Chapter 2

Kelvin and his world: a cultural overview

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Abstract

Any study relating to William Thomson, Lord Kelvin, is a challenging task. In this introductory overview, we address four themes: Kelvin himself, his faith, his politics and his relationship with the industrial revolution and the industrial world. The important question of the change in Kelvin’s reputation from the beginning to the end of the twentieth century is addressed in parallel.

1 A complex challenge

This volume concerns the towering figure of Victorian science and engineering, William Thomson, Lord Kelvin. We see a teenage prodigy who by virtue of his sheer native ability, personal energy and influential connections was awarded a key Glasgow professorship at the age of 22. In turn, this gave him a very long working lifespan which he exploited to the full. He attained national status in the Britain of high empire, and his achievements had world-wide significance in science and engineering.

In consequence, a study of virtually any aspect of Kelvin is demanding, in terms of scale and complexity, as shown in this volume’s initial chapter Lord Kelvin by Ivan Ruddock. Crosbie Smith and Norton Wise’s biography [1], for instance, is not only over 900 pages long, but includes 23 pages of bibliography and almost 2000 footnotes. When the other publications of Smith, addressing the cultural aspects, are included [2, 3], a grand total of some 1670 pages is involved, while the first substantial biography was Silvanus Thompson’s 1910 epic two-volume Life of Lord Kelvin with 1297 pages [4]. But to understand Kelvin we have to go further. He was an inheritor of the first stage of the Industrial Revolution (Chapter 5) being born only 5 years after the death of James Watt. The three-volume biography of Watt by Richard Hills [5–7] similarly comprises over 1000 pages of text. Then, there is the intellectual galaxy of Kelvin’s British and international peers, and the overall scientific context of the age in which they worked. Combining these aspects is the vision of Donald Cardwell [7, 8] and Bruce Hunt [8, 9]; the subtitles of [7] and [8] given in the References list also underline this vision. Cardwell and Hunt’s relatively modest page counts cannot obscure their long and deep devotion: ‘…I have long been interested in the relationships, historical and contemporary, between science and technology, or the industrial arts’, for Cardwell [8, p. ix], and ‘This book has had a long gestation … the leave I needed to complete this book’, for Hunt [9, p. vii].
What greatly increases the task is addressing the dialogue between the biological and energy experts. This requires the consideration of a parallel enterprise to that of Smith & Wise for Kelvin. Adrian Desmond’s biographies of Darwin [10] and T.S Huxley [11, 12] add a further 1700 pages of information to be absorbed! Only by doing this, however, can issues such as the X-Club be assimilated in the round. (The X-club was a dining club of nine prominent scientists, including Huxley, established in 1864 in the wake of the publication of the Origin of Species. Although ostensibly created as a social and scientific network, the membership espoused causes such as naturalism, liberal Anglicanism and the professionalisation of science, and wielded considerable influence within the nineteenth century scientific establishment for almost 30 years.)

The publishing of material does not stop. For Kelvin, there was David Lindley’s Degrees Kelvin [13] in 2004, and then a multi-authored book, simply entitled Kelvin [14] that stemmed from the 2007 Centenary commemoration events of his death held at Queen’s University of Belfast on 7th December.

The sub-title of [2] – A Cultural History of Energy Physics in Victorian Britain – describes Crosbie Smith’s approach to the development of thermodynamics and energy in nineteenth century Britain. Kelvin features throughout, from the first line of page 1 to the last paragraph of page 324, the latter via his doctrine of ‘energy dissipation’. Smith explains his approach in a closely argued and information rich Introduction. We will highlight the, for us, crucial argument. Smith points out that recent studies of Charles Darwin represent the battle of the X-club of Huxley et al. as being principally with Anglican Cambridge, i.e. a combination of establishment science and theology to the Church of England. ‘I argue’ says Smith ‘that the battle lines need to be redrawn to include as a third group our North British scientists of energy, a group not assimilable to Cambridge Anglicanism even though alliances between Scotland and Cambridge were commonplace’ [2, p. 7]. In our own book, which focuses on Kelvin himself, we follow Smith’s approach, re-expressing it somewhat as between thermodynamics and biology. Mainstream biology now fully accepts that the Laws of Thermodynamics apply just as much to the living as to the engineered world and seeks to apply them. Also, since a main motive for this volume is to examine why Kelvin’s reputation is only moderate, and to seek to aid in its recovery, we show how enduring is Kelvin’s thermodynamic worldview. Specifically, how his principal of universal dissipation anticipated the rationale of Ilya Prigogine’s Dissipative Structures, now starting to appear in medicine. In 2], Smith continually addresses the underlying theological background of the energy specialists, and in Energy and Empire [1], Smith and Wise include the interaction between Kelvin’s activities and the high period of the British Empire.

2 An intellectual colossus (Crowther [15, p. 291])

2.1 His mathematics, physics and engineering

He deserves to be called a mathematician, as well as a physicist and even an engineer.

Denis Weaire [16, p. 57]

… we use the term ‘practical’ … it suggests the all-pervasive spirit of engineering and industry that we elaborate in his life and work.

Smith and Wise, introducing their biography [1, p. xxi]
At the age of thirty-five, after a dozen years of almost unparalleled fertility in pure scientific research, he became one of the best and most famous engineers of his time.

*After the first Atlantic cable attempt: James G. Crowther [15, p. 274]*

Such, then, were the first fruits of mathematical physics … the era of the second industrial revolution had truly dawned.

*After the successful fourth Atlantic cable attempt and his knighthood: Smith and Wise [1, p. 683]*

Thomson had virtually an entire career as an engineer, as well as one of a physicist … one of the great engineers of an age of engineering.

