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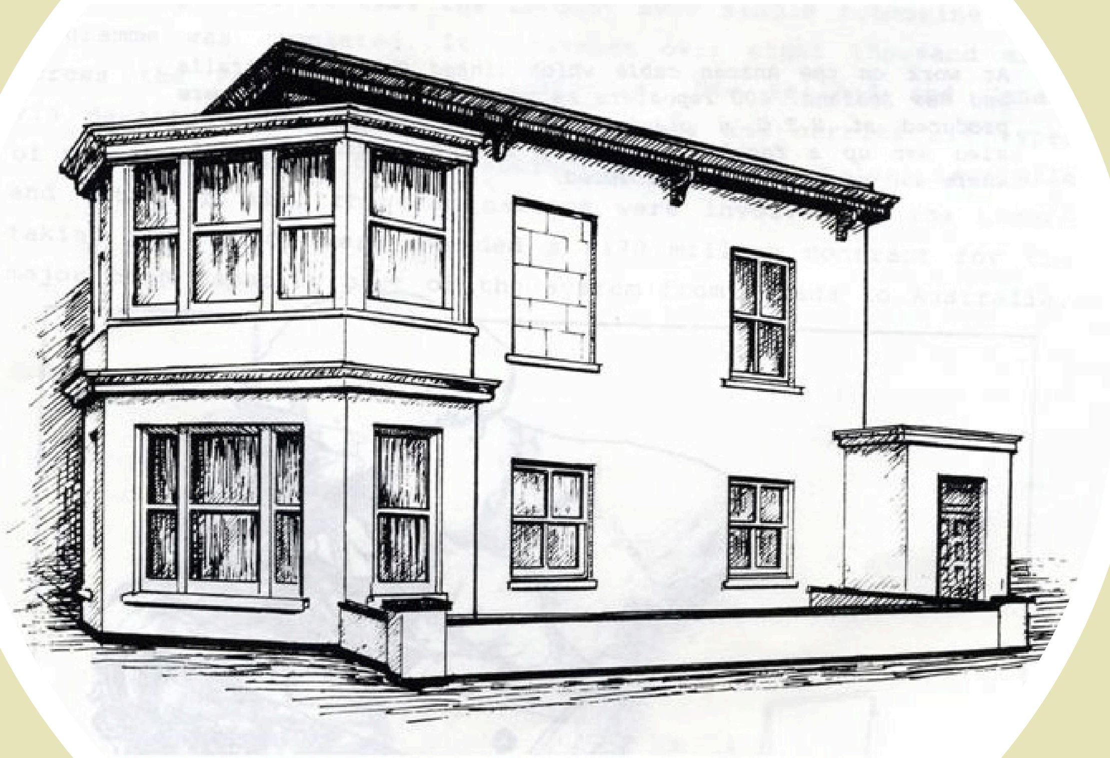
The Story of Subsea Telecommunications & its Association with Enderby House

By Stewart Ash



INTRODUCTION

The modern world of instant communications began, not in the last couple of decades - but more than 160 years ago. Just over 150 years ago a Greenwich-based company was founded that became the dominant subsea cable system supplier of the telegraph era, and with its successors, helped to create the world we know today.

On 7 April 1864, the Telegraph Construction and Maintenance Company Ltd, better known for most of its life as Telcon, was incorporated and began its global communications revolution from a Thames-side site on the Greenwich Peninsula.

For more than 100 years, Telcon and its successors were the world's leading suppliers of subsea telecommunications cable and, in 1950, dominated the global market, having manufactured and supplied 385,000 nautical miles (714,290km) of cable, 82% of the total market.

We can divide the subsea cable industry into three distinct eras.

1850 - 1950: the telegraph era
1950 - 1986: the telephone era
1986 until today, and into the future: the optical era

In the telegraph era, copper conductors could carry text only — usually short telegrams. During the telephone era, technology had advanced enough for coaxial cables to carry up to 5,680 simultaneous telephone calls. And in today's optical era, fibres made of glass carry multi-wavelengths of laser light, providing terabits of data for phone calls, text, internet pages, music, pictures and video.

Today, high capacity optic fibre subsea cables provide the arteries of the internet and are the primary enablers of global electronic-commerce.

For over 160 years, the Greenwich peninsula has been at the heart of this technological revolution, which has also been associated with Enderby House for more than 150 years.

Birth of the Telegraph Era

The start of the subsea cable industry can be traced back to 28 August 1850, when the steam tug *Goliath* laid a fragile copper cable, insulated by gutta percha (latex from the Palaquium gutta tree) from Dover to Calais. This prototype cable only survived a few days but proved the possibilities.

The following year, a more durable armoured cable was installed across the English Channel to replace it. This cable provided reliable service as part of a telegraph link between Paris and London for well over a decade. For the first time, the stock prices on the Paris Bourse could be seen in the London Stock Exchange the same day. The men who had the vision to build this pioneering system were the English art dealer John Watkins Brett (1805-63), described by *The Times* in 1855 as 'the father of submarine telegraphy', and his younger brother Jacob (1808-93). The success of the 1851 cable created some momentum and very quickly other cables were laid across the Irish Sea and the North Sea. Attempts were even made to cross the Mediterranean.

Glorious Failure

With these early successes, minds turned to the possibility of laying a cable across the Atlantic. The visionary and driving force for this great adventure was an American millionaire, Cyrus West Field (1819-92). However, to achieve his dream, Field had to rely almost entirely on British engineering and finance.

Field formed the New York, Newfoundland and London Telegraph Company in the USA, on 10 March 1854 with a capital of US$1.5 million, and then travelled to England to look for British investors. Here he met with John Watkins Brett and others and, on 20 October 1856, the Atlantic Telegraph Company was registered in London, and so the massive enterprise began.

In 1857, a first attempt was made to lay a cable from Ireland to Newfoundland, but this attempt failed after only 334 nautical miles (620 kilometres) had been deployed from the USS *Niagara*, when the cable broke.

More cable was made and, the following year, HMS *Agamemnon* and the USS *Niagara* met in mid-ocean, their cable ends were spliced together and they sailed away in opposite directions. By 5 August 1858, the two continents were connected

Steam Tug *Goliath* laying the Dover to Calais Cable, 28 August 1850

(*Illustrated London News*)

by an Atlantic telegraph cable, but only for a short period of time before, on 20 October, no further messages could be sent over the cable.

After these two failures to lay a successful telegraph cable across the Atlantic, in 1859 a joint committee was set up between the British government and the Atlantic Telegraph Company to investigate the problems. It met 22 times and its report was finally published in 1861. The report was described at the time as *'the most valuable collection of facts, warnings, and evidence ever compiled concerning submarine cables'*. It concluded that ocean telegraphy was not as simple as previously thought; there was much still to learn, and it set out a series of recommendations. These addressed the construction of subsea cables, the procedures for laying them and the methods of testing during production and installation.

Perhaps its greatest achievement was, thanks largely to the work of Professor William Thomson (1824-1907), later Lord Kelvin, to recognise the need for standardisation of the measurement of electric current and resistance. This report led to the creation of the first set of British standards for the Ampere, the Ohm and the Volt in 1862, and these standards gained international acceptance in 1881.

It was the 1861 report that renewed enthusiasm in the Atlantic cable project and led to the establishment of Telcon, which was formed, on 7 April 1864, by the amalgamation of two existing companies: the Gutta Percha Company and Glass Elliot & Company.

