Kelvin and industry in Ireland

Bernard Crossland¹ and Andrew Whitaker²
¹ Department of Mechanical Engineering, Queen’s University, Belfast BT7 1NN, Northern Ireland
² Department of Physics, Queen’s University, Belfast BT7 1NN, Northern Ireland

E-mails: b.crossland@qub.ac.uk, a.whitaker@qub.ac.uk

Abstract. Kelvin was a great mathematician, theoretical and experimental physicist, and educator, founding the first physical laboratory. He worked tirelessly for the creation of a reproducible set of physical units, and he was also an experienced and enthusiastic sailor. All these talents were linked to his extensive technological work, of which the most important examples were the laying of the Atlantic cable, and the marine compass. In Ireland his most important contributions were the occulting nature of the Holywood lighthouse, and his connection with the Giant’s Causeway tramway. Kelvin’s work on cabling and national maritime projects may have stimulated his later strong support of the British Empire and opposition to Home Rule in Ireland.

1. Kelvin – a man of many talents
Kelvin was certainly a man of very many talents [1-3]. From his Cambridge days he was a mathematician of the highest stature. Once he was established in Glasgow, he was able to broaden this talent, applying it to theoretical study of the physical universe, not only analysing a vast range of individual problems in the greatest depth, but also constructing major syntheses of tremendous range, and of at least potentially massive significance. Of these syntheses, thermodynamics has turned out to be the most important, while Kelvin’s work on electromagnetism has also borne fruit through its development by Maxwell, and his work on models of the ether, while it must be judged less successful in the long term, served to raise many important questions and provide many useful techniques.

To this theoretical ability he swiftly added an exceptional experimental ability, both in the construction of novel and sophisticated equipment, and in the performance of difficult and important experiments. One of the most significant examples was the experimental checking in 1850 of the prediction made by his brother James (in the course of discussions with Kelvin himself) of the lowering of the freezing point of ice under pressure. This prediction and experimental confirmation are of the greatest possible importance, since they are based on the theory of Sadi Carnot, and are thus effectively the first results of the Laws of Thermodynamics, obtained, in fact, before these Laws were formally stated.

Kelvin described his experimental achievement to his Glasgow class as follows [4]: ‘My brother James sent in a paper to the Society of Arts in Edinburgh stating that water freezes under a pressure of 760 mm at 0.0075 C below 0°. This has never been verified by any experiment till I did it the other day by myself, with a most delicate thermometer. This thermometer is assuredly the most delicate that ever was made, there being 71 divisions in a single degree F. It is filled with ether…. mercury would not do. …..Under a pressure of 8.1 atmospheres, the temperature was lowered \( \frac{7}{2} \) divisions. 0.106 is the lowering by experiment: 0.109 by theory. This is within
1/3000 of a Fahrenheit degree.’ This triumph came little more than 3 years after he took up his chair, at which time he was practically a novice from the experimental point of view.

In the educational field, while his own lecturing was probably more successful in stimulating the very best students than in communicating effectively with the average ones, he has his deserved fame as the founder of the first student physical laboratory, rather different from the usual style of today in that students voluntarily carried out practical investigations on topics of interest to Kelvin, funded by small grants obtained from the Royal Society. With this experience, Kelvin was able and willing to advise on the new physical laboratories at Oxford and Cambridge, the Clarendon and Cavendish respectively.

Kelvin also played an extremely important role in the setting up of a system of electrical and other units; this was clearly an absolutely essential condition for the production of accurate and reproducible scientific results, for the statement of technical requirements in industry, and for any form of marketing of electricity. Work on units demanded first a detailed understanding of how accurate and reproducible standards might be set up, the various difficulties and errors that are certain to occur and how they may be overcome. It also demanded effective committee work, taking the views of scientists and engineers from different nations, and tactfully but firmly arguing for the most effective conclusions. Indeed Kelvin was an excellent member and chair of important committees, particularly a number of committees to do with naval matters, establishing what had gone wrong when ships had been lost at sea, and helping to plan future generations of naval vessels.