David Wilson, comparing Kelvin with his great friend G.G. Stokes [17, p. 12]

The above quotes identify Kelvin as a mathematician, physicist and engineer. Firstly, his mathematical ability was of the highest level. Expected to graduate as Senior Wrangler (best mathematics undergraduate) at Cambridge, he came second, although he reversed the order by winning the Smith’s Prize [1, pp. 80–82]. Despite ‘only a fraction of his published output’ being ‘predominantly mathematical’ the total was ‘so vast’ that the mathematics was ‘more than a lifetime’s work’ [14, pp. 55–57]. His innate ability and extreme energy combined to lead to Weaire’s claiming him as a mathematician.

We turn to physics, the world in which Kelvin’s mathematical genius was applied. His interdisciplinary character was there from the start. The influence and contributions of his elder brother James Thomson (‘little-known engineers … James Thomson’, dust jacket text [1]) are often unjustifiably forgotten (and addressed by Chapters 3 and 4 in this volume by Andrew Whitaker). In introducing James’s portrait at 16 years of age, Smith and Wise describe the zeal of two teenagers: ‘James’s engineering enthusiasms from an early age provided enduring inspiration for his brother’s physics’ [1, p. 52]. Kelvin’s understanding and application of physics was little short of phenomenal with over 600 papers and 60 patents [16, p. 55]. Smith and Wise refer to him as a mathematical physicist ([1, dust jacket text, p. xxii] and Chapter 6, for example), indeed as Kelvin did himself [1, p. 682] but that hardly does justice to his brilliant inventiveness.

The combination of mathematics and training in experimental methods won Kelvin his Glasgow chair. His university subject area of natural philosophy comprised ‘… the two instruments of investigation, experiment and mathematics’ [1, p. 122]. His university laboratory became an ‘empire’ in the old University of Glasgow building (p. 132) and thence to a ‘vastly superior’ laboratory (p. 135) when the University moved in 1870. It was a further four years before the Cavendish Laboratory at Cambridge was set up, ‘part stimulated by … Glasgow’ [15, p. 238].

Returning to his inventiveness, the most publicly spectacular demonstration of it concerned those ‘numerous telegraphic patents’ [1, p. 667] for the great Atlantic submarine cable enterprise. This required four attempts with increasing input from the plain William Thomson. It was here that his double expertise in physics-oriented mathematics and invention fused into true engineering and resulted in his knighthood [1, p. 682; 15, p. 254].

Smith and Wise take his mathematics and physics further into engineering values as follows: ‘for the engineer, economics and natural philosophy were not separate subjects’ [1, p. 666]
and consistently after the cable success: ‘Sir William regarded the question of economy as paramount’ [1, p. 684].

All in all, then, Kelvin had added brilliance in engineering to that he had already shown in mathematics and physics.

2.2 An iconic figure in scientific history

*It was at such venues that the once-local names of Faraday, Kelvin, Joule and Watt entered into a ‘universal’ language of science.*

Ben Marsden and Crosbie Smith [3, p. 219]

*This communication from the young professor, not yet twenty-three years old, to Faraday astounds and stupefies the imagination.*

Crowther, on Kelvin’s letter of 11 June 1847 [15, p. 251]

*Constructing knowledge in private: the Joule Thomson debates (1847)*

Smith, Section Heading [2, p. 78]

*Maxwell and Thomson agreed not only on the purpose of the demon, but in large degree on its nature.*

Smith and Wise, on ‘Maxwell’s demon’ [1, p. 623]

*Fifty-eight years of friendship: Kelvin and Stokes.*

Alastair Wood, Chapter Title [14, p. 64]

*Helmholtz’s theory and his own meteoric theory might complement one another.*

Smith and Wise, on Kelvin’s 1854 address to the British Association [1, p. 526]

*To mathematical physics, and especially to Fourier, Sir William Thomson owed his strength in commercial telegraphy.*

Smith and Wise, after the success of the Atlantic cable [1, p. 682]

The scientific world in which Kelvin worked was replete with iconic names in the historical development of science. He interacted with all of the following scientists listed below, almost all of whom are named in *The Complete Family Encyclopedia* [18]. For our purposes, this reference is important in so far as it gives a guide to assessed reputation with the general public, a significant issue in this introduction.

(a) In the United Kingdom:

*Michael Faraday* (1791–1867) (37 lines)

‘English chemist and physicist’, ‘three laws of electromagnetic induction and two laws of electrolysis, all proposed originally by Michael Faraday’.

*James Clerk Maxwell* (1831–1879) (17 lines) ‘contributed to every branch of physical science’.

*James Prescott Joule* (1818–1889) (27 lines) ‘British physicist whose work … led to … the first law of thermodynamics’.
George Gabriel Stokes (1819–1903) (14 lines) ‘Irish physicist … in 1840s studied the viscosity of fluids’.

(b) In Germany:
Rudolph Julius Emanuel Clausius (1822–1888) (9 lines).
‘One of the founders of the science of thermodynamics’ Hermann Ludwig Ferdinand von Helmholtz (1821–1894) (14 lines) ‘German physicist … formulated the law of conservation of energy and did important work in thermodynamics’.

(c) In France:
Jean Baptiste Joseph Fourier (1768–1830) (10 lines) ‘French applied mathematician whose formulation of heat flow 1807 …’
Victor Regnault (1810–1878) (not referenced in [18]) ‘If Fourier stood as the heroic master of mathematical analysis in the theory of heat, Regnault stood as an equal master of experimental measurements’ [1, p. 128].

Information about Kelvin’s interactions with Joule and Maxwell is given in Chapters 8 and 9 of this volume by Andrzej Wroblewski and David Wilkie et al., respectively.