The Gutta Percha Company

The Gutta Percha Company was formed on 4 February 1845 by Charles Hancock (1801-77), an English artist, and Henry Bewley (1804-76), a Dublin chemist, who agreed to share their individual patents to make a wide range of products out of the newly discovered gutta percha.

It is generally accepted that Dr William Montgomerie (1795-1856), assistant surgeon to the presidency of Singapore, was the man who first introduced gutta percha into Western Europe. He initially encountered gutta percha in Malaya in 1842 and shortly afterwards sent samples back to the Society of Arts in London, setting out its properties and possible uses.

Early in 1845, Michael Faraday (1791-1867), having seen Montgomerie's samples, is said to have remarked to his friend, Carl Wilhelm Siemens (1823-83), that such a substance, being impervious to damp, might prove very useful as an insulator of electrical current. Faraday was later to recommend gutta percha as an insulator in a letter, published in the *Philosophical Magazine* on 1 March 1848. Siemens obtained a sample of gutta percha from the secretary of the Society of Arts and sent it to his elder brother, Ernst Werner Siemens (1816-92), with a recommendation that it should be tried on German underground telegraph cables, the insulation of which had proved troublesome.

That same year, Henry Bewley developed a machine to extrude gutta percha tubing and, in 1846, his company opened a factory at 18 Wharf Road, Islington in London. In 1848, Charles Hancock modified Bewley's tubing machine in order to coat copper wires in gutta percha.

Although Hancock had developed this machine in the company's time, for some unknown reason he was allowed to patent the concept in his own name. This patent became the basis for all future subsea cable insulation processes until the discovery of polyethylene by Imperial Chemical Industries (ICI) in 1933.

Bewley and Hancock fell out over this patent in a big way. Hancock was dismissed and set up the West Ham Gutta Percha Company in opposition. The price war that ensued resulted in the collapse of the West Ham Gutta Percha Company and led, in 1864, to Hancock's founding of the India Rubber, Gutta Percha and Telegraph Works Company in Silvertown, on the north bank of the Thames. Charles Hancock died on 30 July 1877 at West Grove House, Point Hill in Greenwich.

Gutta percha had been used for several years to insulate underground telegraph wires before the Gutta Percha Company received its first order in 1848, for a cable insulated by gutta percha to be used as an experimental subsea cable.

The experiments were conducted in early 1849 by Charles Vincent Walker (1812-82) on behalf of the South Eastern Railway. Two nautical miles (3.7km) of copper core insulated by gutta percha was manufactured. Walker laid this from the *Princess Clementine* in Folkestone harbour and connected the shore end to the South Eastern Railway's telegraph system at Folkestone station. On 10 January 1849, telegraphic messages were exchanged between London and the ship.

The next subsea cable projects for the Gutta Percha Company were the historic 1850 and 1851 English Channel cables to France, followed by the 1852 cable to Ireland, the 1853 cable to Belgium, the Bretts' abortive Mediterranean cables in 1854 and, of course, the 1857 and 1858 Atlantic cables. By 1864, the Gutta Percha Company was the monopoly supplier of insulated copper core to the subsea cable industry.

Glass, Elliot & Company

The history of this company can be traced back to 8 March 1841 with the granting of a patent for untwisted iron rope to Johann Baptiste Wilhelm Heimann, a merchant based in Ludgate Hill, London. The patent related to improvements in the manufacture of wire ropes and cables.

In 1842, Heimann and Johann George Wilhelm Küper (1808-71) formed a partnership to make wire rope in London. They set up their factory on the Grand Surrey Canal in Camberwell but in 1848, the business went bankrupt.

One of the company's major customers, the mining engineer, George Elliot (1814-93), was appointed as the company's administrator and over the next two years he reduced the outstanding debt.

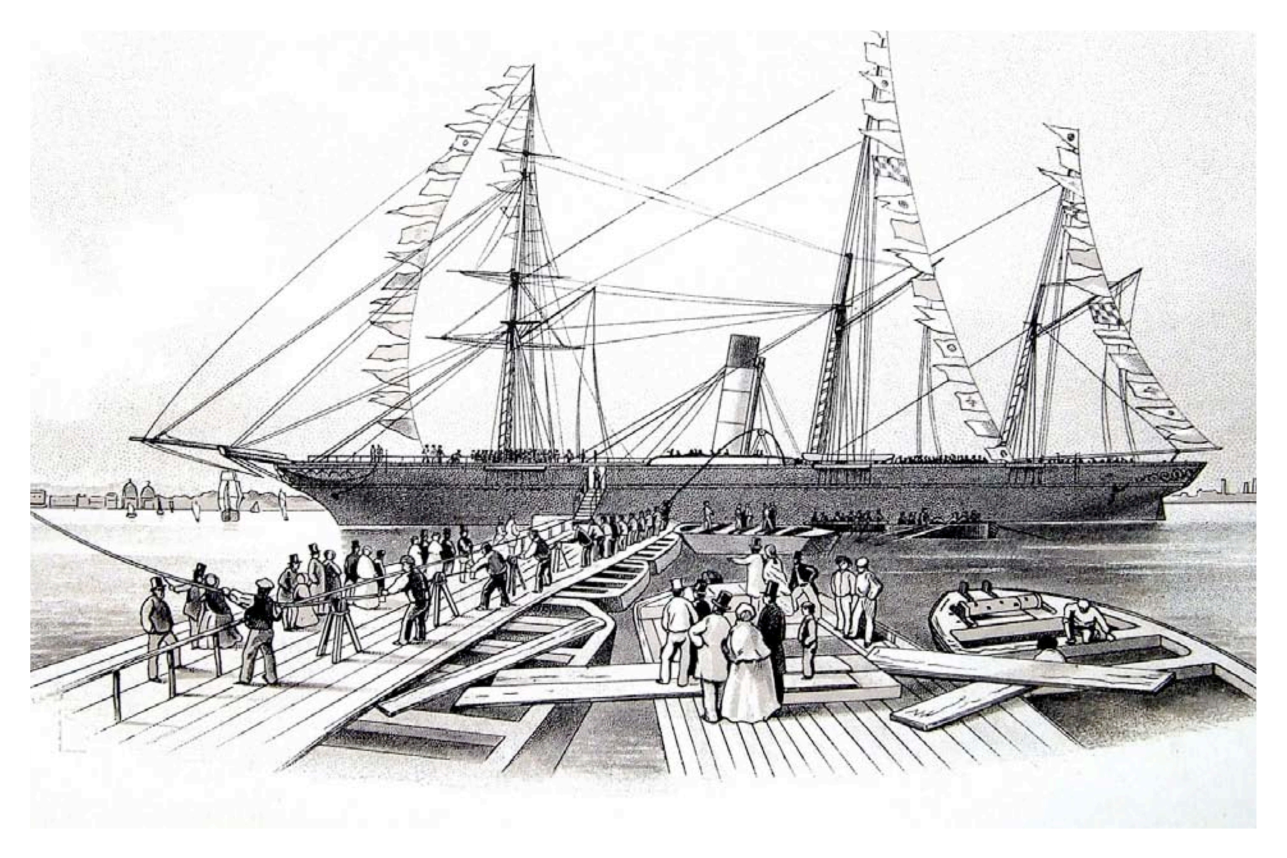
Elliot was, at that time, the leading owner of coal mines in the British Isles and so had a keen interest in the supply of high quality wire rope. The company was re-registered as W Küper and Company, claiming itself *'The original patentees of untwisted iron rope'*. The business quickly grew, finding significant new markets for its wire ropes in mines and as standing rigging on ships, including several major contracts with Britain's Royal Navy.