This takes us to another of Kelvin’s talents, one that seems, at least at first, more a matter of relaxation than those described so far, sailing. By 1870 he was well enough off to be able to buy a substantial schooner-yacht, the Lalla Rookh, which was large enough in fact to require a professional master and crew. From then on, in the yearly six-month break from duties in Glasgow, Kelvin would undertake cruises, both short, around the coast of England and Scotland or to visit family and friends in Belfast, or very much longer, such as the trips to Lisbon, Gibraltar and Madeira. The yacht was a residence, providing him with sufficient peace for work, a laboratory, where he was able to interact directly with the waves that he studied theoretically in the winter months, and an engaging and adventurous hobby. It taught him a great deal, of course, about maritime affairs.

2. Kelvin and the practical application of science

Each of these talents may be described as a piece in the jigsaw of Kelvin’s life and work, but they were certainly not independent, and we have not mentioned as yet the jigsaw piece that connected them all together. This was Kelvin’s work as a technological inventor and entrepreneur. It was a facet of his life that began in the mid-1850s, and came to occupy an increasing fraction of his time, bringing him fame and fortune. The fame included his knighthood. (For his peerage, see the article Lord Kelvin and liberal unionism by Iain Hutchison in this collection.) The fortune amounted to at least many hundreds of thousands of pounds, perhaps in today’s terms many tens of millions of pounds. This in turn enabled Kelvin to own Netherhall, his substantial mansion in Largs, and, of course, the Lalla Rookh. It also enabled him to show substantial generosity to Glasgow University, to Peterhouse, his college in Cambridge, and almost certainly to many other people and institutions.

It is important to stress how much Kelvin’s technology relied on all aspects of his physics and mathematics. Let us first consider his work on telegraphy. It is, of course, well-known that it was Kelvin’s work on the Atlantic telegraph that finally brought success to this venture in 1866 after many costly failures. His work in telegraphy [5] actually began from purely academic discussions with Stokes on some ideas of Faraday, and much of the reason for Kelvin’s involvement with cable-laying was the fact that it seemed by no means obvious to many of those involved that such considerations were at all relevant.
Kelvin’s main protagonist, Wildman Whitehouse, was a medical man not a scientist or engineer, but nevertheless he was designated “electrician” on the 1857-8 attempts to lay an Atlantic cable, and as such he was responsible for all electrical matters, until his summary dismissal after the failure of the 1858 cable. It was obvious that he was an ignoramus; he clearly and categorically separated theoretical matters, with their place in the lecture room, from the practical experience accumulated, he felt, by people like himself. What is more striking, though, as pointed out by Crosbie Smith and Norton Wise [6] is that even such undoubtedly excellent electrical engineers as Lewis Gordon, Professor of Engineering at Glasgow, and indeed the first such professor in Britain, and Werner Siemens, founder of the Siemens empire, “did not approach their work from a thoroughly articulated theoretical perspective”.

It was Kelvin who stressed the importance of physical argument in the design of telegraph cables, and this focused attention on such parameters as the resistance and capacitance of the cable wire. In mid nineteenth-century, however, such attention tended to be abortive because of the absence of reproducible standards for the basic electrical units. The lack of such standards meant that it was impossible for those planning cabling expeditions to demand cable of determined standard from manufacturers. And, of course, it was this requirement that led to Kelvin’s extreme interest for the remainder of his life in the establishment of a set of standards [7, 8].