In conclusion, we return to the question of public impact and reputation. Firstly, in this volume’s Chapter 7, Section 14.1, a wider comparison exercise has been undertaken which includes the biologists. There it is noted that biology has a much greater public impact than thermodynamics. Secondly, in his Foreword to the 2008 Kelvin volume [14], Sir Brian Pippard says that Kelvin’s researches hardly get a mention ‘in a present-day physics students lecture course’. Regarding Stokes, too, ‘his mentor and lifelong friend Sir George Stokes has fallen into similar obscurity’ [14]. For two of the Editors (MWC and CSK) writing as engineers, the Navier–Stokes equations are the foundation of Computational Fluid Dynamics, the joint names being encountered perpetually.

2.3 First among equals

…. 1896 saw Glasgow University celebrate the 50th Jubilee of its most distinguished professor … certificates of membership of the 80 or so learned societies across the world which had elected Thomson to their ranks ….

Mark McCartney [14, p. 21]

…. the Royal Society … in 1924 to celebrate the centenary of Kelvin’s birth … from Japan stated: The National Research Council of Japan specially desires to recall with gratitude … his eminent disciples as organisers. Dyer, Gray, Ayrton, Perry, Ewing and Knott, personally recommended by Kelvin himself, came to the Far East.

Colin Latimer [14, pp. 213–214].

Kelvin was first among equals in the world of British science and engineering, notwithstanding the competition of the biologists. A national level of scientific attainment in the UK is recognised by Fellowship of the Royal Society (of London) (RS), which dates back to 1645. There is a Scottish equivalent, the Royal Society of Edinburgh (RSE), which originated in 1783. Kelvin was
a Fellow of both. He was elected to the RS in June 1851, at the same time as his friend Stokes and antagonist Huxley. More significant than Fellowship, and unique at any one time, is the elected Presidency. The doubly unique Kelvin served both as President of the RS from 1890 to 1895 and as President of the RSE no less than three times totalling 21 years (1873–1878, 1886–1890 and 1895–1907). This is a self-evident manifestation of the highest regard that Kelvin enjoyed among his peers; moreover, that regard spanned more than three decades. Regarding the RS, there was a problem with the biologists. T.S. Huxley, besides being a radical for science, was a reactionary when it came to technology and engineering. ‘He lashed the techno-flunkeys … the ‘Engineers, Chemical traders … who find it helps them to appear to the public as if they were men of science’…He feared the veneration switching to science’s products … its ‘froth and scum’, its engines and telegraphs, as he angrily put it to Disraeli.’ [12, pp. 249–250]. Consistent with this, Huxley did not want the RS ‘exploited by enterprising commercial gents who make their profit out of the application of science’. So he was persuaded to stand for President ‘because this would keep out Kelvin’ ([14, p. 281], quoting from [19]). In the event, Huxley had to resign early on health grounds, Stokes followed him and then Kelvin followed Stokes.

The position of President of the RS carried considerable national influence which Huxley used as much as he was able: ‘It also gave Huxley the ear of Prime Ministers and Privy Counsellors’ [12, p. 149]. Subsequently, no doubt Huxley felt justified when Kelvin did indeed quote his President’s position in commercial advertising, bringing upon himself considerable criticism. Finally, turning to Glasgow University, 5 years after retiring from his Chair [1, p. 115] in 1904 [14, p. 13] Kelvin was elected as the chancellor. Including his years as undergraduate and retirement ‘research student’, Kelvin was a member of the University for 67 out of his 83 years lifetime. Moreover, given the extreme age of the university (founded in 1451), this represented an amazing one-seventh of its entire existence.

2.4 Kelvin’s faith and worldview: Huxley and Darwin’s agnosticism

Kelvin, who was a practising Christian … In his view, a creative power was needed for animate – but not inanimate – objects.

Ivan Ruddock, on the 1903 debate in The Times on the origin of life [20].

… the cosmic evolution of the earth as an abode fitted for life seemed to have been the result of benevolent and wise design by a God who had chosen well …

Kelvin’s ‘reply to Hooker’s criticism of natural theology … 1868’, Smith and Wise [1, p. 641].

The debate between the Thomson brothers contributed to a major discourse among Scottish natural philosophers. During the 1860s and early 1870s, Maxwell, Jenkin, Tait, and Balfour Stewart (1828–1887) all participated. Their special concern with thermodynamics and molecular physics in relation to free will was at first largely a response to their German friend Helmholtz.

Smith and Wise [1, p. 617].

We have the sober scientific certainty that heavens and earth shall ‘wax old as doth a garment’ [Psalm 102: 26] … the theological framework was an unambiguous expression of his own deepest convictions.

Smith and Wise, quoting Kelvin & Tait in Energy, 1862 [1, p. 535].

Desmond, on Huxley speaking to the Young Men’s Christian Association [11, p. 374].

The mystery of the beginning of all things is insoluble by us; and I for one must be content to remain an Agnostic.

Charles Darwin, autobiographical material on Religious Belief [21, p. 54].

… a man undoubtedly can be ‘an ardent Theist & an evolutionist’, look at Charles Kingsley and Asa Gray. For himself, he had ‘never been an atheist …’

Desmond and Moore, on Darwin’s views late in life [10, p. 636]

In current scientific and engineering publications, matters of personal belief are conspicuous by their absence. After all, the reliability of both predicted and experimental scientific data should be reproducible and independent of the views of the researcher. However, in scientific history and certainly here, it is virtually obligatory to address such belief systems. They formed an essential part of Kelvin and colleagues on the one hand, paralleled by their positive lack in the worldview of the biologists on the other. This fundamental disagreement became a matter of intense interest in British public and scientific life in the late nineteenth century.

