot'. In place of the studio lights are light-cells. These detect the ambient light which, in a darkened room, is the light reflected off the subject. As the light-cell detection area could be physically large, this was much more efficient than imaging a lit scene in the conventional floodlit way. In any case, the intense light is only present in a tiny beam at any one time, relieving heat stress on the subject.

From an engineering viewpoint, implementing the flying-spot technique is an obvious step to take. However from the viewpoint of demonstrating the achievement of television to a critical audience, it could well have run the risk of not being convincing. A demonstration 'before the most critical audience possible'[51] — members of the RI, the UK's greatest authorities on science — could give Baird's achievement their blessing and affirm his success. If he had used the flying-spot technique, there was the risk that the 'men of vision', as Baird described them, would not have accepted that television had been demonstrated, as the studio needed to be in complete darkness (apart from the light beam scanning the subject). That also meant the flying-spot technique could never work outdoors in daylight. To ensure acceptance and recognition, the lowest risk approach would have been to televise a conventional floodlit scene.

In any case, there is published evidence for a floodlit studio. In the account of his achievement of image in light and shade in October 1925, Baird refers to intense floodlighting. Baird used a live subject, Taynton, who worked in the same building. He was made 'to sit in front of his (Baird's) projection lamps. These were enormous electric bulbs, and gave out a tremendous amount of heat'.[52] Also, a Dundee newspaper reporter,[53] referred to sitting under bright lights around the time of the January 1926 demonstration. The flying-spot technique came into common use at Baird's labs from 1928 onwards, and was the primary means of creating studio-based television images at the BBC from 1932 to 1935.

Review of original reports

There is no record in the RI's archives of the January 1926 demonstration. This suggests that Baird and Hutchinson, through their own network, targeted individuals who were members of the RI, though with the RI's awareness.[54] By referring to the RI, there was more than a hint of gaining professional acceptance. Notably, Asa Briggs' account of the January 1926 demonstration incorrectly states that it took place at the RI.[55] More recently Aldridge makes a similar statement.[56] Although these seem minor errors today, the same reporting error made in the June 1928 'Television' magazine for a subsequent demonstration to members of the RI was seen by Swinton

to be sharp practice. Swinton even wrote to Sir William Bragg saying 'The seriousness of these statements is that they are being used on the Stock Exchange to fleece the public'.[57] Notably the subsequent exchange of letters between Bragg and Baird was more professional and less emotional; a correction to the report being made in the next issue.

The reports in newspapers and articles referring to the January 1926 demonstration make comments on the equipment, the novelty of the achievement and, in a few instances, reservations about the system's readiness. *The Times* reporter described the camera equipment as 'consisting of a large wooden revolving disc containing lenses, behind which was a revolving shutter and a light sensitive cell [. . .]'.[58] On 27 January, the *Daily Chronicle* described an earlier demonstration, saying 'all that one sees at first glance is the huge revolving disc of the transmitter and the smaller one of the receiver going at exactly the same speed'.[59]

W. C. Fox was a Press Association reporter and friend of Baird's who shepherded the visitors at the event. In early 1928, Fox reported being thrilled by a positive comment from RI member Sanger-Shepherd, without mentioning any adverse comments.[60] Many years later, Fox qualified his remarks, saying

> Some thought it nothing worth consideration; others considered it the work of a young man who did not know what he was doing, while a few, a very few, thought there was something capable of development. There was no realization of the fact that they had been present at the birth of a new science.[61]

Fox's first-hand recollection of comments overheard as the dignitaries left is much cited (with the positive account from 1928 being more often used, such as in Kamm & Baird).[62]

Overheard comments (rather than elicited views from a survey) are a poor guide to what the visiting dignitaries thought of the demonstration. In Fox's accounts, there was no mention of Sir James Percy, co-owner of the Sackville Press in Dublin. His son, J. D. Percy, who later worked for Baird, claimed his father was one of the dignitaries who attended the demonstration. It 'sold him forever on the future of television, and got him immediately, and actively, involved in the formation of Baird Television Limited, and in the founding of the Television Society of which he became one of the first two Vice Presidents'.[63]

Baird gave many other demonstrations to reporters and possible sponsors both before and after the January 1926 demonstration[64] and was improving his system continuously. Fox stated that Baird

> contrived to do a little development work, and when the time came to move to Motograph House, St Martin's Lane, (early February 1926) it was marked by a decided improvement in the image obtained, both as regards size and by the first appearance of true detail. There he gave further and more convincing demonstrations.[65]

Baird himself declared the quality was improving, '[. . .] much better than a couple of months ago' in the New York Times for 25 April 1926. Burns believes this could have marked the shift away from selenium to a new, much improved type of light-cell that became generally available during 1926.[66]

After Donisthorpe was given a demonstration in early 1926, he described the image errors caused by misplaced apertures in terms of geometric distortions. '[. . .] The human face may have the nose flattened out, or one side of the chin may be higher than the other'.[67] The novelty of television meant that the technical language for faults in the televised image had yet to develop.

The Gas Light and Coke Company report

E. G. Stewart was given a demonstration and reported back in April 1926 to his firm, the Gas Light and Coke Company. The report '[. . .] is probably the most important document available on the state of Baird's system during the early part of 1926'.[68] Stewart was the first observer who appeared to understand the importance of geometric faults and what they showed, as he asked to see what the effect of straight edge test patterns would look like. These would have revealed the quality of the construction of the Nipkow disc and 'been much more satisfying from the scientific point of view, but no facilities for introducing one's own subjects were existent'.[69]

Stewart refers throughout his report to the image being 32 lines refreshed at around five images per second. One comment describes progressive scanning: '[. . .] a black shadow passes repeatedly and rapidly across the picture from left to right'.[70] This effect is also seen in the Phonovision images from 1927–28. The 'black shadow' is a result of the refresh rate being so slow that the eye's persistence of vision cannot show the image as a single image, and the observer sees the sweep of the lines. Stewart's reference to 32 lines does not fit with the other reports and the equipment, suggesting that either Baird used more than one system or Stewart was misinformed. After all, Stewart was not permitted to study the equipment and could not have easily counted the lines on the display.

Stewart's comments and appraisal were based on the state at the time of his visit. Even so, his conclusions were positive for the achievement and for future prospects, yet negative for Baird's proposed immediate commercial exploitation. He said that placing the system as demonstrated on the market, would be 'an error of judgment' as the image was crude and distorted, the televised area was limited to a human face at a fixed distance from the camera, and 'the public would quickly tire of the results', discerning that it had mostly novelty value in that form.

Recognition rather than resolution

In terms of perceived quality, the subject matter was a major factor in the viewing experience, and this is evidenced when watching the restored recordings of 30-line TV from this period. At such low definition, general scenes and still objects look meaningless, yet human gestures and movement are instantly recognizable. Much like the movements of stick figures, the brain 'fills in' the detail. Recognition rather than resolution played a significant part in the viewing experience for Baird's television system, and this would have been a key part of the experience at the 1926 demonstration.