Offices were opened at 115 Leadenhall Street in central London. The Camberwell site was expanded and a new factory was opened on property leased from Morden College at what is now Morden Wharf, a Thames-side site on the Greenwich Peninsula, in south-east London. The leasing of Morden Wharf is believed to have occurred early in 1851, although records are sketchy.

In late 1850, the armouring of the 1851 English Channel cable had been entrusted to Wilkins and Wetherly, a wire rope manufacturer based in Wapping High Street, London, some distance from the River Thames. However, an injunction against Wilkins and Weatherly was obtained by Scotsman Robert Stirling Newall (1812-89), due to infringement of his 1840 patent, which caused the works to be closed. R S Newall & Co, based in Gateshead, had tendered for the work but had failed to receive a response from the Anglo-French Telegraph Company. Newall was able to take over the project, modify the machinery and bring in his own labour force from Gateshead. The majority of the cable was made on the Wilkins and Wetherly site but a small amount of cable was subcontracted to W Küper and Co, possibly at the Morden Wharf site.

In 1851, George Elliot became sole proprietor of W Küper and Co, having paid off the creditors and bought out the original company directors.

Richard Atwood Glass (1820-73) was educated at King's College, London; he became a trained accountant and played a significant role in the recovery of W Küper and Co. In 1852, he suggested to Elliot that there could be a significant business opportunity in protecting subsea cable with iron wire armouring. Elliot agreed and W Küper and Co secured a number of such contracts, including a Sweden to Denmark cable and the initial abortive Mediterranean cables for the Brett Brothers.



SS *Persian* loading the Brett's Mediterranean Cable at Morden Wharf, June 1854

(*Illustrated London News*)

The Glass-Elliot Partnership Is Formed

In 1854, Elliot took Glass into partnership and Glass, Elliot and Co was formed, absorbing the W Küper business. In that year, the Gutta Percha Company supplied W Küper and Co with 700 nautical miles (1,300 kilometres) of insulated core. The market continued to grow rapidly and soon Glass, Elliot and Co needed to enlarge its manufacturing capability. To do so, the company made an agreement to share the purchase of the Enderbys' hemp rope works with a rival subsea cable manufacturer, William Thomas Henley (1814-82).

The Enderby Wharf Site

The Thames-side site, next to Morden Wharf, had been Crown land since 1694, when it was purchased to build a gunpowder store. Due to ongoing public protest about the risk of explosions, the store was finally shut down in 1769, although it appears that the gunpowder store was not entirely demolished until 1771.

The land lay idle for several years until, in 1800, it seems to have been leased as a bleach works which included the production of vitriol - then the common name for sulphuric acid. In 1802, the land was purchased by Henry Vansittart (1777-1843), the fifth son of George Vansittart (1745-1825), nephew of Henry Vansittart (1732-70), Governor of Bengal, and first cousin to Nicholas Vansittart (1766-1851), created first Baron of Bexley on 1 March 1823.

Henry was a naval man and had risen to the rank of Vice-Admiral by July 1830. It has been suggested that it was Henry Vansittart who, during the period of his ownership, was responsible for refurbishing the dilapidated wharf and existing jetty. It is also possible that Henry was the first person to establish the manufacture of hemp ropes on the Greenwich Peninsula site. In 1808, the rope works was in the hands of James Littlewood but he became bankrupt in 1817, and the rope works was made over to a Mr Young. Horwood's map of London, dated 1819, is the first to show a 'rope walk' on the site. The 'rope walk' also appears on the later Greenwood map of 1827.

Samuel Enderby & Sons was established by Samuel Enderby Senior (1717-97) in 1775, on the outbreak of the American Revolutionary War, better known in the UK as the American War of Independence (1775-1783). The company traded as oil and shipping merchants with offices and warehouses at Paul's Wharf, Thames Street, in the City of London, on land leased from the Dean and Chapter of St Paul's. Under Samuel Senior's second son, Samuel Junior (1755-1829), the business expanded into whaling and seal hunting in the southern Atlantic and Pacific Oceans. On Samuel Junior's death, control of the company passed to three of his five sons, Charles, Henry and George, in partnership. The company then traded under the name of Messrs. Enderby Brothers.

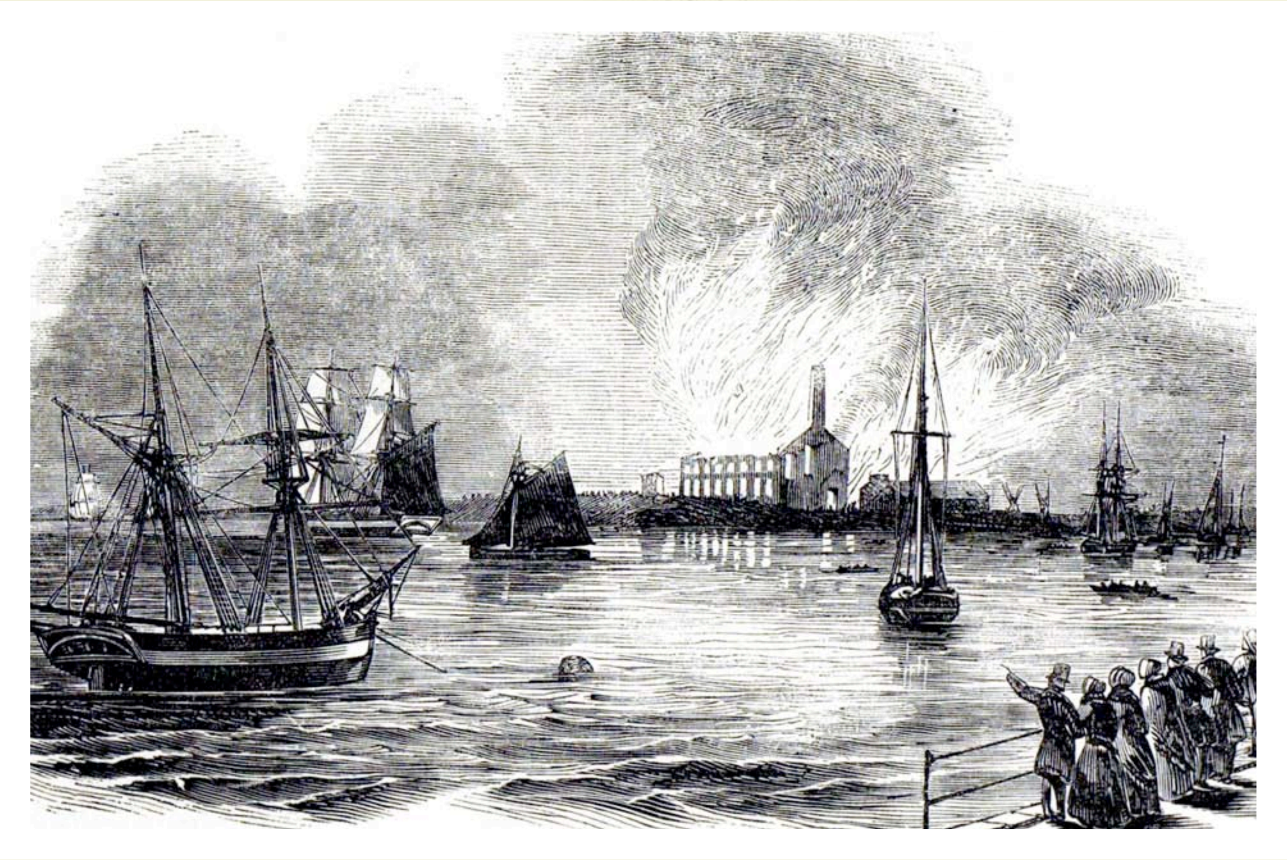
It was Messrs. Enderby Brothers that purchased the Thames-side site in 1830. They added a sail works, a hemp factory and mechanised the already existing rope-making facilities. Until then horses had been used to provide the power to form and lay the ropes. This facility became known as Enderby's Hemp Rope Works and the river frontage became known as Enderby Wharf.