Kelvin had a clear Christian faith, in common with his North British energy peers. Smith describes it thus: ‘The scientists of energy belonged to a post-evangelical culture whereby human beings, in their moral and material actions, had an obligation to aspire to the perfections of nature and of Christ’ (Chapter 2, Note 15 [2, p. 317]). The conflict with Tyndall and the X-club biologists is also represented in precise and careful terms by Smith as between: ‘scientific naturalism (united by a stand against Christian doctrine) and the science of energy (promoted as a natural philosophy in harmony with, though not subservient to, Christian belief)’ (ours in italics [2, p. 172]). The three aspects of design, free will and finite duration and universal dissipation of the cosmos are highlighted by the relevant quotes above. Here, the significance is that Kelvin’s faith was strongly based on an intelligent interpretation of the Bible: the above aspects of his basic convictions became part of a thermodynamics worldview.

In absolute contrast to the explicit Christian faith of Kelvin and his energy peers was the agnosticism promulgated by Huxley and his fellow biologists. In fact, Huxley actually invented the word. The current dictionary meaning of agnostic is virtually identical to Huxley’s: ‘a person who believes that we know nothing of things beyond material phenomena – that a Creator, creative cause, and unseen world are unknown or unknowable things [coined by T.S. Huxley in 1869 from Greek agnostos, unknown, unknowable]’ (Chambers Concise Dictionary [22, p. 18].

Finally, there was Darwin himself. The first quote shows that agnosticism was also his position, but his writings betray a certain reluctance to obliterate the traces of being a ‘Theist’ [21 pp. 53–54]. In fact, he was ‘Never an Atheist’ (also Title of Chapter 41 [10]). In contrast to Kelvin’s robust health, Darwin seemed to be perpetually in poor health. No reader can remain untouched by the graphic record by Desmond and Moore of the intensity of his suffering when he died. Darwin’s uncertainty, too, was reflected on that day: ‘Oh God’, he cried helplessly, ‘Oh Lord God’ [10, p. 662].
2.5 Kelvin’s politics: Irish Home Rule

Already privately converted to Home Rule, Gladstone took over by February 1886.

Smith and Wise [1, p. 803]

… his (Kelvin’s) opposition, a continuation of … the liberal and political outlook of his father.

Smith and Wise [1, p. 803]

The X had regrouped … Tyndall wanted them to draw up ‘a scientific declaration’ for the Union.

Desmond [12, p. 168]

Kelvin’s politics are a significant issue in two respects. They were certainly a contributory, possibly the principal, factor in the award of his peerage. Of equal importance, given our interest in the cultural background, is his reasoning for being against Irish Home Rule. The story is told in some detail by Smith and Wise in Chapter 23: Baron Kelvin of Largs [1].

The complex political structure of the United Kingdom and its history are given in this volume’s chapter Conclusion: Honoured by Banknotes. Over the whole of Kelvin’s lifetime, Ireland was in political union with Britain (1801–1921) sending Members of Parliament to Westminster. However, the political unity hid a consistently troubled history involving much violence. This resurfaced in the latter half of the nineteenth century, with the disestablishment of the Irish Church and land reforms occurring around 1870. After 1885, it dominated British politics. In the general election of that year, the Irish MPs held the balance of power. The Liberal Prime Minister Gladstone [1, p. 803] led a Government pledged to grant Home Rule. This irrevocably fractured an already divided Liberal party and the Home Rule Bill of 1886 was defeated. The election of 1886 produced a new government led by the Conservative Salisbury. It was a strong coalition including Liberal Unionists, meaning that Irish Home Rule was a dead political issue. (History would cruelly vindicate both Gladstone and Salisbury within 10 years of Kelvin’s death – Home Rule was successfully achieved via armed rebellion but it was accompanied by partition, with Northern Ireland remaining in Union with Britain).

Within this story, Kelvin who had been a ‘faithful supporter’ [1, p. 803] of the Liberals, left them at the time of the split and campaigned heavily for the Liberal Unionists in the 1886 election. Smith and Wise are in no doubt – Salisbury offered Kelvin a peerage essentially because of this support [1, p. 807]. However, although they dismiss the idea (current at the time in the press and subsequently by biographers) of the peerage being awarded primarily for his national scientific prominence, the latest Kelvin volume [12] repeats this view. ‘…his peerage…was in considerable part for his support of the Liberal Unionists in Lord Salisbury’s coalition government, but it was generally assumed that it was for his work in science and engineering and, as such, it was extremely widely welcomed’ (Whitaker [14], p. 279).

Kelvin’s reasons for supporting Unionism are illuminating (explained in detail in [1, pp. 802–806) and resonate with our theme of cultural background. On the one hand, ‘Britain and the British Empire were now the best guarantee of liberty for all the citizens of Ireland’: Kelvin ‘had in mind the British notion of equality before the law’. On the other hand industry and manufacturing (in the wake of the industrial revolution) had brought ‘unprecedented economic growth’ to Belfast, widening the gap between the north and south of the island. Kelvin wanted
to see ‘the growing economic prosperity of the province – founded on industry, technology and ingenuity’.

Unionism was one issue that united Kelvin and the biologists. ‘Huxley thought the destruction of the Union ‘a cowardly wickedness’ ... Tyndall wanted the X to draw up ‘a scientific declaration’ for the Union’ [12, pp. 167–168]. Interestingly, though, Huxley ‘scuppered this’ being aware of the Separatist groundswell among the younger Fellows of the Royal Society.

2.6 Kelvin’s national status

When his peerage was awarded ... it was extremely widely welcomed.

Andrew Whitaker [14, p. 279]

Buried beside Newton in Westminster Abbey.

McCartney [14, p. 13]

The national status of Kelvin was high in the extreme, with his peerage, his Order of Merit award, appointment to the Privy Council, and burial in Westminster Abbey.