The demonstration of January 1926 was a point in time in the continuous technical development of Baird's system when he and Hutchinson believed the image was good enough to be demonstrated to a discerning audience, Their primary aim was to gain recognition, support and financial backing to develop and broadcast television such that they could sell television receivers and make a viable business out of television. That the sentiments overheard after the demonstrations were mixed, suggested the demonstration was not entirely convincing. Baird had however emphasized that this represented an early stage in development and was illustrative of the potential; the quality could only improve.

Any of the image faults in Baird's equipment around the time of the 1926 demonstration were merely symptomatic of a lone experimenter with limited resources rather than any inherent limitations. The refresh rate of around 3–5 images per second was well below the rate for the persistence of vision to show a single image. This made recognition difficult, made prolonged viewing unpleasant and restricted the speed of subject movement. Additionally, being only able to have the televised object in a face-sized frame a fixed distance from the camera with only a few dozen lines per image stretches the definition of 'television' from a purely engineering perspective. Yet at the time, being able to discern and even recognize the image of a face sent instantly by electricity along a wire from one room to the next defined the event where the key principle of television — seeing at a distance — was at last demonstrated, hinting at the possibilities yet to come.

Beyond the 1926 demonstration

The novelty value, the technical feasibility and the commercial potential of a broadcast service are largely what carried the low definition television systems of Baird and others into the 1930s. Eyewitness accounts of people watching the Baird 30-line broadcasts from 1929 and the later BBC 30-line broadcasts (1932–35) were noted from as far away as Iceland, Scandinavia and North Africa,[71] limited only by the propagation of the transmissions from the BBC's existing medium-wave radio transmitters. Viewing those programmes live, received over great distances, played strongly to the imagination.

From 1926 onwards, Baird and his team significantly improved the opto-mechanical 30-line television system (Figure 7), increasing the image rate to 12.5 per second, yet still allowing the 30-line television signal to be broadcast as if it were an audio signal. This was a deliberate choice by Baird to get a television service on air soonest using the BBC's existing audio broadcasting infrastructure. This, more than any technical limitation with camera systems or the like, was the reason the Baird Company appeared to persist with 30-line broadcasting from 1929 to 1935.

By 1935 however, considerable research investment in several countries resulted in the development of practical all-electronic cameras together with the studio and broadcasting infrastructure to support them. Unconstrained by mechanical scanning, these systems allowed for much higher definition and superior technical quality that led the way to the permanent establishment of dedicated television services around the world.

FIGURE 7 An off-screen photograph of Jane Carr showing studio quality 30-line TV from 15 November 1932. *Royal Television Society [RTS38-72].*

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THE GREAT BRITISH BROADCASTING COMPETITION
A multi-disciplinary analysis of the emergence of BBC television

Donald F. McLean

The business reasons behind the decision to start the BBC television service in 1936 remain unclear despite the volume of literature on the subject. Additionally, controversy has persisted regarding foreign involvement in what has been considered a fully British system. What is apparent from the literature is an emphasis placed on the technical development, generally under-representing other aspects of television. A new multi-disciplinary approach is proposed and applied here to explore the circumstances around the emergence of the service, together with hitherto neglected industry aspects: the business and commercial issues relating to broadcaster and suppliers. This paper highlights the primacy of the BBC television service as providing the first instance of what became a common template for live television creation whilst illustrating, with new evidence, foreign influence on British engineering development for the BBC service.

KEYWORDS Television; EMI; BBC; Baird television; Marconi-EMI

Introduction and Approach

The historiography of the emergence of British television broadcasting in the 1920s and 1930s encompasses a complex political, commercial, technical, social and cultural mix involving the UK government, the BBC as broadcaster and creative content provider, and the companies developing state-of-the-art technical systems—Baird Television Limited (BTL) and Marconi-EMI Television Company Ltd. From 1934, Electric and Musical Industries Ltd (EMI) had teamed with Marconi's Wireless Telegraphy Company Ltd to form Marconi-EMI, solely for the provision of broadcast television systems. The BBC launched its television service on 2 November 1936 in the course of its competition between the two companies. That service and its programme creation capability were entirely dependent on and constrained by the limitations of those systems. Consequently the published work on the events in establishing television as a service has tended to maintain engineering as the dominant viewpoint.

Proposed and implemented here is a fresh way of considering this period in television history. This approach recognises that 'television' can have quite different meanings and priorities when viewed from within each of its main constituent disciplines.

For the engineering community, pre-war television history is centred on the story of the technical systems that defined and enabled the television service, and on an affordable means to receive it. For those delivering creative content, the history is about exploring possibilities in programme-making and production techniques using and constrained by those technical systems. For the broadcasting organisations the history includes the

political, commercial and financial pressures, and the need to increase the number of, and to retain the existing, viewers.

Extending this approach beyond the UK to Germany and the USA, and investigating details of the systems developed by BTL and Marconi-EMI, reveals external influence not previously identified. In the case of Marconi-EMI, new evidence has been uncovered that clarifies the scale of the foreign involvement in the development of their EMItron television camera.

Analysis of the competition for the BBC's television studio system using the multi-disciplinary approach provides a better understanding of the influences, decisions and actions that gave rise to the emergence of what the BBC has called 'the world's first high definition television service'. Additionally and hitherto neglected, the business and commercial constraints for the industry (especially broadcasters and suppliers) along with relevant foreign developments are explored, all proving to be essential elements that define the early history of the medium in the UK.

The challenges for the historian are to recognise and understand the importance of the disciplines (both individually and with their cross-dependencies), to have the expertise in all the relevant disciplines sufficient to investigate rather than to report, and to bridge those aspects coherently.

Review of Existing Works

The study of television from multiple aspects has been commented on by Corner, who states that 'the greatest value for understanding television' lies in the historical interconnection between different aspects'.[1] Those aspects he presents are generic and consistent with more recent practices.

The approach presented here reflects the circumstances surrounding the early establishment of British television broadcasting. It has been applied as a framework for assessing and classifying existing publications and for determining the gaps in research by purposely positioning analysis within each of the viewpoints.