The Enderbys were always prepared to lease parts of the site to other industries and, in 1837, Charles Enderby (1797-1876), Samuel's grandson, was approached by William Fothergill Cooke (1806-79), joint owner with Charles Wheatstone (1802-75) of the first telegraph patent, to develop a waterproof insulated telegraph cable to be laid across the Thames. Unfortunately, the experiments were unsuccessful and the Enderbys had no further involvement with subsea cables.

On 8 March 1845, a devastating fire at Enderby Wharf put an end to the family's involvement in the sail and rope making business.

Contemporary reports in the *Kentish Mercury* and the *Illustrated London News* give a description of the factory and the damage caused by the fire:

'The factory, or waterside premises, containing joiners' workshops, spinning, card, and loom rooms, is totally destroyed. The hemp and spinning-rooms over the engine and boiler-house are burned out, and the iron roof has fallen in. The engine-room beneath is considerably damaged. The weaving workshops, fronting the



The Fire at Enderby Wharf, 8 March 1845

(*Illustrated London News*)

factory, are greatly damaged; the roof has been partly demolished by the falling of the opposite walls. They contained twelve weaving looms, worked by machinery, which are all damaged. The dwelling-house of Mr Enderby, on the north side of the factory, is much damaged by fire, and most of the furniture and its contents destroyed; as are also the stores at the back, and part of the rope manufactory. The rope gallery, adjoining the manufactory, is a quarter of a mile in length; about 100 feet is gone, and but for the firemen cutting off the communication, the whole would have been levelled to the ground.'

The Tithe Map of 1840 only shows a small cottage and gardens on the site to the north of the rope works. On 6 June 1841, when the first national census was taken, Charles spent the night on the rope works site in East Greenwich. His occupation is given as merchant and in the same house that night were George Adamson, a rope maker, his wife Sarah, who is described as a housekeeper, and Thomas Goodger, a groom. This is an unusual household for a rich merchant and so it is questionable as to whether this was Charles' permanent address. The *Illustrated London News* article does suggest that Charles was living on the site by the time of the fire; however, the existing Enderby House was built between June 1845 and April 1846, in roughly the same location as an earlier house or cottage that had been badly damaged in the fire.

Around 250 local workmen were put out of work by the fire and it appears that the Enderbys did not have the money available, or the inclination, to fully redevelop the site - so much of it fell into disuse for several years.

Charles Enderby's interests switched to his passion for exploration of the Antarctic. In 1846, he set up the Southern Whale Fishery Company and, in December 1849, he established a settlement at the north-east end of Auckland Island, the main island of a now uninhabited archipelago between New Zealand and Antarctica. At the same time it was announced that Messrs. Enderby Brothers was in financial difficulties and the Enderby Rope Works was put up for sale.

This settlement was the start of a community to be known as Hardwicke, whose economy relied on agriculture, the resupply and minor repairs of ships, plus whaling and seal hunting. The colony did not prosper and was abandoned in August 1852. Charles Enderby returned to London in 1853 and it is unlikely that he returned to Enderby House.

With Charles back in England the affairs of Messrs. Enderby Brothers were wound up and the partnership was dissolved. It would be a further three years before the Enderby Rope Works was sold to Glass, Elliot and Henley. Charles Enderby died intestate in London on 31 August 1876.

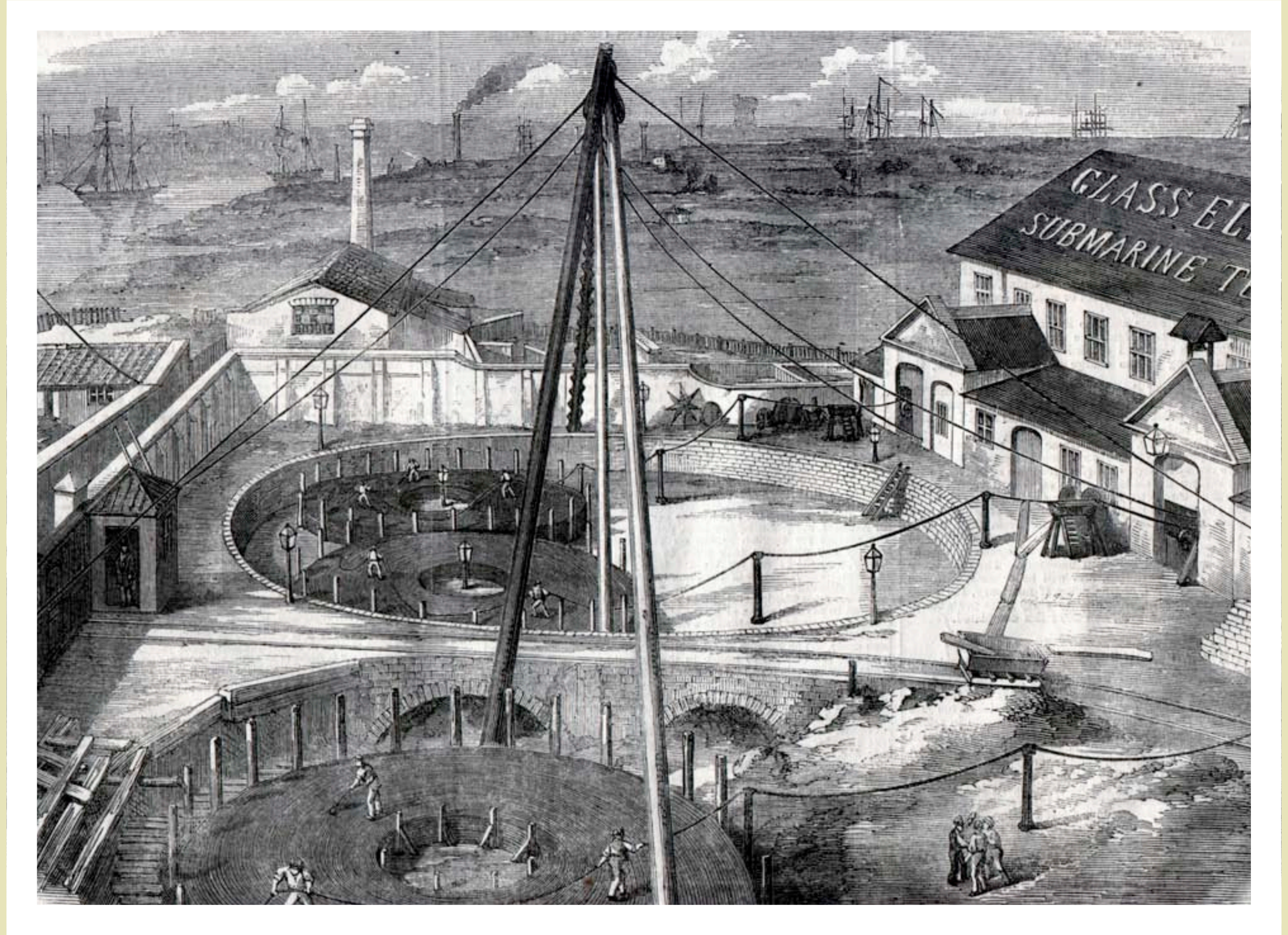
For a more comprehensive history of the Enderby Family please see the companion booklet to this: *The Eponymous Enderbys of Greenwich*