In January 1892, he became the ‘first scientist’ to receive a peerage [3, p. 218]. In fact, the honours list citation quoted ‘for most valued service to science and progress in this country’ [17, p. 84]. In 1887, his lifelong friend Stokes had been elected to Parliament as an Independent for the Cambridge University seat, and made a baronet (essentially a hereditary knighthood [14, p. 79]) in 1889. Kelvin viewed the situation as giving them parallel voices for science, and he himself spoke in the House of Lords on a number of occasions [14, p. 84].

Twenty-first century Britain has two highly restricted and classless national honours, Order of Merit and Companion of Honour: both are termed as ‘orders of chivalry’. The Order of Merit was founded by King Edward VII in 1902 and restricted to 24 members, with the Companion of Honour founded by George V in 1916 and restricted to 65 members [18, pp. 205, 616]. They are without title, but with designatory letters OM and CH, respectively. Kelvin became an inaugural member of the OM in 1902.

The Privy Council originated with the Norman kings, became the English governing body under the Tudors and was displaced by the Cabinet (the existing British system) in 1688. Cabinet members were and are automatic members of the now formal body [18, p. 674]. To be made a Privy Councillor (PC) is both an honour (with the title Right Honourable) and a position of national influence. Kelvin was made one in 1902.

This links with the biologists, because Huxley, too, was made a PC but earlier than Kelvin in 1892. Huxley was ‘dead against’ decorations, but Kelvin, by then a Lord, ‘assured him that it was something he could accept’ and Huxley’s appointment made him ‘the first Crown adviser on science’ [11, pp. 210–211]. What is equally telling, however, is that scientific disagreement with the biologists was not personal with Kelvin.

Finally, Kelvin received the ultimate double accolade of burial in Westminster Abbey and that beside Isaac Newton [14, p. 13]. Again, this can be compared with the biologists: in this case
Darwin, who substantially predeceased Kelvin in 1882. The story of Darwin is detailed by Desmond and Moore in Chapter 44 [10] and what is helpful for the reader is the explanation of how it was done and the criteria involved [10, pp. 664–668]. As with Kelvin later, Newton was the gold standard of comparison: ‘Was he not the greatest Englishman since Newton … Newton’s honour had to be Darwin’s’ [10, p. 668].

3 Kelvin and the industrial world

3.1 The timescale of the industrial revolution: Kelvin’s participation

William Thomson identified himself as much with the shipyards and engineering works of his adopted city of Glasgow as with the democratic education offered in its university

Smith and Wise, dust jacket text, Energy & Empire [1]

Timescale estimates of the traditional understanding of the Industrial Revolution (I.R.) are given in Table 1. Toynbee’s original dating, given in 1884, of 1760-1840 has been followed until relatively recently. Crump’s very recent ‘Brief History’ extends the start to the early 1700s. Toynbee’s finishing date is also important for us, as it implies that Kelvin was simply an inheritor of that Revolution.

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These days a more reasoned interpretation of the Industrial Revolution gives it three stages: The First, The Spread, and The Second, as summarised in Table 2 using Koeller’s analysis [25]. Smith and Wise also discuss this chronology [1, pp. 652–653].

Kelvin’s working lifetime, also given in Table 2, therefore covers over half of the second and the whole of the third stages of the redefined I.R. This is really significant: it means that Kelvin is no longer just an inheritor, but a participant in the wider Industrial Revolution of 1700–1900. In the interests of Kelvin’s reputation we expand the point.

Table 1: The Industrial Revolution according to Toynbee’s traditional timescale.

<table>
<thead>
<tr>
<th>Ref.</th>
<th>Comment</th>
<th>Timescale</th>
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<tr>
<td>[23]</td>
<td>Arnold Toynbee’s original estimate (1884)</td>
<td>1760–1840</td>
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<td></td>
<td>For example, [18, 22]</td>
<td>Range from encyclopaedia</td>
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Table 2: Kelvin and the industrial revolution after Koeller [25].

<table>
<thead>
<tr>
<th>Stage of the I.R.</th>
<th>Subject area</th>
<th>Timescale</th>
</tr>
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<tbody>
<tr>
<td>First I.R.</td>
<td>Textiles and steam</td>
<td>1712–1830</td>
</tr>
<tr>
<td>Spread of the I.R.</td>
<td>Steamships, steel, oil</td>
<td>1830–1875</td>
</tr>
<tr>
<td>Second I.R.</td>
<td>Electricity and chemicals</td>
<td>1875–1905</td>
</tr>
<tr>
<td>Second I.R.</td>
<td>After Smith and Wise [1, p. 652]</td>
<td>c. 1865–1900</td>
</tr>
<tr>
<td>Kelvin’s working lifetime at G.U.</td>
<td>Appointment to Chair</td>
<td>1846</td>
</tr>
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<td></td>
<td>Retirement from Chair</td>
<td>1899</td>
</tr>
<tr>
<td></td>
<td>Active until death</td>
<td>1907</td>
</tr>
</tbody>
</table>
Firstly, Kelvin now should be recognised as an increasingly important figure in the Spreading Stage of the Industrial Revolution. Koeller’s first event in this stage is the inception in 1840 by Samuel Cunard of the transatlantic steamship service [25]. The date resonates with Kelvin’s 1840s activities related to ‘the magnetism of iron ships and its effect on compasses’ [1]. This continued for the decades up to 1880 by when his patented instruments had become the standard of the commercial fleet of the Empire. The 1840–1880 timescale agrees with Kubicek’s ‘mid-Victorian period’ in which ‘Kelvin developed telegraphic, directional and sounding devices of great importance … on ocean routes’ [26]. Secondly, Kelvin should be seen as a principal British participant in the Second Industrial Revolution’s primary subject area of electricity. This affiliation includes the Atlantic cable, but is much wider; indeed, Smith and Wise devote three chapters of [1] (some 150 pages) to Kelvin’s achievements.