The emergence of television within the more general history of broadcasting in Britain has been tackled by Briggs and since, briefly, in Crisell.[2] Briggs writes from a senior-level government-broadcaster viewpoint as the provider of Britain's television service, as evidenced by the high percentage of government-sourced or BBC-sourced document references (around 85%) for his description of the pre-war television service.[3] Regarding EMI, Briggs leaves the company's claimed UK-only position open to interpretation, and suggests a degree of influence from the USA ' … in 1929, the Gramophone Company thus became a subsidiary of the huge American corporation'.[4] He suggests some direct support from the Radio Corporation of America (RCA): 'after modification, [RCA's] ionoscope [*sic*] served as a model for the "Emitron Camera", developed in Britain by … EMI'. He then states that EMI's heritage had links with American business interests, ' … when EMI was founded, it did not have to start from scratch in the process of invention. Zworykin's early work could be used in British development'.[5] Later, he attributes EMI's success of developing 'the world's first high-definition television system' to the genius of Shoenberg and his team in EMI's Research Laboratories, 'drawing on Zworykin's early work'. There is no qualification of what that work was and how 'early', leaving the degree of its influence unspecified.[6]

Winston presents a more general context for television, socially and technically, balanced alongside the emerging technological developments in communications and other media.[7] More general discussion around the social effects of television, the interaction between television and society, the broadcasting institutions, their motivations and the primary differences between the USA and the UK at this time is covered by Williams.[8]

The technical history of the UK pre-war television competition and service has been extensively documented as chronologically ordered collations of primary source material, such as in Abramson[9] and Shiers.[10] Maintaining a similar theme of technical development, Burns' works assemble primary source material chronologically with linking narrative.[11,12]

The reasoning behind introduction of the service, and the financial, political and commercial actions relating to it, appear incomplete in these technical works, illustrative of the advantage that a multi-disciplinary approach might provide. Significantly, whilst facts and data are provided from primary sources, these technical histories would benefit from further investigation, exploration and interpretation of the material, together with a business-level discussion of the primary motivations and the key commercial decision processes of the systems suppliers: BTL and Marconi-EMI.

In Goldie, the viewpoint is centred within the broadcast organisation, exploring the government and BBC policies that defined and determined the service and Goldie's significant involvement in it.[13] In addressing the historical background to BBC television there is no distinction as to television technologies (nor does there need to be for the book's main argument), referring to earlier systems as low definition and poor quality. As such, details on events in the period before 1936, and specifically, matters relating to the Selsdon Report are better addressed in Burns and Briggs.[14] Nevertheless Goldie does refer to the challenges of costs of start-up, and that British television was not financially dependent 'upon having a number of viewers to make it a commercially attractive proposition'.[15]

A Multi-disciplinary Model

Whilst essential to the implementation of a broadcast television service and a fascinating story in its own right, television's technical development could never have happened without the business direction and commitment to undertake it. Restricting the historiography to be centred on technical development (such as in Burns), without clearly distinguishing it as such, can give the artificial impression of technology determinism in action.

The emergence of television, though, was being driven by the industry's (including the broadcaster's) perception of demand, based on media publicity and public feedback on broadcast content, all built solidly on the commercial success of sound broadcasting and state-of-the-art technology capability. This paper argues that there is a strong case for ensuring that any historiography for television should encompass all active and relevant disciplines and their interdependencies. Such a broad approach provides a basic framework that allows a wide-ranging review of existing works for gaps, bias and completeness.

The following is a subset of an ideal complete multi-disciplinary analysis, adapted to this period in television history. It observes television from three different primary viewpoints—television as an engineering system, television as a service and television as industry.

Television as an Engineering System

The demonstrations of early technical achievements of television raised government, corporate and public awareness. Collectively, they can be viewed as accelerating the introduction of public television services. However, the achievements revealed in those demonstrations need to be considered distinct from the engineering systems intended for broadcast usage. Only a few of the early headline-grabbing demonstrations led directly to systems for public broadcast services, and were often presented by solo pioneers (such as John Logie Baird in the UK) with the main purpose of encouraging financial investment for further development.

An operational broadcast television service required a viable engineering system to deliver it. A complete system would ideally include everything from cameras and studio, communications for broadcasting, through to displays for viewers. To be successful, the system had to meet the needs of the service, in terms of performance, quality, cost, flexibility, usability and reliability.

Television as a Service

Given the pre-requisite of a suitable engineering system to enable a service, the viewpoint here is centred on the organisation providing the television service, including the creation, presentation and scheduling of content, much of which had yet to be developed and refined. The rate of public uptake and acceptance of the service were essential factors to success, requiring a suitable balance of the artistic, dramatic and entertainment content, ideally aligned with what the public wanted.

Relevant for the introduction of a television service in the 1930s were the constraints that the engineering systems placed on the programme makers. How usable and reliable a system would be to make programmes, and how able it would be to deliver a complex live linear service from each of the two small studios in Alexandra Palace at a quality consistent with production needs and developing values, would determine how suitable and ready the system was for broadcasting.

Television as Industry

From a cross-discipline industry viewpoint, television encompasses all business decisions, actions and operations including any national, political directives or commercial imperatives affecting its emergence. The responsibility for the business of television as a generic industry lay with the decision-makers, and mainly with those able to secure funding from their sources—whether that be from within government and/or broadcast service provider (to launch and operate the service), or from within the engineering suppliers (for crafting the technology systems).

The viewpoint of the broadcast service provider includes the business and economics of starting up and operating a television service and all business aspects of developing and delivering content. For completeness, in the pre-war years, this included the planning for extending broadcast communications to provide a nationwide service.

From the viewpoint of the system supplier, the relevant areas are the commercial and financial aspects and implications of the company inventing, developing, selling and delivering television systems to the service. This applies equally at all levels—from an individual pioneer as owner of their own company, to the leaders of a large corporation.

Transnational Pre-war Television

Illustrative of the breadth of the disciplines that cover all aspects of television is how the term 'transnational' has been applied. The transnational nature of television in terms of production and distribution has been covered by Hilmes.[16] Transnationalism in television technology and engineering has been discussed in Marshall.[17]

However, arising from the proposed approach in this paper, considering the broader definition of television in terms of engineering, service and business, any discussion of television *at this time* as being transnational can only be considered valid for the engineering systems, as the introduction of television services was peculiar to national needs. Even then, those systems were largely localised implementations of widely published principles that were based on underlying common applied science and engineering practices, and implemented using, for the most part, globally commoditised components.

To describe television as transnational in the 1930s, based solely on commonality, or perceived simultaneity of engineering developments, would be to exclude the national, regional, corporate and industry imperatives and the commercial and political drivers for advances in television. All of these points are needed to explain the purpose behind developing and launching a television service in each country. None of these points allows pre-war television *in its broadest definition* to be considered as transnational.

Background

The growth in sound broadcasting in the 1920s and 1930s encouraged a few individuals globally to explore broadcasting with vision as well as sound. Some of those (such as Baird, Jenkins and Ives) applied the emerging electronics systems to ideas that extended back to the nineteenth century and achieved success in the mid-1920s.[18] Demonstrations followed by fledgling service offerings fuelled the media in the late 1920s, but the low quality of the images contributed to a limited uptake and consequently to the short-term nature of the resulting broadcast services.

In the late 1920s, established companies in the home entertainment business were inspired by media reports and public reaction to investigate television. Home entertainment companies (such as EMI in the UK) embarked on research programmes into television with a view to extending their business.