While Kelvin thus stressed the importance of theoretical ideas for technical purposes, in particular for cabling, he made another massive and completely different contribution to this area. This was his ability to construct instruments that could not only work effectively, but would do so in the most difficult of circumstances. A very important example is Kelvin’s mirror galvanometer. Its sophistication briefly saved the day for the 1858 expedition when Whitehouse surreptitiously substituted it for his own crude instrument. The Board remarked that Whitehouse’s investigations had cost the company £12000, but would have rendered it a laughing-stock had not the Board been “fortunate enough to have an illustrious colleague who had devoted his mind to the subject, and whose inventions produced in his own study – at small expense and from his own resources are available to supersede the useless portions of apparatus prepared at great labour and enormous cost for this special occasion” [9].

Equally significant was Kelvin’s siphon recorder, the first instrument to provide automatic recording of telegraph signals on moving tape, thus saving immense amount of operative time watching and recording the fluctuations of galvanometers. Even more interesting, perhaps, was that Kelvin also worked on a completely different aspect of cabling, that of laying the cable in such a way to avoid it breaking, a very difficult task, of course, when seas may be fierce. Kelvin’s invention, based on the technique of fly-fishing, had the potential to save large amounts of time, effort and money for the cabling company, and all these inventions were also eventually, of course, to prove exceptionally lucrative for Kelvin and his associates.

Exactly the same combination of inputs was involved in what was probably Kelvin’s second most important and lucrative set of inventions, those associated with the marine compass [10]. Kelvin’s work started with a highly theoretical analysis of the magnetism of ships – essentially to study the joint effect of the magnetism of the earth and that of the iron in the ship. This work was developed from earlier studies of Poisson, and also Kelvin’s friend, Archibald Smith. It also involved incisive study of the mechanics of the various components of the compass. The final stage of this work was the far more pragmatic matter of ensuring that the compass would work effectively, giving a quick and accurate reading even in the most atrocious weather conditions.

It is clear that all aspects of Kelvin’s library and laboratory based “pure research” impacted directly on his technical and entrepreneurial work, but, of course, this was a two-way process. Ideas and problems generated while carrying out practical applications constantly fed back to innovative investigations in the laboratory.

Kelvin’s developments in teaching also related directly to his technical work. In fact it was precisely the requirement to provide the necessary data to enable industry to use physical theory effectively that led him to encourage undergraduate students to carry out highly relevant research.
While this appears a somewhat pragmatic approach, it is certain that Kelvin came to value greatly the teaching of science and engineering via the science laboratory, which was so important in developing a physical understanding of the science and a feel for its practical applicability.

Kelvin’s protégé in this approach was John Perry. Perry was an extremely important and interesting character, who may best be described as a science-based engineer, who interacted with Kelvin at several periods of his life. He makes a number of appearances in the article by Andrew Whitaker, *Is Kelvin representative of an “Irish tradition”?,* in this volume, and there is a longer account in a collection to be published soon [11]. For the present purpose, Perry’s importance is that he was exceptionally keen on the practical teaching of physics and engineering. As mathematics master and physics lecturer at Clifton College in Bristol from 1870-84, he was to set up the first physics laboratory and the second mechanics workshop in an English school. Later, in Japan and back in London, he was to demonstrate the same commitment.

Lastly we turn to Kelvin’s devotion to maritime affairs. What may have seemed initially just a pleasant hobby can now be seen to be an essential part of his approach to life. His voyages not only showed him clearly the perils and difficulties of life at sea, but also gave him magnificent opportunities for testing possible solutions. Probably the most important example of this is his apparatus for sounding, or ascertaining the depth of water while at sea, clearly an essential task in order to avoid running aground with great danger of loss of life. The considerable advantage of the apparatus produced by Kelvin was not only that the procedure may be carried out efficiently and accurately, but that the ship need not be halted to carry out the sounding, thus avoiding the loss of time, or indeed the temptation to sail or steam on to avoid such loss of time.

Very many of Kelvin’s inventions were connected with the sea, and it should not be thought that his only motivation was to make money. As a sailing fanatic himself, he certainly and genuinely wished to reduce loss of life, remarkably common through at the very least the first 65 years or so of the nineteenth century. Silvanus Thompson [12] quotes “the highest authority in the British navy” as saying that he considered Kelvin to be “the man who had done by far the most for the advancement of navigation” in that period, and he also quotes a sailor as saying that “I don’t know who this Thomson may be, but every sailor ought to pray for him every night”.