Glass, Elliot Acquires Enderby House

The purchase of the rope works site was finally completed in 1857. The sale included Enderby House, which became the management offices and boardroom. However, the joint arrangement with Henley did not go well and by 1859, he had moved his manufacturing facilities to the other side of the Thames, establishing W T Henley's Telegraph Works Co, at North Woolwich.

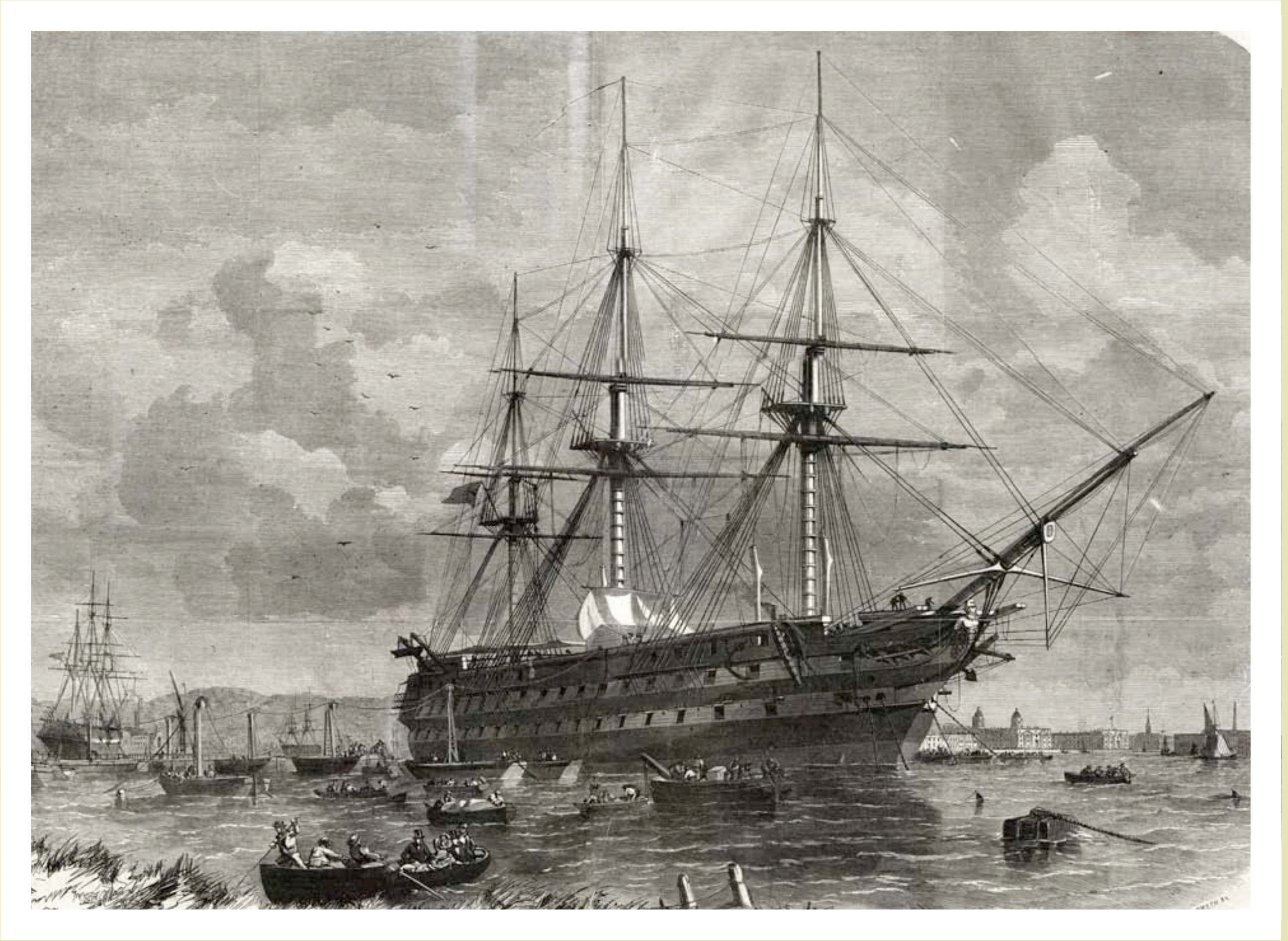
For the first attempt to lay a transatlantic cable, on 1 January 1857, the Atlantic Telegraph Company placed an order with the Gutta Percha Company for 2,500 nautical miles (4,630 kilometres) of insulated core at £40 per nautical mile and awarded two separate contracts, worth £60,000, for armouring 1,250 nautical miles (2,315 kilometres); one with R S Newall & Co and the other with Glass, Elliot and Co.

Both companies worked to the same design but unfortunately it did not specify the direction in which the armour wires were to be helically lapped around the core; this is known as the armour lay. R S Newall used a right-hand lay, which was the conventional approach adopted for rope manufacture and colliery winch cables.



Glass, Elliot Factory at Enderby Wharf, 1857

(*Illustrated London News*)



HMS *Agamemnon* Loading the Atlantic Cable at Enderby Wharf, July 1857

(*Illustrated London News*)

To accommodate such long lengths of cable they had to be stored in circular tanks with a central cone, rather like a cable drum turned on its side and the top flange removed. The cable is presented over the centre of the cone and then coiled down by hand. For every turn that is coiled in this way a 360° twist is induced into the cable. This twist is, of course, removed when the cable is paid out of the tank again.

The engineers at Glass, Elliot had observed that human beings have a preference for and are much more effective at coiling cable into these tanks in a clockwise direction. If you coil cable clockwise that has a right-hand lay, the induced twist tends to open up the armour wires, which exposes the core and also makes it much harder to handle. Glass Elliot had therefore adopted left-hand lay armouring and clockwise coiling, where the coiling process tightens the armour wires around the core and makes the cable far easier to handle.

Over 100 nautical miles (186 kilometres) of cable had been manufactured at Glass, Elliot before R S Newall started production at its Birkenhead factory, on the River Mersey, and the difference in armouring approach was discovered.

Manufacture of the cable, at both factories, was complete by 6 July 1857 and then loading commenced. At R S Newall the cable was loaded onto the USS *Niagara* in three separate coils.