BTL was already established in the public eye as the leading UK company developing television as a result of the work of John Logie Baird. Demonstrations given by BTL and EMI in the early 1930s proved encouraging for the BBC. It recommended to the Postmaster-General that an independent appraisal of the state of television in the UK and abroad be commissioned.[19] When the resultant Selsdon Report was published in January 1935, it advised that a service be started soonest, with the sole technical constraint that the television picture should have a minimum of 240-lines refreshed at a minimum of 25 times per

second.[20] Marconi-EMI and BTL were invited to supply their own respective systems for assessment.

In support of the Wireless Telegraphy Act of 1904, the General Post Office (GPO) was the government department in charge of, amongst other things, administering transmitting licences for the use of radio for sound (strictly, 'wireless telephony'). The GPO granted the BBC sole responsibility for sound broadcasting, reflecting the Act. The BBC was effectively responsible for all aspects of broadcast services and for funding them from a budget agreed with the GPO and Treasury, but based on revenue from broadcast receiving licences administered by the GPO. Any systems to support the BBC's services would be developed independently by and bought from suppliers.

The BBC formally started a broadcast television service for the London region at Alexandra Palace on 2 November 1936. The service initially alternated weekly between the BTL and Marconi-EMI systems. Within a matter of weeks, the decision had been reached to proceed with the Marconi-EMI system and, with the last broadcast on the BTL system made on 30 January 1937, the BBC television service commenced exclusively on the 405-line standard using the Marconi-EMI system.

German Television 1935

In late 1934, when the Selsdon Committee was assessing the readiness of systems within the UK, it was also exploring where the UK stood in relation to Germany and the USA. The published aim of initiating a service soonest in the UK would have been noticed by the authorities in both countries.

Despite denial of any such immediate plans to the visiting members of the Selsdon Committee, the German broadcasting company started a 180-line television service for the Berlin region on 22 March 1935 using camera systems that had been demonstrated in August 1934.[21] The public viewing rooms for the Berlin service had already been planned and partially implemented by the end of 1934.[22]

In August 1935, German pioneer, Baron von Ardenne, openly stated that 'the present definition (180-lines) is not sufficiently good'.[23] With no available domestic receivers, the public were expected to view the television service in public viewing theatres around Berlin. Uricchio suggests several reasons for this,[24] for which the most likely is that German authorities had made a conscious decision to make the 180-line service temporary, and therefore able to be upgraded without affecting the public. To support this opinion, a statement about imminent system upgrade appeared in the 1936 Olympics brochure just one year after the German service started.[25]

The BTL System

In the UK, during the competition with Marconi-EMI, BTL made much of the fact that they were fielding a fully British development. However the system they supplied included an enhanced British implementation of the Fernseh system providing the German television service. BTL had been an active partner of Fernseh AG (Aktiengesellschaft) since its foundation. The complexity of the BTL–Fernseh relationship may have obscured the scale of the German influence on BTL's system developed for the competition.

The studios of both the 240-line BTL system for the BBC and the 180-line German broadcast system of 1935 were centred (literally) around a single static camera—the film-based Intermediate Film Transmitter (IFT). The BTL implementation for Alexandra Palace did not include either the German system's mobile IFT unit or a telecine capable of replaying the special 17.5 mm IFT footage, as neither was required by the BBC specification (Figure 1). In the IFT, the television image and sound were delayed by film processing some 54 seconds. Additionally, the film capacity of the IFT limited programmes to segments of 16 or 39 minutes of action depending on size of reel. This placed severe restrictions on studio production techniques.[26]

Anecdotes about the problems with the BTL system installed at Alexandra Palace tend to amplify the negatives (Figure 2). An often-repeated story, originated by James D. Percy, concerns one of the woman presenters trailing her dress through a puddle of cyanide fixer and having to be hosed down.[27] In a previously unpublished letter, Gordon Craig, the person responsible for the film processing in the IFT, said:

> I can only think that Percy was trying to make a comic turn out of his little piece, because of course it is pure fantasy. There was never the sort of risk, electrical or otherwise, which

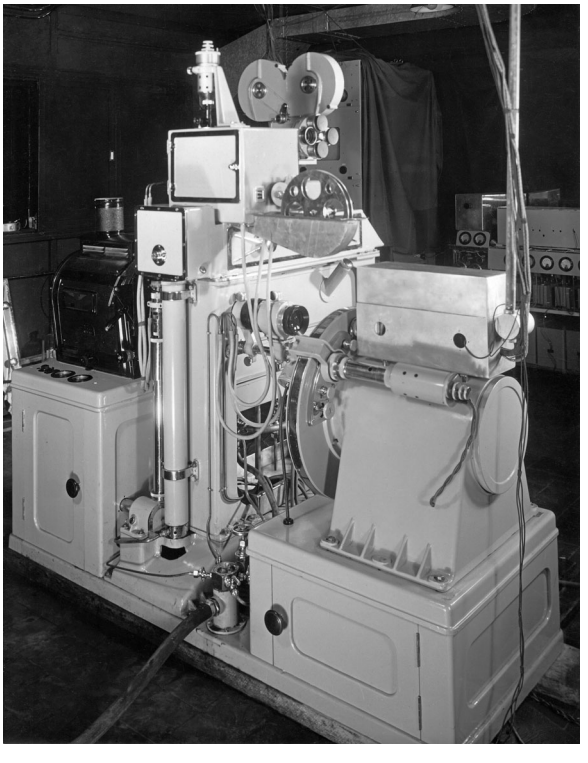

Figure 1
The BTL IFT camera prior to installation at Alexandra Palace. Exposed film from the camera (top centre) passed through the processing tanks (centre). An arc lamp (left in dark housing) shone through the tank and lenses to a scanning disc assembly (right), almost identical to the BTL telecine. Courtesy D. F. McLean

Figure 2
A restored 17.5 mm frame from the IFT taken during commissioning tests at BTL laboratories in Crystal Palace. The subject is Arthur C. Banfield, leader of the IFT film processing team at BTL. Restored by and courtesy of D. F. McLean

he describes … Still, I suppose comments like this are made in an interview in the hope of instilling a bit of heightened drama.[28]

Between IFT reel changes, continuity was provided by a spotlight scanner, which was a real-time device requiring strict time-keeping in the studio to align its output with the 54 seconds delay of the IFT. The principle of the spotlight scanner was a work-around developed by Baird in 1928 to obtain a high quality picture from his 30-line broadcast-ready system. However, like the IFT, it placed serious constraints on production, not the least of which was that the subject was in darkness. Burns makes almost no reference to the spotlight scanner, reflecting the lack of available documentation. Marshall considers it to be British, as it was based on the 1926 Baird patent for spotlight scanning.[29]

Although no blueprint of the BTL spotlight scanner has survived, a description exists.[30] Research for this paper reveals that the description matches exactly a diagram of the Fernseh spotlight scanner in operational use in 1935.[31] Each scanner had the same dual-motor two-disc four-spiral arrangement running at the same speeds. Very little documentation exists, but the above observation suggests that the BTL spotlight scanner, though based on a Baird patent, was modelled closely on an existing design implemented by Fernseh in Germany. The precision scanning discs for the BTL telecine system and cameras for the BBC were configured for 240-lines and provided to BTL by Fernseh in Germany, as were the photocells for the BBC spotlight scanner studio.[32] If the German spotlight scanner had initially been designed by BTL, there is no record and it

would be distinctly out of character for BTL not to publicise that widely. The conclusion from this argument is that the entire BTL system (comprising spotlight scanner and IFT) was an uprated British-built version of the German studio system, adapted for BBC needs.