Kelvin produced a very wide range of inventions; he wrote, in fact, 70 successful patents [13]. He came up with the idea of the heat pump which was, in principle at least, an extremely cost effective way of causing a transfer of heat from the cold exterior of a building to the warmer interior. (A heat pump is essentially a refrigerator acting in reverse.) More prosaically he invented a very well-known non-drip tap. Rather than further general description of this work, for the remainder of this paper we concentrate on that work closely connected with Ireland, and then finally mention the effect that the success of much of his technical work may have had on his political views.

3. The Holywood Bank lighthouse in Belfast Lough

In May 1873, Kelvin wrote to Thomas Andrews, an old friend and Vice-President and Professor of Chemistry at Queen’s College Belfast, replying to an invitation to stay with him and his wife. Kelvin hoped to be able to stay for a night when he travelled over to Belfast to set up the eclipsing arrangement that had been ordered by the Harbour Commissioners for the lighthouse on the Holywood Bank [14]. By April 1875 he was able to report [15] that: “I am told by the harbour authorities that captains, pilots, and sailors are all much pleased with [the lighthouse]. They know it with perfect confidence from any other light afloat or ashore.”

Kelvin’s interest in lighthouses was first demonstrated in an article he wrote for *Good Words* in 1873 [16], while many of the ideas were amplified in a lecture given at the Naval and Marine Exhibition at Glasgow in 1881 [17]. Lighthouses were naturally a topic of great interest to him, since they combined technical ideas with safety considerations at sea. For Kelvin, a lighthouse must fulfill two functions: first it must be seen, and secondly it must be recognised, by which one means distinguished from any other light in a sufficiently large region of sea. He felt that the
system of lights in 1873 failed mariners in many ways, and indeed that there was little improvement by 1881.

In both years the very great majority of lights were either fixed or flashing. In 1873 the count was 490 out of 623 fixed and 112 flashing. Fixed lights have the obvious positive point of always being visible, thus fulfilling the first function, but, as long as they transmit white light, equally obviously fail to fulfill the second function, as all lighthouses will appear identical. In a very few cases red light was used, but Kelvin considered this a highly retrograde step. Red lights were easily confused with the red side lights of sailing ships, and also were not easily visible in fog. (Kelvin did admit that, when used in conjunction with a white light, red light could be useful for indicating a particular direction.)

When categorising lighthouses, a flashing light is taken to be one where the period of light is much less than that of darkness. In fact in nearly all cases the flashing is caused by the light revolving, so that an observer in any particular direction will see the light appearing to flash. (In fact Kelvin uses different names in his two papers; in the 1873 paper, what we are following his 1881 usage in calling flashing, was called revolving, while the term flashing was used for a very small number of rather different sets of light we will mention shortly.)

While such lights could be cost-effective, in the sense that the light was produced in a narrow but intense beam, Kelvin considered them highly ineffective from the point of safety. The problem was compounded by the fact that in nearly all cases, the overall period was long, of the order of minutes, and the period of light was a very small fraction of that period. Kelvin wrote of the sailor in awful weather or very low visibility who gets a glimpse of a light, and then has to peer into the mist hoping to catch another glimpse some minutes later.

One possible perceived merit of the flashing (revolving) light, one “defence” of the existing system as Kelvin calls it, is that the period of the light may be used to characterise the particular lighthouse. “This defence”, Kelvin says, “is utterly invalid. It is scarcely possible for any one, counting time to himself on a gusty, showery night at sea, to distinguish a one-and-a-half minute from a two-minute revolving light.” One general recommendation of Kelvin was that all periods of any time sequence of light should be short, so that the sailor does not have to wait searching for the reappearance of the light. In the 1873 paper the term flashing was reserved for the rare lighthouses where there are five or more flashes within a minute, thus at least satisfying this criterion.