At Glass, Elliot and Company the cable was paid out of the factory over a series of floating gantries, mounted on barges, and then stowed in a single coil, 45 feet (13.8 metres) in diameter and 14 feet (4.3 metres) high. Loading was completed by the 22 July.

On the 23 July 1857, Sir Culling Eardley Eardley (1805-63), third baronet, held a fête champêtre (large garden party) on his estate at Belvedere House, Erith, for managers and workers of Glass, Elliot and their families, officers and men of the *Agamemnon* and senior members of the Atlantic Telegraph Company. In all there were 850 guests and this party was reported in *The Times* of 24 July 1857. To commemorate this occasion John Watkins Brett, a director of the Atlantic Telegraph Company, had two pendants made out of cross-sections of the cable, mounted in twisted silver. These he presented to Sir Culling Eardley's daughters, as mementoes of the day.

Due in no small part to the superior handling of its cable, Glass, Elliot and Company was awarded the sole contract for the additional 900 nautical miles (1,666 kilometres) that was required for the 1858 cable. Glass, Eliott's philosophy of left-hand lay

Telegraph Cable Pendant, 1857

armouring and clockwise coiling was advocated in the 1861 joint committee report and from that day to this, subsea armoured cable has always been manufactured with left-hand lay and coiled clockwise into tanks.

From 1861 onwards, Glass, Elliot and Co and W T Henley's Telegraph Works Co competed aggressively for the available subsea cable projects - but it was Richard Glass who recognised that the only way to address such a massive undertaking as an Atlantic cable was through a single company controlling every element of the project.

The Founding of Telcon

Richard Glass's idea led to the formation of Telcon. How this occurred is best described by John Pender (1816-96), its first chairman. The following is an extract from a letter written by Pender to Thomas Egerton, second Earl Wilton (1799-1882), on 10 October 1866, from his Scottish estate, Minard Castle in Argyllshire:

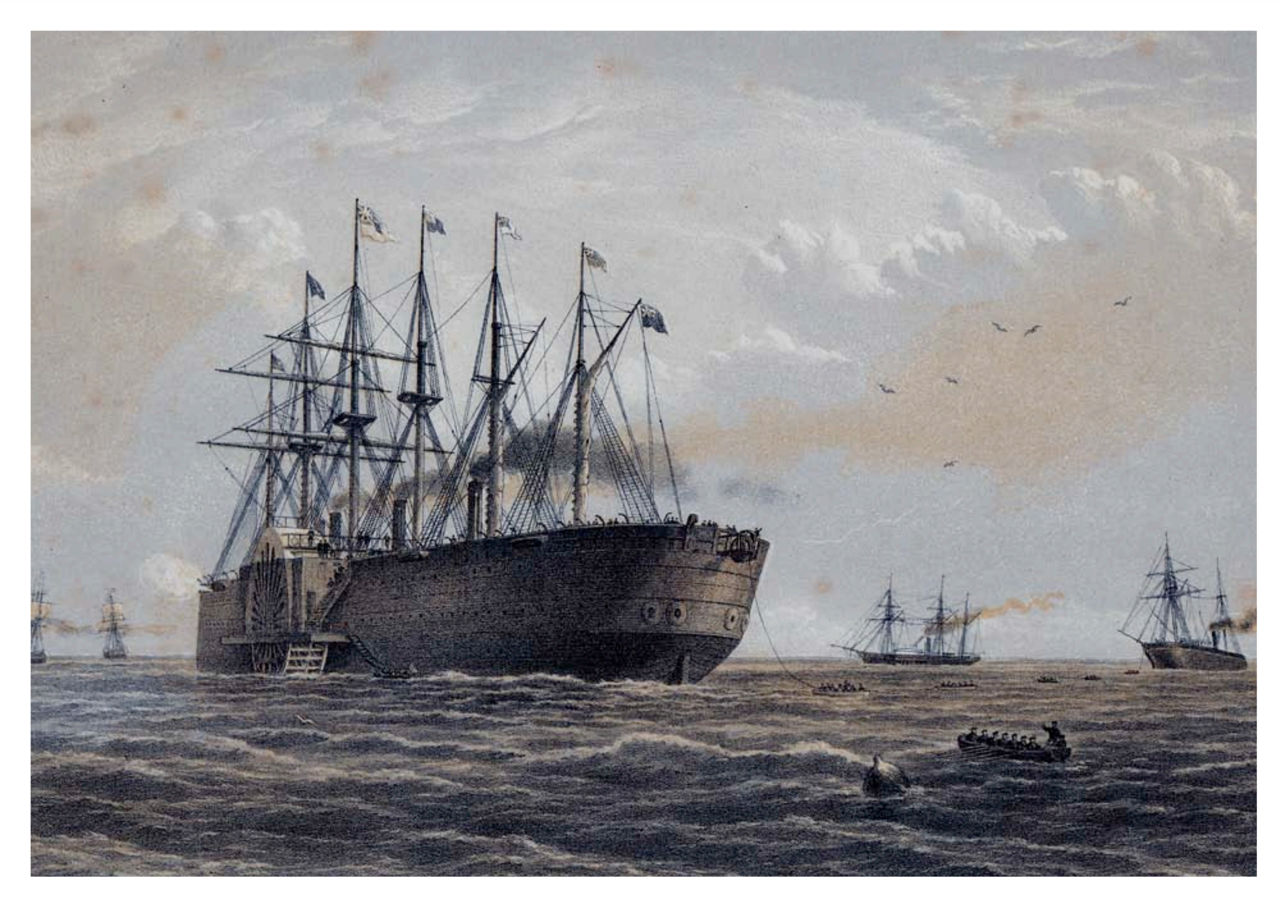
'It was not until May 1864 that a further attempt was made to obtain capital upon an eight per cent Preference Stock; & I myself raised amongst my own personal friends subscriptions to the amount of £20,000.

Negotiations were opened with the Firm of Glass Elliot & Co cable manufacturers but after a time it was found the public, who had been appealed to, did not make any sufficient response and that firm as a private company did not feel justified in taking the number of Shares required to complete the work. At this time Glass Elliot & Co first broached the idea of purchasing the Gutta Percha Co's works and Patents and having obtained the option of purchase for a fixed sum they applied to one of the principal Financial Companies under the Limited Liability Act. These negotiations however proved fruitless.

It was at this discouraging crisis that Mr Cyrus Field, whose ardour in the cause and success of the Atlantic Cable has been most unreserved, consulted me as to the best course to be pursued with a view to another attempt, he knowing that I felt most deeply interested in the success of an undertaking in which we had both been engaged so many years. I told him that in my opinion with a little energy a Company might be formed embracing Glass Elliot & Co & the Gutta Percha Co which combined Company would, I believe, be able to carry out this great work. Further I stated to Mr Field I would undertake the formation of such a Company. I knew that the Gutta Percha Co were willing to sell their business & plant to Glass Elliot & Co for £250,000 provided they were guaranteed for that amount.

I took upon myself this heavy responsibility & this I may say was the turning point of the whole enterprise.

The new Company was accordingly formed (mainly by my exertions) called 'The Telegraph Construction & Maintenance Company' uniting the business of the Gutta Percha Co with that of Glass Elliot & Co & it was through this new Co that the enterprise was brought to a successful issue.'