Almost exactly reflecting the actions of Fernseh in Germany in mid-1936, BTL ordered the Farnsworth image dissector camera system from the USA as an alternative to the IFT and integrated it into their studio. Records show it had been used on at least one occasion in place of the IFT.[33] The camera's extremely short exposure time left it insufficiently sensitive for broadcast television. BTL's and Marconi-EMI's studio lighting requirements prior to installation were 94.4 and 24 kilowatts respectively for the same studio size, indicating BTL's need for plenty of light.[34]

The EMI System

In early 1930, the Gramophone Company, closely aligned with the RCA Victor branch of the Radio Corporation of America, had projected a year on year fall in global record sales, linked with the rise in audience figures for sound broadcasting.[35] This contributed to a merger in 1931 of the Gramophone Company and Columbia Graphophone Company in the UK to form EMI. Their focus on television research was only part of a strategy for diversification, maturing into a system that became central to the BBC's ability to launch an advanced all-electronic television service in 1936.

From an industry point of view, EMI (Marconi-EMI from 1934 for broadcast television systems) had very little commercial incentive to engage in the research and development of advanced camera systems. In the UK, the BBC held the monopoly on broadcast services. As with BTL, Marconi-EMI therefore would see none of the revenue for the day-to-day service. Selling receivers and gaining royalties would be the only business generating a steady revenue stream. The BBC and the GPO procured finished products rather than funding external research or development, as exemplified in the BTL–BBC agreement for the 1932 BBC television service.[36] As such, for EMI, a high financial and commercial risk research programme followed by just one system sale to the BBC and, if all went well, downstream patent royalties, would be a difficult business choice to make (Figure 3).

In Germany, there was a stronger relationship between the government-run broadcast company and industry than existed in the UK. German companies, such as Fernseh and Telefunken, could be contracted to undertake funded research and to develop trial systems at the request of the German broadcasting company. Using the supplier's expertise as the research and development arm of the broadcaster made sound business sense. This joint way of working initially accelerated systems and development of the service in the early 1930s. However, the German television industry was placed under Air Ministry control on 12 July 1935, changing the nature of the service. Consequently the military involvement may well have negatively influenced the way we perceive pre-war German television engineering achievements.

In the USA, RCA was part-owner of the National Broadcasting Company (NBC). Already profitable in sound broadcasting, NBC was an additional revenue source for RCA. RCA's business objectives reflected this in their message of audience growth and retention.[37] With the potential for extensive downstream revenue from the sale of receivers and studio systems along with income from broadcasting and royalties, RCA were in a

Figure 3
The 196 foot (60 metres) prototype for the Alexandra Palace Tower was installed at EMI Research Labs in late 1935 and dismantled almost 40 years later. Both towers were built by J. L. Eve Construction who also built, later, the Chain Home RADAR towers. Courtesy of the EMI Group Archive Trust

position to invest in long-term research, just as long as the company could handle the adverse cash flow. According to Magoun, the President of RCA, David Sarnoff, 'had pushed RCA's board to invest $10M (£2M) in television's innovation … ' for the 12 years to 1939 when RCA made a false start in television broadcasting.[38]

Shoenberg, the director of research at EMI, had spent around £250,000 from 1933 to 1937 (or roughly £16 million in 2016).[39] EMI had invested in launching a complex, state-of-the-art independent research and development programme for a single one-off operational television system using brand-new untried technology, with only the possibility of recouping development costs through receiver sales, possible foreign sales and royalties. For such a risky venture, there had to be something that would allow Shoenberg to be confident of success. In the course of researching this paper, new information was found that explains how this was achieved.

American Influence on EMI

EMI's formal relationship with RCA prior to 1937 was a simple patent sharing arrangement, where RCA and EMI could see each other's patent applications.

When EMI's all-electronic camera—the 'EMItron'—appeared, it bore a remarkable physical similarity to RCA's camera from 1933. Both cameras used electronic camera tubes with similar dimensions and form factors (Figure 4). Even though the underpinning electronic designs to turn the tubes into television cameras were different, suspicions remained about RCA influence.

The claim of RCA support—of the transfer of 'know-how'—has persisted, despite assurances from every member of the EMI team that there was no such information or material transfer between 1931 and 1936.[40] By contrast, Abramson claims, without identifying a source, that before September 1933, 'Zworykin brought with him to England complete specifications, including Essig's method for producing silver mosaics'.[41] The principle of the mosaic was known at that time as generally how a television camera could produce an image.[42] Recently, Marshall believes more detailed information than contained in patents had to have passed from RCA to EMI.[43]

The camera tube development team, led by James D. McGee, already had relevant experience in vacuum physics and had access to previous published works in the photoelectric effect required for the camera, such as in the standard reference of the day, Hughes and DuBridge.[44] In addition, they could readily access previous works of Zworykin.[45] In August 1932, Tedham and McGee had lodged a patent on a method of forming an array for scanning.[46] Subsequently they developed an electronic camera tube in their

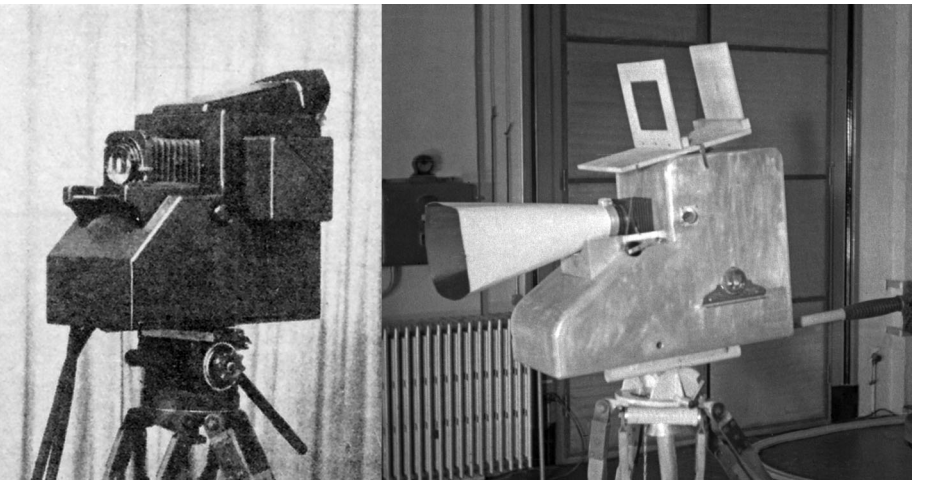

Figure 4
(Left) the RCA iconoscope camera of late 1933 as it appeared in the referenced Zworykin paper. The viewfinder was simply a mirror that allowed the operator to peer at the lens image on the tube surface, to check for framing and focus. (Right) one of the first EMItron cameras at Alexandra Palace in summer 1936, adapted by Mark Savage (BBC) to provide a viewfinder and lens hood. Just visible is a lever attached to the focusing knob (below the lens bellows) which is linked to the viewfinder to adjust parallax with focus. Image focus could be checked through a spy-hole to the right of the lens bellows. The narrow field of view (30 degrees with standard lens) is evident from the lens hood. Courtesy of D. F. McLean, unknown photographer (right)