A nice quotation that Kelvin gives to this effect is from Captain Moriarty, the man who, in mid-ocean in 1866, was able to find the end of the Atlantic cable that had been lost the previous year, and was thus undoubtedly, as Kelvin says, “a very practical man”. While making for the Irish coast in dirty weather, Moriarty said that “Those lighthouses should flash out their characters like your electric signals; every lighthouse should flash, and flash and flash, many times in a minute, showing you which lighthouse it is every time. That long minute of the revolving light has often seemed to me like an age, when I have been anxious to make out where we were in a gale of wind and rain.”

Even flashing lights with a short period, however, still have two defects: the dark period is longer than the light period, and there is still the question of distinguishing different lighthouses. Here Kelvin’s suggestion was a development of the idea of the famous mathematician Charles Babbage made as early as 1851, though Babbage’s note had been pigeon-holed by the Admiralty. This was the method of the eclipsing or occulting light. In this method, the period of the light is much greater than that of the dark. This certainly makes it easier for the sailor to catch sight of the light in difficult conditions. Kelvin believed that the presence of a short dark period actually made the light easier to see than a fixed light, because the switching on catches the attention of the watching sailor.

For recognition of lighthouses, Babbage and Kelvin suggested breaking the eclipse itself into characteristic sets of short periods separated by periods of light. Babbage’s suggestion was unwieldy – for lighthouse number 347, for example, the periods of eclipse would be in groups of
3, 4 and 7. Kelvin’s approach was much neater: there would be a group of eclipses consisting of short and long dark periods. There might be a single long eclipse of 3s in an overall period of 12s (i.e. 75% light). There might be a single short eclipse of $\frac{1}{2}$ s in an overall period of 10s. In all other cases a short eclipse would be 1s and a long eclipse 3s, and they may be combined to give, for example, short-short or short-long or long-short-short; in 1881 Kelvin lists ten possibilities in all. In each case except the single short, the time from beginning to end of the group of eclipses would be about $\frac{1}{3}$ of the total period.

It is clear that Kelvin’s proposal was based on the Morse code. For example the Holywood Bank lighthouse would be distinguished as short-short-long or dot-dot-dash, which is just U in Morse code. By 1881, Kelvin thought it unwise, though, to stress this aspect of his plan, as it might frighten “practical” men! Actually in 1873 Kelvin had listed all 26 codes (figure 1).

![Figure 1](image)

Figure 1
Kelvin’s full list of groups of light and dark periods presented with the corresponding Morse codes in 1873. For example the tenth down is U: short-short-long, or dot-dot-dash, the sign for the lighthouse on the Holywood Banks.

By 1881, Kelvin had removed the stress on Morse codes as liable to frighten “practical men” and he had decided to concentrate on the ten simplest patterns.

Kelvin added that the same idea might be applied to the fog-siren also used at lighthouses. In this case, though, the distinction between short and long would not be satisfactory, as echoing may make the distinction difficult to appreciate. However this distinction may be replaced by one between a high note and a low note, which, he reports, is readily appreciable to the least musical ear.

Kelvin discussed the practical means of achieving the eclipsing of light, using oil or gas; gas was quite convenient and economical, because it could just be turned down for the dark periods.
He recognised, though, that the future for lighthouses must lie with electricity. He wrote that: “The great adaptability of the electric light to furnish increase of power when wanted gave it a value which no other source of light possessed” [18]. In his 1881 paper he reported that he had developed a simple and inexpensive apparatus that was able to produce any of the groups of eclipses. His machine was applicable to any lighthouse, large or small, and, by appropriate optical arrangements, it could channel the light to the horizontal plane or in a particular direction as required. This machine, he said, had been at work for a month in the college tower of the University of Glasgow, performing for four hours an evening without any sign of wear.