The SS *Great Eastern* Laying the Atlantic Cable, 1865

(Illustration by Robert Charles Dudley 1826-1900))

I went amongst my friends and business connections & in the course of a few days obtained subscriptions for considerably more than half a million in money. Prospectuses were prepared and brought before the public under the following very influential direction.

John Pender Esq Chairman
Alexander Henry Campbell MP Vice Chairman
Richard Atwood Glass Esq Managing Director
Henry Ford Barclay Esq, Gutta Percha Co
George Elliot Esq, Glass Elliot & Co
Alexander Smithers Finlay Esq MP
Daniel Gooch Esq CE
Samuel Gurney Esq MP
Lord John Hay RN
John Smith Esq (Smith Fleming & Co)
Captain Sherard Osborn RN

The majority of these gentlemen were my own personal friends and were introduced by me.'

While not a major player in the formation of Telcon, the railway engineer Daniel Gooch (1816-89) played a significant role in the success of the Atlantic Cable and the future of Telcon.

Gooch had made his fortune under Isambard Kingdom Brunel (1806-59) with the Great Western Railway (GWR). In 1864, he resigned from GWR and joined the board of Telcon. At that time he was also a director and shareholder in the company that owned the SS *Great Eastern*, the iron steamship designed by Brunel.

The *Great Eastern* was built by J Scott Russell & Co at Millwall, just upriver from Greenwich on the south-western side of the Isle of Dogs, and was launched on 31 January 1858. Brunel designed her to carry 4,000 passengers from England to Australia without refuelling but the *Great Eastern* failed spectacularly as a passenger ship. The company was wound up and the ship was put up for auction in Liverpool. Gooch bought the *Great Eastern* for £25,000, set up a new company with the bondholders and chartered her to Telcon for £50,000 worth of shares in the cable company.

The *Great Eastern* led the next attempt to lay an Atlantic cable in 1865, this time with a much improved cable design manufactured by Telcon. However, the project still failed after 1,186 nautical miles (2,200 kilometres) had been laid and *Great Eastern* was just 600 nautical miles (1,113 kilometres) short of Newfoundland, when the cable parted in a water depth of 2,000 fathoms (two nautical miles or 3.7 kilometres) and could not be recovered.

New capital was required to keep the dream alive and Daniel Gooch and John Pender answered the call by raising the necessary investment and co-founding the Anglo-American Telegraph Company. It took over the New York, Newfoundland and London Telegraph Company and Richard Atwood Glass was appointed as its chairman.

Telcon was awarded the contract to manufacture a second Atlantic cable, which was successfully installed by the *Great Eastern* between Valentia in Ireland and Hearts Content in Newfoundland on 26 July 1866. The *Great Eastern* then went back and recovered the end of the 1865 cable, repaired it and completed the remainder of the system on 8 September 1866.

A number of the key men involved in the Atlantic cable were recognised by Queen Victoria for their contribution to the success of this massive undertaking. Captain James Anderson (1824-93), commander of the SS *Great Eastern*, Richard Glass, the managing director and Samuel Canning (1823-1908), the chief engineer of Telcon, were knighted. Daniel Gooch and Curtis Miranda Lampson (1806-85) were created baronets. Lampson was originally an American from New Haven, Vermont, but had become a naturalised British citizen in 1849. He had been on the board of directors of the Atlantic Telegraph Company since 1856, and then became a director of the Anglo-American Telegraph Company.

Although the contribution of Cyrus Field was greatly appreciated, it was considered inappropriate to offer an American citizen an English honour. Despite his pivotal role in the final success of the Atlantic telegraph, John Pender received no recognition whatsoever. Why this should be has never been made public but it is almost certainly due to the Totnes General Election of 1865.

John Pender had been the Member of Parliament for Totnes, in Devon, since a by-election in 1862, when he was elected unopposed as one of two Liberal burgesses. On 12 July 1865, he had been re-elected at the next General Election. However, a petition alleging corrupt practices was brought shortly afterwards by John Earle Lloyd and Edmund Tucker. This led to a hearing by a House of Commons Select Committee, under the chairmanship of Edward Pleydell Bouverie (1818-89). Evidence was heard from 16-23 March 1866 and the outcome was that John Pender's election was declared void, and in addition, he was found guilty of bribery by offering Robert Harris, a local blacksmith and Conservative agent, a position worth £300 per year, if he voted for him.

This type of vote buying was common practice in a number of so called *'Rotten or Pocket Boroughs'* at that time. Although Pender strenuously denied these accusations and Harris was exposed as a convicted perjurer, the political mood was for clamping down on such electoral practices. On 6 June 1866, Queen Victoria ordered a Royal Commission to look into electoral corruption at the Great Yarmouth, Lancaster, Reigate and Totnes elections. The commission finally reported in March 1867; the report was a precursor to Benjamin Disraeli's (1804-81) Reform Act of 1867, under which Totnes was disenfranchised in 1868. The Queen's honours for the Atlantic cable were made public on the 15 November 1866, so it would have been impossible for Pender's role to have been acknowledged by the Queen at that time.

Foots Cray Place, date unknown

(Courtesy of English Heritage)

Sir John Pender GCMG

The success of the Atlantic Telegraph was, in no small part, due to the endeavours and courage of Pender but he stood down as Telcon chairman in 1868 in favour of Gooch. He moved his focus from telegraph cable construction to network operation, setting up a number of businesses that became the Eastern and Associated Telegraph Companies and earning him the sobriquet *'Cable King'.*

Pender remained a shareholder and director of Telcon and, largely due to his patronage, the company went from strength to strength. Pender's central London home was 18 Arlington Street, just off Piccadilly, backing onto Green Park. However, on 16 May 1876, he leased a country house, Foots Cray Place, a Palladian mansion, then in rural Kent but whose site is now in the London Borough of Bexley, from Coleraine Robert Vansittart (1833-86).

Over the next few years his contribution to subsea telegraph was recognised by many countries around the world, and it was finally recognised in Britain in 1888, when he was knighted KCMG. This was later elevated to GCMG in 1892. Sir John Pender died at Foots Cray Place on 7 July 1896 and is buried in All Saints' churchyard, Foots Cray. There is a strong circumstantial evidence to suggest that he was soon to be created Baron, but he died before Queen Victoria could sign the warrant.