4 The telegraph and Empire

4.1 The 1866 Atlantic cable and Kelvin

When the … cable finally reached the American coast on 27 July 1866, having been successfully unrolled and dropped along the ocean floor by Isambard Kingdom Brunel’s mighty Great Eastern, it was plainly the dawn of a new era.

Niall Ferguson [27, pp. 168]

… the spread of the telegraph network meant that details from even the most far-flung battlefields could reach Britain in twenty-four hours, the time it took … in June 1896

Lawrence James [28, p. 211]

… the one triumphantly unifying factor was cable construction: ‘the nerves of the empire’ by the 1890s girdled the world with 121,000 miles of telegraph wires. The web of submarine cables transformed the conduct of trade and diplomacy, as well as colonial administration.

Ronald Hyam [29, p. 19]

The British Empire has been described as a web of submarine cables, and they so excited Kipling that he wrote a poem about them.

Hyam [30, p. 212]

… communications technology, especially the telegraph and undersea cables, that made London (and Britain) the information hub of the world.

John Darwin [31, p. 112]

Lord Kelvin, more self-effacing but perhaps an even more significant figure (than Sir Robert Murchison), developed telegraphic, directional, and sounding devices of great importance to the maintenance of Britain’s hegemony on ocean routes.

Robert Kubicek [26, p. 256]

Table 3 addresses the following question: to what extent does credit for this accrue to Kelvin? It summarises whether the texts of a wide range of recent references on the British Empire give
explicit information about cables, telegraphs and Kelvin. The four test questions are: (1) Are cables and telegraphs mentioned?; (2) Is the cable/telegraph network discussed?; (3) Is the 1866 laying of the Atlantic cable mentioned? and (4) Is Kelvin mentioned?

The six quotes at beginning of this section, show that the successful laying of the Atlantic cable in 1866 was a climactic event in the integrated global history of transoceanic communication and travel. And yet, Table 3 reveals only one explicit mention of Kelvin. Even then, the quote, given in full from Kubicek [26], does not unambiguously connect the Atlantic cable with him. Whereas at the time in Britain, Kelvin’s achievement was fully appreciated in the awarding of his knighthood, the appreciation of him today is a completely different matter. Why is it that Kelvin’s name has been almost air-brushed from these histories? This question is now addressed.

4.2 The British Empire

4.2.1 Marxist interpretation of the Empire

Since the Atlantic and subsequent cables greatly helped communications within the British Empire, any negatively critical history will be unlikely to treat Kelvin sympathetically. Until comparatively recently, the historical appreciation of the empire has been subject to a Marxist approach. Marxism as a political creed may be summarised as an extended set of keywords: ‘capitalist society … the exploitation of the proletariat by the bourgeoisie’ … ‘communism will be achieved when the class struggle results in the overthrow of capitalism by the dictatorship of the proletariat …’ ([22, p. 684], item on Marxism). The eminent British Marxist Eric Hobsbawm (1917–2012) whose Obituary was published recently (October 2, 2012 [43]), ‘was widely considered to be one of the greatest British historians of his age’. As a Communist Party member, ‘he
wielded enormous influence during the 1960s and 1970s’ but still ‘persisted’ in his apologetics for ‘totalitarian communism’ in the 1990s, when that system had collapsed and even its proponents found it to be ‘an unmitigated catastrophe’. The Obituary explains both his brilliance and controversialism in considerable detail, the former reflected in his being made Companion of Honour in 1998. His book *The Age of Empire 1875–1914* [44] expresses this Marxist approach. Hobsbawm’s Obituary coincided within a few days, with a Book Review published by the same newspaper (30 September 2012 [45]) on John Darwin’s *Unfinished Empire* (our reference [38]). Andrew Roberts concludes his review thus: ‘Darwin’s book might at long last herald the victory of the post-Marxist phase of imperial historiography, and not a moment too soon’.

### 4.2.2 Negative assessments of the Empire

Despite Roberts’s confidence, however, consistently negative assessments of the Empire are still being made. A significant example is Piers Brendon’s *The Decline and Fall of the British Empire* [32], published in 2007. (The title harks back to the iconic 18th century work of Edward Gibbon, *The History of the Decline and Fall of the Roman Empire*, 1776–1788 [46] being a current well-illustrated abridged version). Brendon’s rationale is that it was ‘a fundamentally weak empire … It enshrined a belief in freedom that would fatally undermine its authority. It left a contested legacy: at best a sporting spirit, a legal code and a near-universal language; at worst: failed states and internecine strife’ (dust jacket text). Despite its length (xxii + 786 pages), ‘the development of the dominions … is only a sketch’ (p. xxi) and the clear accent is, like Gibbon, on the negative aspects. (‘Dominions’ refer to the self-governed major territories of Australia, Canada, New Zealand and South Africa). The reviewer Robert McCrumb is enthusiastic and, again, negative in tone: ‘If the First World War reduced the Empire to a near-bankrupt charade, the Second World War, more genuinely global, finished it off completely’ [47]. Kwasi Kwarteng’s *Ghosts of Empire* ([33], 2011) follows Brendon’s line more sharply. Its focus again excludes ‘the white dominions’. For Kwarteng, ‘The British Empire was not merely undemocratic; it was antidemocratic. By comparison, the United States’s avowed values could not be further removed from those of the British Empire’ [33, p. 7]. He concentrates on residual chronic post-imperial problems such as Kashmir. Even more damning is Richard Gott’s *British Empire, Resistance, Repression and Revolt* [35, 2011]. For him the violence exerted in the Empire was comparable to ‘the exploits of Genghis Khan or Attila the Hun ‘rather than Alexander the Great’ [35, p. 3]. Richard Drayton’s review of [35] ([48], 7 December 2011) founds Gott’s approach lacks balance: ‘nor does he explore how the economic and technological bases of British power changed between 1750 and 1850 … the Empire was made by more than violence’.