own time to prove the patent's concept. Though the tube worked after a fashion, McGee stated the work had been abandoned.[47] However in May 1933, Shoenberg had encouraged the completion of the patent application 'because it works better than the RCA techniques'.[48]

Later, in June 1933, Zworykin of RCA presented a landmark paper in Chicago, submitted on 17 July 1933 to the Institution of Electrical Engineers (IEE) in London.[49] It described not only Zworykin's iconoscope (along with photographs and outline diagrams) and how it was constructed in brief, but also the overall television system of which the camera tube was the key element. Versions of his original paper were published in the IEE Journal in October 1933 and in several other journals. The papers were influential throughout the television industry in the USA and in Europe.[50]

The different versions of Zworykin's paper included photographs of the camera housing, as well as a key operational piece of information on how RCA envisaged their design of television studio (Figure 4).

> Since the iconoscope is practically a self-contained pickup unit, it is possible to design a very compact camera … Since the camera is portable, it can be taken to any point of interest for the transmission of a television picture.[51]

The Zworykin paper provided an outline template to develop not just a camera tube but a television system based around it. However any company considering doing this would have needed to understand the science and engineering behind it, and then develop all the electronics. Alternatively they could have bought a complete package from RCA, as the Soviet Union had done in 1935 for $2.9 million.[52]

Without referring to any specific document, Burns gives the most logical explanation:

> '… a research laboratory seeking to construct an inconoscope (*sic*) had the advantage of knowing such a tube would work, as well as the disadvantage of being compelled to devise the necessary fabrication procedures ab initio. This was the position of McGee's group in the summer of 1933.[53]

Fisher more succinctly believed that EMI had based their designs on Zworykin's work.[54]

In 1975, McGee recalled:

> The main effect of Zworykin's paper, as far as we were concerned, was that it finally convinced our management in September 1933, to allow us actively to take up this aspect of television research.[55]

Imitating the Iconoscope

McGee's laboratory notebook, held in the EMI Group Archive and covering 1932–1934, is highly relevant to understanding EMI's role in developing the EMItron.[56] The handwritten notebook of 100 numbered pages comprises McGee's assessments of various patents, and other items. What seems to have escaped previous study is that embedded in the notebook is the proposal detailed below followed by weekly reports on 'transmitting [camera] tube developments' continuously from 11 November 1933 to 23 June 1934. This document is not cited by any previous publication. Here, McGee sets out the objectives of a

Programme of Work in an entry dated 3 November 1933, which was recorded elsewhere as submitted to McGee's management.[57] The first part is reproduced here verbatim:

> Proposed programme of work on cathode-ray transmitting [camera] tubes:-
>
> In view of the fact that although we know that the Zworykin 'Iconoscope' will work we do not know the details of the physical processes involved in its operation, it is proposed that two main lines of investigation should be followed, namely:-
>
> (1) The production of a tube as nearly as possible identical with the tube described by Zworykin in his paper.
>
> (2) The detailed investigation of each operation that occurs in the iconoscope, separated as completely as possible from the complicating influence of the other operations involved in the complete tube.
>
> Following the first line it is proposed that transmitting tubes should be constructed to imitate the tube described by Zworykin as accurately as possible. This admits considerable variation since the description is very vague.

The note describes what work was needed within EMI Research Labs to 'imitate' the RCA iconoscope. Throughout the notebook, McGee repeatedly refers to the EMI camera tube as an 'iconoscope'—the RCA term (probably for lack of a better name)—and also refers directly a few times to Zworykin's tube, reinforcing the position that they were trying to repeat the conditions for RCA's success. For example, the entry in McGee's notebook for 2 June 1934 states: 'An iconoscope is being made which has a signal plate 4 inches x 4 inches [100mm by 100mm] in a bulb of nearly 8 inches [200mm] diameter. This is roughly the size of the tube described by Zworykin'.[58] Burns was apparently unaware of this notebook as, apart from making no reference to it, he refers to 'The iconoscope or emitron as EMI called its version of this type' emphasising a distinct separation between the RCA and EMI designs.[59]

The information in the Zworykin paper could fast-track EMI's development and provide an outline template of what RCA had demonstrated as being a viable television system, in terms of not just the iconoscope but the form factor for the camera and the studio system in which it operated. It was after all quite remarkable that EMI could develop such a production-friendly studio system when they had no prior experience in television or film production.

For Shoenberg, the Zworykin paper would have been a vital element in reducing any concerns the EMI Board had of commercial and technical risk and in reducing the likelihood of cost overruns and delays. For McGee, he could not praise Zworykin and the RCA team enough.

> Whatever proposals had been made in the patent literature or whatever results had been achieved in the privacy of laboratories, they are of little significance beside this paper which entitles Zworykin to the considerable credit due to such a momentous step forward.[60]

What impressed McGee was that it had taken the RCA team just 30 months to develop the tube, camera electronics and the overall architecture of a studio system.

Sarnoff was aware of the similarity of the EMI studio to that of RCA: 'The system is known abroad as the Marconi-EMI Television System which is fundamentally based on the RCA Television System developed in the RCA laboratories in the United States'.[61] Neither Zworykin nor Sarnoff ever made any formal claim that RCA provided 'know-how' to EMI, nor is there evidence of any business incentive to provide it.

The research topics that McGee set out in his notebook are consistent with having no prior knowledge of the tube's performance and construction beyond that in Zworykin's paper. The extent of the research work listed in the notebook provides evidence that McGee and his team did not require any 'know-how' from RCA.

Although the EMI team had consistently denied any such support from RCA, not one of them mentioned McGee's programme of work or the objective behind it. By not doing so, they had inferred greater independence of thought than is evidenced in McGee's notebook, thereby attracting suspicion. When we look in detail at the design of the Marconi-EMI system, we see that the tube is just one component of a complex system of electronics, all of which was based on the demonstrably world-class design capability of the EMI team, introducing new functions, such as preserving black-level in the television picture, not present at that time in the RCA system.[62]

Alexandra Palace

Both BTL and Marconi-EMI systems were installed in adjacent areas at Alexandra Palace in the late summer of 1936. The selection of the Marconi-EMI system for the BBC less than three months into the trial period seems today so obvious a choice that it calls to question why there had been a competition in the first place. The Marconi-EMI solution had shown itself to be technically (picture quality and detail, engineering quality and reliability), financially (running costs) and operationally (usability) superior to the BTL solution. From the broadcaster's point of view, the flexibility in the productions created by the fully integrated suite of highly mobile cameras—even allowing broadcasts from outside the studio on long extension cables as a bonus—was truly exceptional (Figure 5).