Kelvin began his 1873 paper by presenting a number of accounts of cases, imaginary and real, where the failures of the present system of lights could lead or had led to disaster; one of the real cases had led to 183 deaths. By 1881 there had been little enough improvement. Kelvin considered that the responsible authorities were too little concerned with the issue to take on the necessary work and expense. Sailors, of course, looked on lighthouses as works of nature rather than art, and “would as soon think of asking to have the shape of Knockdolian changed, so that it could never be mistaken for Ailsa Craig” as to request the changes suggested by Kelvin, which might actually save their lives.

However Kelvin had been given his head with the Holywood Bank lighthouse at the head of Belfast Lough [15]. Until November 1874 it was a red fixed light that could only be seen from two miles off and was constantly liable to be mistaken for a ship’s port-side light. At that time the red shade was removed and Kelvin’s eclipsing machine was attached. Besides having the advantage of being unmistakeable for anything else, it was then visible for distances up to five miles away.

Subsequently Kelvin reported the following events [17]. In the small hours of a summer morning, he was approaching Belfast Lough with a celebrated lighthouse engineer. They saw a light, which Kelvin asked his companion to identify. His companion could not do so, and for the first time admitted that it was possible to confuse a lighthouse light with one on a steamer’s masthead. It was, in fact, as they subsequently learned, the Copeland lighthouse off the south entrance of Belfast Lough, which is a fixed light. Soon afterwards they saw the Holywood Bank lighthouse, which was actually just visible a full ten miles away. With its distinctive short-short-long pattern of eclipsing, its identity was immediately clear, together with that of the until then unidentified fixed light they had seen before. Kelvin’s theoretical ideas had, as he always wished, been proved to work in practice.

4. The Giant’s Causeway tramway.
Kelvin became interested in the use of electricity for light and power in the late 1870s [19]. He argued that waste coal burned at the pit head, or hydroelectric energy at Niagara Falls could be used for the creation of electricity using dynamos, and this could then be transmitted hundreds of miles. Not only the economy but also public health would benefit.

In 1890 he chaired the Niagara Commission to discuss the way in which the power of Niagara could be utilised for the production and transmission of electricity. While many of the recommendations of the Commission were taken up, at least in part, the part of Kelvin’s position that has become best known is his steadfast opposition to alternating current; he felt direct current should be used. He did admit that, for the sake of economy, extremely high voltages were required for electric transmission over long distances, and, of course, it is that feature which is usually said to make the use of alternating current essential, since with alternating current transformers can be used to transform the voltage to the low value required for safety in the home or factory environment. Kelvin’s argument for using direct current was that, when using alternating current, the average size of the voltage is reduced by a factor of $\sqrt{2}$ over the direct current value with the same circuit components.
Kelvin became involved with the company set up by Joseph Swann to manufacture the Swann glow-lamp. So excited was he by the idea of electric light that in 1881, he arranged to have his University residence, his laboratory and his yacht lit by Swann lamps, a Clerk gas-engine and Faure cells. He was particularly interested in the use of the Faure cell for the storage of electrical energy, and expended much research time on this project. He suggested that a source of electrical energy such as a windmill might be made practicable by the use of Faure cells to store some of the energy which could then be used in calm periods. Well over a century and a quarter later, the problem of efficient storage of energy is still unsolved; windmills are very much with us, but there are still potential major problems in feeding their energy into the electric grid.

Also in the 1880s, Kelvin became associated with the budding engineer and entrepreneur, Sebastian de Ferranti. Actually the cause of their involvement was the fact that a patent for an alternator that Ferranti obtained in 1882 was practically identical with a machine Kelvin had designed in the previous year. Kelvin remained associated, primarily financially, with Ferranti for a long period, as the young man (born only in 1864!) survived early calamities, to move on to become a major provider of electric light by the end of the 1880s, and of course his name is still famous in today’s industry, particularly in the area of defence.