We conclude as follows: from any negative assessment of the Empire, whether Marxist or otherwise, the reputation of Kelvin suffers by neglect.

### 4.2.3 Balanced assessments of the Empire

The other authoritative surveys referenced here give more balanced interpretations, and, more importantly, *make a virtue of that balance*. Trevor Lloyd, in his concise *Empire* ([40], 2001) introduces it thus ‘…advocates of empire pointing to the tranquillity … enemies of empire pointing to the wars of conquests … .the important thing is to explain it’ [40, p. x]. Similarly, Martin Weiner’s in-depth analysis of imperial justice (Brendon’s above positive factor of a ‘legal code’) *An Empire on Trial* [41, 2009] highlights the ‘fallacy of thinking of the Empire in terms of an ‘im-
perial project’ whether one of good or evil. Rather, the Empire was a site of many simultaneous ‘projects’, worthy of both celebration and indictment, often at the same time’ [41, p. 231]. Finally, there is the twin enterprise of John Darwin: The Empire Project ([31], 2009) and Unfinished Empire ([38], 2012). These latter two comprise a total of some 1300 pages, that is, on a par with the core material on Kelvin and on Darwin/Huxley. So we read ‘…the place of the political history of the dominions has been all but ignored by two generations of imperial historiography … Revision is long overdue.’ [31, pp. 15–16]. Also, Darwin refers to the Marxist interpretation: ‘This depiction of Empire as (more than anything else) a system of racial oppression was the sharpest prong of a much wider attack … There is no need to take up a dogmatic position on the truth or untruth of these various claims …’ [38, pp. 3–6]. Finally, at about the same time (2010) Ronald Hyam, ‘the leading British authority on the end of Empire’ [30, p. xii], published his ‘swansong’ [29, p. xiii], Understanding the British Empire [29]. The book cannot be a comprehensive guide … It is not an advice manual, more of an academic confection. Nor with one exception … does it engage much with other historians’ theories’ (p. xiii).

But do these ‘balanced’ assessments help Kelvin’s reputation? Broadly speaking, from Table 3, they do not.

4.2.4 A positive assessment of the Empire

Nothing, in short, had prepared him for Sydney … ‘It is a most magnificent testimony to the power of the British nation’.

Charles Darwin on seeing Sydney, Australia, 1836
(Desmond and Moore [10, p. 177])

I was constantly struck by its (the Empire’s) … ubiquitous creativity … the glorious skyline of Sydney …

Niall Ferguson on visiting Sydney in 2002 [27, p. xxii]

Of the histories of the British Empire referenced, hardly any are explicitly positive. Niall Ferguson’s Empire is an exception. Above, we have chosen a less generally featured aspect, that of its enduring built environment. (Also, Hyam’s [29] cover illustration is an 1880 view of ‘The Great Indian Peninsular Railway, Victoria Terminus, Bombay’.) Brendon gives a quite complimentary description of 1810’s Sydney as a: ‘dignified metropolis … full of handsome residences and smart shops’ [32, pp. 71–73]. While Brendon does not update this, Sydney astonished Darwin only 15 years later, and 170 years after that was able to more than inspire the twenty-first century Ferguson. Much more significant is Ferguson’s general conclusion: ‘In truth, the imperial legacy has shaped the modern world so profoundly that we almost take it for granted’ [34, p. 365]. Further, Ferguson then goes on to give a more positive exposition of the questions of liberty, the rule of law and peace and violence, the concerns of the ‘negative’ histories above.

Does Ferguson’s treatment have any helpful consequence for Kelvin? It does!

4.3 Light breaks through

‘Before the coming of the telegraph………’

Hyam [30, p. 1]
'The crucial development from the point of view of imperial rule was the construction of durable undersea cables … When the cable … finally reached the American coast on 27th July 1866 … it was plainly the dawn of a new era. That the cable ran from Ireland to Newfoundland made it clear which power was most likely to dominate the age of the telegraph'.

Ferguson [27, p. 168]

It is clear from Table 3 that while the cable/telegraph system is recognised as a crucial element of the British Empire, the key Atlantic facilitation of that system remains an untold story. Hyam’s six-word quote above from the very first page of his exposition takes for granted the system’s importance, while his quotes in Section 4.1 expand on this. But it is Niall Ferguson alone who tells the Atlantic cable story, and moreover, uses ‘Passing the Cable on Board the Great Eastern’, 1866, as the lead of his second illustration set. In this present volume, the whole achievement constitutes the premier Story in Pictures in the Appendix.

4.4 Kelvin and Brunel

4.4.1 The magnificent achievement: Kelvin, Brunel and seamanship

Isambard Kingdom Brunel (1806–1859), the builder of Britain’s Great Western Railway, was an (or possibly the) iconic Victorian engineer. In 2002, he was voted as the second Greatest Briton in the BBC’s national poll behind Sir Winston Churchill, and together with Churchill, appeared as a major character in the opening ceremony of London’s 2012 Olympic Games. Brunel’s engineering glory is still conspicuously evident in twenty-first century Britain in his railways and bridges. That glory impacted national life from the start, immediately leaping the cultural divide. In the General Introduction to Volume 6 of The Cambridge Cultural History of Britain, covering the years 1785–1851, Boris Ford writes: ‘Turner’s wonderfully evocative painting of the Great Western Railway offers a glimpse of the energy and bustle of the new age and of the misty grandeur of the neo-classical world it was superseding’. Brunel’s inventive genius also included three ‘firsts’ in shipping: the mammoth Great Eastern, launched in 1858 shortly before his death was the world’s largest ship, by the end of the nineteenth century, it was still the largest and was used in 1866 as the cable carrying ship [27, p. 168]. Therefore, the core technology for the Atlantic cable laying was a combination of Kelvin’s design of undersea cable, with the ability of Great Eastern to carry the entire cable and be navigated for the actual laying. In subsequent publicity, Great Eastern became very prominent (for example, front cover of [3]), but (while Kelvin’s name is unfortunately omitted by Ferguson), the illustration mentioned above comprises both the cable and Great Eastern.