The BTL telecine was the only component superior in technical quality to the equivalent in the Marconi-EMI studio. However, the significant advantage of the Marconi-EMI telecine was that it allowed perfectly stable 'dissolves' at any time with any of the studio cameras, as formally required by the BBC.[63]

The 1935 Selsdon Report had centred on establishing the suppliers' capability, engineering readiness, camera performance, coverage of the transmitters and home receivers. The Report and subsequent system specifications made no reference to the criteria by which the BBC would evaluate each system from the viewpoint of programme creation and operating a service. The BBC's specification contained only a loosely specified purely technical requirement with no regard for functional and operational performance or indeed usability.[64] It apparently intended its production team to use whatever the companies provided. Closer liaison early in procurement might have allowed the BBC as operator to influence what features and functions could be supplied.

Figure 5
Rehearsal in Studio A at Alexandra Palace, with Leslie Mitchell presenting and Elizabeth Cowell on the far left of the stage. Courtesy of D. F. McLean, unknown photographer

Installation and commissioning of both systems and initial tests took place at Alexandra Palace in summer of 1936. The BBC had planned to have some months of rehearsing with each system prior to starting a service and determining the best way of making programmes within the constraints and features of the systems. During this period, which included early transmissions to Radiolympia in August 1936, the intention remained that no early elimination would take place and that each of the Marconi-EMI and BTL systems would deliver the on-air service to the public as part of the competition.

The Selection

The service that started on 2 November 1936 initially alternated between two, unproven, technically and operationally incompatible television systems, using two completely different methods of making television programmes, in an on-air competition that would have been more appropriate as an internal commercial trial.

After the decision to drop BTL had been made, the Postmaster-General formally announced on 4 February 1937 that all future transmission would be on 405-lines.[65] Critical factors in that decision, made weeks before, had included the serious constraints that the BTL system had placed on making programmes.

The lack of any prior consultation or formal internal trial on usability to the formal launching of the service, as might be expected from a commercial competition between two suppliers of such new systems, is remarkable. This suggests the BBC was unaware of the benefits that such a trial would bring, was uncertain how to undertake it with a definitive outcome, or, for some reason, was cutting corners to get a public service on the air soonest.

The Postmaster-General's briefing to the Cabinet, accompanying the issue of the Selsdon Report, suggests the urgent timing for launching the service was to allow BBC funds to be used for start-up costs before the renewal of the BBC Charter at the end of 1936.[66] In the same letter the following comments were made, suggesting a national reason for initiating the television service and adding to the case for urgency:

> (5) The Television Committee have stressed the importance of establishing a public service at the earliest possible date. Television has made about as much progress in the United States and Germany as in this country, and whichever of these three countries is the first to establish a successful public service will probably have the best chance of securing business for its manufacturers in the development of television services in other countries.[67]

The 'First' Television Service?

On the opening day, speeches made by the three officials representing those involved in getting the service on the air, clearly stated they were proud that Britain was leading the way for the world. Ronald Collet Norman, Chairman of the BBC Board of Governors: 'At this moment the British Television Service is undoubtedly ahead of the rest of the world. Long may that lead be held'. Major George Clement Tryon, Postmaster-General: 'On behalf of my colleagues in the Government, I welcome the assurance that Great Britain is leading the world in the matter of television broadcasting … '. Lord Selsdon: 'Technically, Britain leads today'.[68]

Germany and Britain both had claims for launching the 'world's first television service', usually with qualifying statements such as 'high definition'. However, there has never been any mutually agreed definition that would allow 'first' to be applied. In the case of the BBC in 1936, Norman suggests that the technical quality of picture and the meaning of 'high definition' were deciding factors.[69] Claiming to be 'first' as dependent on the technical quality of picture is a weak argument without any internationally agreed reference. The distinction for 'high definition' is also unspecific, and has remained so; the term was also used in the UK in 1964 for the arrival of 625-lines replacing 405-lines and later for the arrival of 'HD' replacing 625-lines.

Goldie states that the 1936 service was ' … the first regular high-definition television service in the world', referring to work in other countries, including Germany and the USA, as 'experiments'. The only reference to a service outside the UK at that time in Goldie is to the failed low-definition service of the US station W2XAB in 1933, thus supporting Goldie's view of the significance and primacy of the BBC television service in 1936.[70] The omission of any reference to the 1935 German television service (broadcast only to small theatres at the time) may be an oversight or may be inferred by her claim that television programming received and shown in a cinema or theatre was not television—'Fundamental to television

is that it is received at home'.[71] This position is consistent with the earlier basis for 'radio' (i.e. sound broadcasting).

In the 1930s, BTL and Scophony in the UK, and companies in Germany and the USA, pursued the development of cinema projection systems as an additional or, most likely, an alternative means of viewing to the domestic receiver which was expected, and later proved to be, too expensive for most of the public. However, at that time, the distribution mechanisms for television (as a service to the public) were understood technically but with a degree of commercial uncertainty regarding affordability of the receiving sets.

'First' by Lines-Per-Picture

Preston's description of Shoenberg's commitment of EMI to 405-lines in early 1935 as being 'courageous and far-seeing' seems an exaggeration when compared with developments in Germany and the USA.[72] EMI had re-directed its research programme in late 1933 based on Zworykin's paper, which had described a laboratory-proven US 343-line system (equivalent in line rate to 405-lines in Europe). Preston's comment though may relate purely to the financial risks.

Possibly encouraged by the success of BBC television, Telefunken in Germany in 1937 was working on 441-lines. RCA up-rated their system to the US 441-line standard in 1937 (the closest equivalent in line rate being 525-lines in Europe) and then the USA finally standardised on the 525-line standard (equivalent line rate to 625-lines in Europe) allowing broadcasting to commence on 1 July 1941.[73]

Rather than making a bold move, EMI had been aiming at a rapidly moving target. The leap forward in lines per picture from the required minimum of 240-lines in the Selsdon Report was more a consequence of the move to all-electronic television, illustrating the limitations of opto-mechanical systems.

An argument based on line-count is only relevant to a purely technical assessment. For the viewing public, this was not about counting lines; it was about daily entertainment, coverage of major London events such as the 1937 Coronation procession, live sports and west-end plays (Figure 6).