With this great interest in the use of electricity for light and power, it is not surprising that Kelvin took the opportunity to become involved in an interesting project in his “beloved Ireland”. This was the Giant’s Causeway tramway [20, 21], the first electric tramway in the United Kingdom, and the first in the world to be powered by hydroelectricity.

The progenitor of the tramway was William Acheson Traill (1844-1933) [22], who was born in Bushmills, around two miles from the famous tourist attraction, the Giant’s Causeway, and educated as a civil engineer at Trinity College Dublin. Traill was well-acquainted with Sir William Siemens, the member of the Siemens dynasty who had travelled to and worked in England. At the 1879 Berlin Exhibition, the Siemens brothers had demonstrated a working electric railway using their own dynamo and motor, and when Traill and his brother Dr Anthony Traill proposed a tramway to link the Causeway via Bushmills with the popular seaside resort of Portrush, Siemens Brothers Ltd took £3500 of shares, and Sir William Siemens was given a seat on the Board as technical adviser. Kelvin also took out shares of value £1000; this might be worth around £100,000 today, so he must be regarded as a major shareholder.

Construction began in 1881, with Siemens providing much of the expertise and equipment, and operations started in 1883, though initially only from Portrush to Bushmills. At first sight this seems strange, as one would have assumed that the main purpose of the tramway was to bring people to the Causeway; however from the start a connection from Bushmills to the Causeway by horse car was available. The main source of power was hydroelectricity generation at Walkmills on the River Bush near Bushmills, though this was augmented by a steam-powered generator at Portrush. In the usually damp and salty atmosphere of North Antrim, it was discovered during construction of the tramway that two rails could not provide the necessary current, so a third higher conductor rail was required. This third rail was too dangerous to be used in the towns of Portrush and Bushmills so a steam locomotive was available to work these parts of the line, and also to convey goods and minerals. The system was designed to work at 225/250 volts direct current. Rolling stock consisted of first and third class coaches, some open and some closed, and also goods and mineral wagons (figure 2).

The official opening was not held until September 1883. At this ceremony it appears that Kelvin was in exuberant mood, shaking hands with various of the guests while holding a live wire in his other hand. He apparently believed that electric shocks were a cure for many illnesses, and local doctors were prepared to back up this claim for such conditions as rheumatism. Several members of the Board also dropped their trousers and sat on the live conductor rail in order to demonstrate the safety of the system to the public and, most importantly, to the Inspectors. (Years later Traill’s daughter asked him: “Did sitting on the rail not hurt?” He replied: “It hurt like blazes, but we weren’t going to let the Inspectors know that!”)
Clearly Kelvin was already taking practically a proprietorial interest in the tramway as a result of his large investment and also his very close relationship with Sir William Siemens. Sadly only two months later, Siemens suddenly died. Kelvin was devastated; Lady Thomson wrote to a friend: “We have been at Sir W Siemens’s funeral today. His death has been a great grief to [Kelvin] – so much so that I felt I must come up with him and look after him” [23]. Kelvin replaced him on the Board and also as technical adviser.

The good news was that the tramway was a commercial success. At the opening Traill was able to report that, in the 12 weeks since the first of July alone, over £1000 had been taken, and by 1887, the Board felt able to increase the length of the tramway by a further mile and a half, taking it on to the Giant’s Causeway as originally planned. This required the building of a relatively substantial bridge across the River Bush, and it may have been this requirement that cause the initial limitation to Bushmills.

A trip from Portrush to the Causeway and back, with the section from Bushmills initially covered by horse car, cost 1/9, 8 3/4 p in today’s terms, though the equivalent to 1/9 today might be more like £10. It seems clear that the main clientele were holiday-makers and trippers, prepared to pay a good sum for a dramatic trip through sometimes breathtaking scenery. Throughout the life of the tramway, the summer months were always by far the busiest, and indeed from the mid-1920s the tramway shut down in the winter. Most of the employees were laid off for the winter, but fortunately these months were the prime ones for employment in Bushmills Distillery.