It was a huge triumph of seamanship and British engineering, partnered by US/UK organisation and funding. Daniel Gooch, Brunel’s closest colleague and the Chairman of the British Cable Company, was on board Great Eastern at the time. In his diary entry for 26–27 July 1866 [49, pp. 141–146], he witnessed that ‘all seemed mad with joy’, the ‘old hands’ from a previously unsuccessful attempt ‘danced round’ the cable end, cheering at the top of their voices! A service of thanksgiving was held ‘in the little wooden church in the village’ and soon after, a reporting cable was sent to Britain, resulting in a congratulatory cable being sent by Queen Victoria to the US President. Daniel Gooch, eventually to receive a Baronetcy, had the Times leader (cabled of course to Great Eastern) posted on its deck. On reading it, borrowing its words ‘one of the sailors said “I say, Bill, we be benefactors of the human race”. “Yes” says Bill, “we be”, and strutted along … two inches higher!'
While Brunel, sadly, had died some years before, in essence he was represented by his friend Gooch. *For Kelvin, it was a working voyage and he was deservedly present at this momentous event.* The further spectacular achievement of the recovery of the previous attempt’s broken cable and successful linking is also told by Gooch, as is the immediate financial income from the (now) two cables. More details are given in the *Story in Pictures.*

### 4.4.2 Kelvin loses out, Brunel is remembered

We have shown that in histories of the British Empire, the cable/telegraph system was recognised to be a crucial element. Moreover, the 1866 success enters world history as a primary part of the Second Stage of the Industrial Revolution. It is particularly unfortunate, therefore, that only one British Empire history referenced here addresses that event, and even that single instance credits only Brunel, not Kelvin. The pattern of neglect is repeated in [39] which gives (pp. 115–117) an extensive chronology of the Empire from 1815 to 1914 but 1866 simply does not appear.

As a postscript to this, in Adrian Desmond’s biography of Huxley [11], the cable-laying exploit *does feature* (‘… Brunel’s gigantic *Great Eastern* paid out the enormous tonnage of telegraphic cable’, p. 351). However, the engineering achievement is incorporated by Desmond into ‘the revolution’ led by ‘human antiquities more ancient than the Bible’s, of evolution more stirring than Genesis’ [11, p. 351]. Again, incidentally, Brunel is credited, Kelvin neglected.

### 4.4.3 Kelvin and Brunel are credited

However, there is an additional Industrial Revolution issue. Via their contribution to shipping, Kelvin and Brunel additionally participated in the ‘spread of the Industrial Revolution’. In this case, however, both have been named.

*For Kelvin:* ‘Lord Kelvin … .developed telegraphic, directional, and sounding devices of great importance to the maintenance of Britain’s hegemony on ocean routes’, Robert Kubicek [26, p. 256]

*For Brunel:* ‘Yet the Great Britain, built by Isambard Kingdom Brunel in 1843, provided an irresistible model of strength and speed … Leviathans constructed on the principles of the Great Britain secured the nation’s rule over the waves’, Brendon [32, p. 146].

This latter is a welcome corrective to previous comments about the negative aspects of Brendon’s study.

### 5 Kelvin’s reputation

An ongoing theme is the question of the tepid reputation of Kelvin today, although there are signs this is changing. Wherever appropriate this has been addressed. Far from questioning his diversification as Crowther [15] and others have done, we conclude that his engineering and thermodynamic achievements on which this book focuses deserve to be highly honoured. What, then, are the problems? We have found the following:
Firstly, in the historical development of the British Empire, the successful laying of the Atlantic cable was a landmark event for which Kelvin received his knighthood. But our analysis shows that with few exceptions Kelvin’s name is unjustifiably absent.

Similarly, it is comparatively only recently that the Industrial Revolution has been interpreted (by Koeller) as three stages. Kelvin made substantial contributions to the latter two stages. One aspect was that the cable laying was significant in international terms.

Finally, the common faith of Kelvin and his energy colleagues helped him to develop a thermodynamic cosmic worldview, consistent with today’s thinking. Crosbie Smith has addressed this aspect comprehensively.

We live in a world dominated by energy considerations, including security of supply, living standards for the third world or carbon-reduced emissions to name perhaps the most important. Energy was Kelvin’s word, and he needs to speak to us today.

The final message of this overview is a straw in the wind. Reputations need to enter popular culture and Marcus Chown’s We need to Talk about Kelvin [50], subtitled What everyday things tell us about the universe, is written for a popular readership. Sure, Kelvin’s under-prediction of the sun’s age is there (pp. 86–88), but joint with Helmholtz, and as part of a constructive story that puts it as one stage in a scientific progression. What is more significant is his unqualified tribute to Kelvin – one of the greatest scientists of the nineteenth century, responsible for the temperature scale used by all scientists today and for the laying of the first transatlantic telegraph cable. In praise of Kelvin, Chown pretty much trumps all the other recent publications in our reference list. Hopefully, it is a sign of things to come: it’s about time!

References