'Historical Erasure' in Action

Another way of ensuring that the BBC was 'first' was to diminish any previous service. One way of doing that was by considering anything before as 'experimental'. Goldie refers to the 1936 service as 'having passed decisively out of the experimental stage and become a developing service'.[74] Britain's two previous low-definition services were dubbed 'experimental' by the BBC—the 1929 Baird television service correctly so. However, Bridgewater, BBC Chief Engineer 1962–1968, persistently rejected the 'experimental' description for the later 1932 BBC 30-line service.[75] From his first-hand experience as one of the first BBC television engineers on that service, he described programmes full of movement—contrary to persistent derogatory comments about the 30-line service.[76] In 1996, the earliest dateable video recording of BBC television was restored and identified as being a fragment from a broadcast made in 1933, providing the direct evidence to support Bridgewater's claims.[77] Disregarding the BBC 30-line television service may however be justified by the BBC as

Figure 6
Rehearsals for a drama, believed to be Tristan and Isolde with Oriel Ross, who mimed the performance, and Sir Basil Bartlett. Rehearsals were not just required for the actors and performers, but for the camera 'racks' engineers who manually adjusted the signal corrections depending on scene content. Courtesy of D. F. McLean, unknown photographer

there was no significant establishment of a new organisation and infrastructure within the BBC to support it (relative to the 1936 television service), and the broadcasts were time-shared with the existing national sound broadcasting service. The term 'experimental' may have been used to describe it retrospectively for want of a better term.

'Experimental' though can have positive connotations. The Postmaster-General had described the initial alternating BTL and Marconi-EMI broadcasts as 'the London experimental period'.[78] The Selsdon Committee interviewers of Sir John Reith for the BBC, discussed with him (in November 1934) the need for three experimental phases starting with the alternating broadcasts of the two competing systems.[79] Jacobs suggests that 1936–1955 should be considered 'experimental' from the service viewpoint.[80] Sarnoff of RCA in 1937 called all television 'experimental' based on the progressive stepwise improvements that he was experiencing.[81] In advance of the BBC 1936 service, a magazine editor wrote, ' … the word "experimental" can be read as meaning a step on the road to even better things'.[82]

This vilification of previous television services is however not peculiar to Britain; the similarities with Sewell's observations of 'Historical Erasure' of low-definition systems in the USA are remarkable.[83]

The Template for Television Studios

From the business point-of-view of the broadcaster, what started in 1936 was the establishment of the BBC organisation to provide a television service on a scale and scope that rapidly exceeded anything before.

Using the approach described in this paper, the 1936 Marconi-EMI all-electronic studio at Alexandra Palace can be seen as providing the first successful alignment of both service provision and production creativity with an engineering system. It was the first in-service use of a studio configuration and live production environment that would become the template for television studios for the remainder of the century. Over the years, the BBC's systems would evolve and improve significantly, yet the operating procedures and technical studio configuration of the Marconi-EMI studio would remain globally recognisable for decades.

The USA Looks to the BBC Service

Whilst applauding the BBC for launching its television service in 1936, it is worth exploring what had delayed television broadcasting in the USA. The studio configuration at Alexandra Palace in 1936 with lightweight cameras was, after all, based on RCA's idea.

Both Germany and the UK had broadcast media state-run to differing degrees (with the UK more in government direction and oversight). The USA equivalent was entirely driven by private enterprise and commercial businesses. Companies in the USA could set up their own service, subject to regulatory controls. Hence the manufacturers were responsible for the broadcasting companies, such that the NBC, formed in 1926, was owned by RCA, General Electric and Westinghouse.[84] The company making the equipment could also be, or was directly associated with, the broadcaster.

The major reason for the slow start of US television broadcasting is claimed by Udelson to be down to the way that the business of television was handled in each country:

> … in Britain, where in 1936 the publicly financed BBC provided funds for a single public telecasting facility in London, private industry had no need to win the confidence of potential advertisers for the new medium and therefore could continue to experiment with television technology after commencing public transmissions. But in America, where all financing was to be derived from the private sector, a nationally marketable system was required before public broadcasting could be expected to begin producing any significant return on initial capital outlay.[85]

Concern Over Low Audience Growth

Due to low audience figures (hence low revenue from licence fees) and the costs of national roll-out of the broadcasting infrastructure, the BBC television service, if considered as a stand-alone business, would remain loss-making for many years. In August 1939, the Treasury, according to Briggs, stated that the television service was 'very experimental and had little prospect of becoming self-supporting within a "reasonable period"'.[86]

Industry leaders in the USA closely monitored how the UK had been dealing with the service. The mixture of government and commercial interests in the UK served as a better model for learning lessons prior to US services starting, according to Sewell.[87]

The US Hazeltine Service Corporation sent two engineers to assess the technical quality of the British service. Their report was effusive about the quality of the broadcasts, reflecting frustration with the lack of television broadcasting in the USA, 'That these British standards constitute a major improvement over present American practices is an inescapable conclusion because television is technically successful and an accomplished fact in England'.[88]

Service uptake by the public was a critical measure for US television businesses; the revenue from advertising would have to fund both the service and the nation-wide communications infrastructure to deliver it. Sarnoff was deeply concerned that the slow uptake in the UK would be mirrored in the USA.[89] To illustrate the problem, the coverage in 1936 from Alexandra Palace was an estimated 27% of the country's population—some 12.4 million people, of which there were roughly 3 million licence payers for sound broadcasting.[90] Despite that, after 3 years of television broadcasting, only around 19,000 sets had been sold by 1939. Money written off on RCA's research for 10 years was one thing, but losing money daily on a television service—as the BBC television service was effectively doing in the UK—would be quite unsustainable for private enterprise.

Conclusion

The approach presented here has demonstrated the benefits of analysing the emergence of BBC television in 1936 using three primary disciplines and their cross-dependencies; television as industry and business, television as the embryonic creative service for the public, and television as engineering technology. By investigating the business interactions within and across government, broadcaster and suppliers, by retaining a focus on the needs of the service and by incorporating new evidence relating to foreign influence on Marconi-EMI and BTL, we gain a fresh understanding about how and why the television service started. This also illustrates the essential need to incorporate the influence of other nations; from their engineering influence on the UK suppliers, and from the national, political and economic pressures that determined their and Britain's actions. Taken together, this new approach emphasises the benefit in using multiple disciplines and viewpoints to appreciate the establishment of the BBC television service.

The case for the BBC's claim for primacy is supported by this being the first operational implementation of a long-term public broadcast service using an all-electronic studio configuration from Marconi-EMI. The new evidence reveals that the configuration (lightweight, highly mobile studio cameras, centralised controls and timing) and especially the electronic camera technology, were fully developed in Britain by Marconi-EMI, yet inspired by and deliberately based on the earlier work of RCA.

The operational success of the BBC's studio systems made it the technology template for other future television services in Britain and abroad. Its success and longevity can be seen to be based on the adaptation of technology to provide a highly usable studio environment promoting creativity in the production of live broadcast content that encouraged long-term acceptance of the service by the public.

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