Traill was frequently to write to Kelvin with requests for advice [24]. Not surprisingly, with a new technology, there were many teething problems with the electrical systems, and there were additional constraints due to the situation of the electric rails very much adjacent to people and animals. Despite the death of Siemens, Kelvin was able to negotiate maintenance of the favourable terms with the Siemens Co. for technical improvement and repair. When the Bill for
the extension was sought, there was an Inquiry and it was Kelvin who took the brunt of the technical questioning, particularly with regard to the safety of the hazardous third rail.

For such a small undertaking, the Giant’s Causeway Tramway actually had quite a long period of useful life, but eventually it was to close in September 1949. However it is pleasant to report that the mile and a half stretch from Bushmills to the Causeway was reopened in Spring 2002, the operation being run by a not-for-profit organisation (figure 3). Incidentally, to compare with the prices above, a return on this line today costs £3.50.

Figure 3.
The Giant’s Causeway line in use today

5. Kelvin: engineering and imperialism

In 1798, the United Irishmen took up arms against the government [25]. The aim was to unite ‘Catholic and dissenter’ – effectively Catholic and Presbyterian - to demand complete religious equality and radical reform of Parliament. In broad terms the opposition in Ireland was the established Irish church, which was actually the Irish branch of the Church of England, many of whose members might be categorised as Anglo-Irish land-owners. The rebellion was crushed without mercy. James Thomson, Kelvin’s father, was witness to the Battle of Ballynahinch, in which the rebels were routed; after the battle the Crown forces took the opportunity to burn, wreck and loot the town of Ballynahinch. In the words of Smith and Wise [25]: “James Thomson’s [later] account of the battle emphasised the futility of the rebellion, while at the same time expressing an implicit sympathy with the ideals of the rebels – the ideals of liberty, equality, and freedom from sectarian dogmatism – and an explicit hatred of the repression and atrocities perpetrated by the establishment forces.” Doubtless these were views he passed on to his children.

Yet, as Kelvin’s career developed, while he retained his religious toleration, he inevitably became closer and closer to what might be called the “establishment” of the British Empire. His achievement with the first Atlantic cable, of course, made him famous and brought him his knighthood, but this was only the beginning of his successes in cabling. Bruce Hunt [26] has written that: “Submarine telegraphy was one of the characteristic technologies of the British Empire in the second half of the 19th century, and well into the 20th, and William Thomson sat
The most famous cables were those across the North Atlantic, but there was an extensive network running throughout the rest of the globe, particularly linking the parts of the British Empire. Almost all of these cables were built, laid and operated by British companies, and between the 1870s and 1900 all of them used instruments designed and often manufactured by Thomson and his partners.

Equally significant was his work on navigation and sounding, in particular his magnetic compass [10], which was first used universally on merchant vessels, and then became the standard compass for use in the Royal Navy. The size of the market may be judged by the fact that, in the decade after Kelvin’s death, over 3000 compasses of his design were sold. It was no idle remark that in the second half of the nineteenth century, the British navy ruled the waves, and Kelvin may justifiably have claimed that his maritime inventions had a large part in achieving this. During his campaign of persuading the Admiralty to adopt his compass, Kelvin naturally became on close terms with many of the most important men in the Navy.

Almost inevitably Kelvin’s contributions to the Empire through cabling and through his maritime inventions led to his becoming a strong supporter of the Empire. Thus the scene was set for one of the last adventures of his life. As an Irishman, he believed that the future for Ireland should be as a full participant in the British Empire. One of his arguments brought together politics and engineering; via the telegraph Dublin and London could communicate “at the rate of 500 words per minute” and hence a separate parliament was not needed [27]. Thus, though a Liberal to that point, he broke with Gladstone over Home Rule. This story is told by Iain Hutchison in this volume.

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