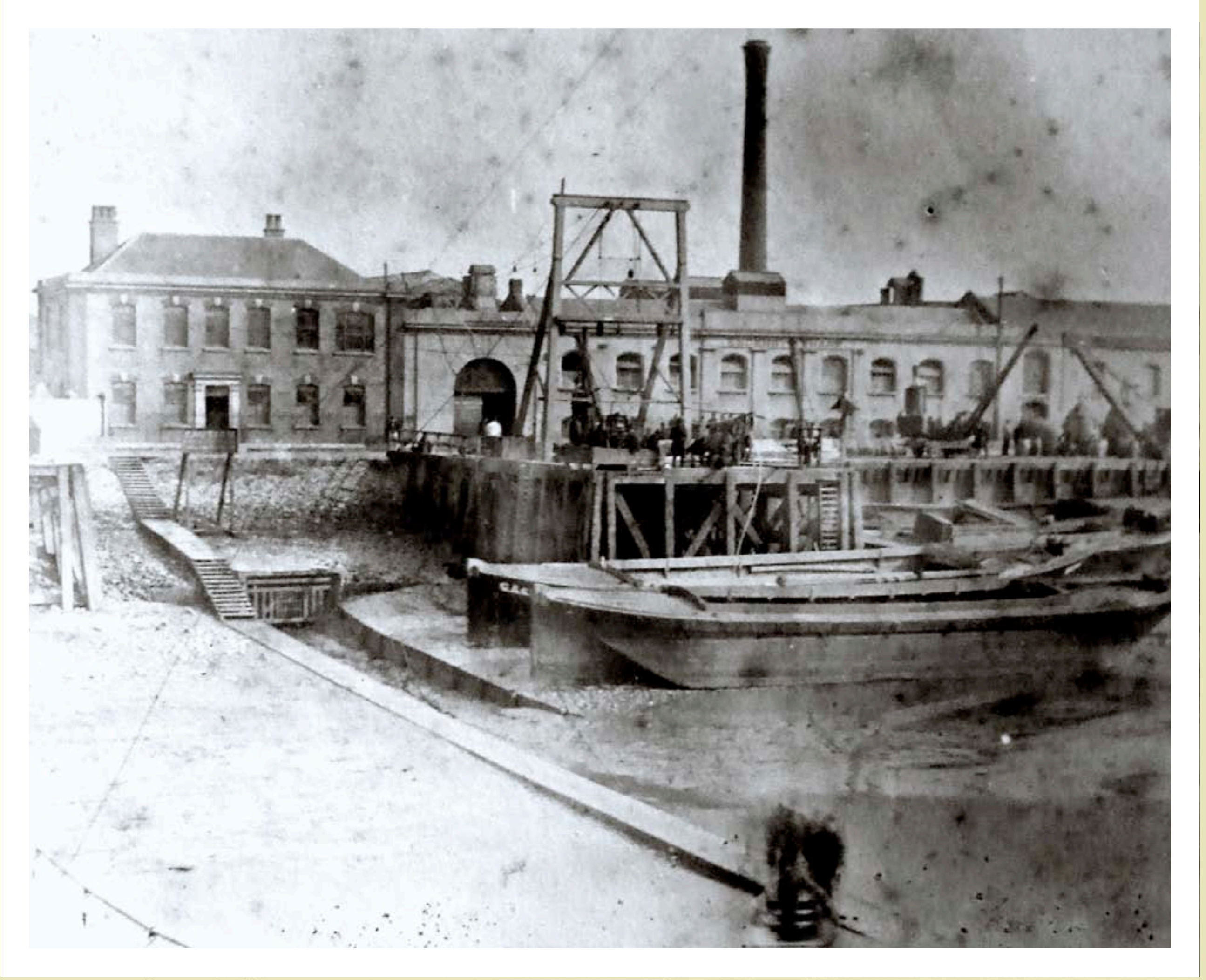
Global Expansion

Under Gooch, the new chairman, Telcon came to dominate the subsea telegraph cable supply industry, with the SS *Great Eastern* providing sterling service until 1874, when she was decommissioned soon after laying her fifth transatlantic cable. During this period, cables manufactured and installed by Telcon for the Eastern companies had connected Eastern's Porthcurno station in Cornwall (now Porthcurno Telegraph Museum) with India, Penang, Singapore and Djakarta (then Batavia) in 1871.

Then in 1872, Telcon cables were laid from Singapore to Saigon, Hong Kong and Darwin. From Darwin, telegraph services were extended overland to Adelaide and Sydney. By June 1872, telegraph messages could be sent over the 12,500nm (23,190km) route from London to Sydney in less than a day. During the 1880s, new routes were opened up and major routes duplicated, then triplicated to provide network resilience. Almost all of this work went to Telcon.

Gooch continued as chairman of Telcon until his death in 1889, when Sir George Elliot (created baronet in 1874) succeeded him until he died on 23 December 1893.

Telcon's dominance continued into the twentieth century, when in 1901 the company was awarded the supply contract for the first transpacific telegraph cable system. The system linked Australia with Canada and included the longest ever single span telegraph system of 3,458nm (6,416km) between Bamfield on Vancouver Island, Canada, and Fanning Island, now part of Kiribati. All the cable was made in Greenwich and the system went into service in 1902. Through the completion of this massive project, Telcon could claim, as did Puck in *A Midsummer Night's Dream*, that its cable had *'put a girdle round about the earth'.* However, the bridging of the Pacific marked the zenith of submarine telegraphy.



Enderby Wharf 1886

(Courtesy of Jane Claire Wall)

Industry Decline

By the end of 1901, a young Italian-Irish engineer, Guglielmo Marconi (1874-1937), had proved that it was possible to send telegraph messages across the Atlantic wirelessly. However, cable manufacture remained important during the first decade of the twentieth century, as early experiments with radio telegraph proved to be unreliable. With the start of the First World War, submarine cable manufacture was largely switched to making 'trench cable' for connecting military field telegraphs and telephones.

Marconi went back to the drawing board to improve the reliability and security of his radio telegraphy. As a result of his success, in 1919, Marconi was granted an operating licence and commercial radio (wireless) telegraphy became a viable commercial competitor to cables. Short-wave radio could send telegraph signals at three times the speed of telegraph cables, using a fifth of the power and at a twentieth of the cost. The only benefit that cables could offer was security, which remained essential for government and military traffic. The glory days for subsea telegraph cables were over.

By the 1920s, competition from Marconi's radio telegraphy and telephony networks depressed the subsea cable market. Because of its size and the support of the Eastern Telegraph companies, Telcon had been able to see off almost all of its UK competition. R S Newall & Co had left the industry in 1870, followed by W T Henley's in 1900. Hooper's Telegraph and India Rubber Works left in 1910 and the India Rubber, Gutta Percha and Telegraph Works Co went in 1922. The only other manufacturer remaining was Siemens Brothers, with its factory downriver at Woolwich. This site had been established in 1863 by Charles William Siemens (Carl Wilhelm having changed his Christian names when he became a naturalised British subject on 19 March 1859) and they had become Telcon's greatest competitor.

Competition from wireless telegraphy also affected the subsea cable operators' business. In April 1929, Pender's Eastern companies merged with Marconi's Wireless Telephone Company Ltd, and some smaller subsea cable operating companies, to form Imperial and International Communications Ltd. Additional overseas cable operating companies were acquired and in 1934, Imperial became Cable & Wireless Ltd (C&W).

On the 1 January 1947, C&W was nationalised by the British Government and remained so until privatised once again as a public limited company by the Thatcher government in 1981. C&W plc survived until 2010, when it was split into two companies, C&W Worldwide and C&W Communications. The global subsea cable interests were vested in C&W Worldwide and were sold to Vodafone in July 2012.

Submarine Cables Limited

Telcon and Siemens Brothers merged their subsea cable divisions in 1935 to form Submarine Cables Limited (SCL), with the headquarters on the Enderby Wharf site.

After that merger SCL was the sole manufacturer of subsea cable in the UK, at Enderby Wharf and later at its new Erith factory in Kent, until Standard Telephones & Cables (STC) — the UK subsidiary of a US-owned group, International Telephone and Telegraph (ITT) — opened a cable factory in Southampton, in 1956. STC entered the subsea systems market in 1950 at what was the start of the next era of subsea cable transmission technology. This is known as the Telephone Era.

Telephone Era (1950-86)

In 1854, the Belgian telegraph engineer, Charles Bourseul (1829-1912), wrote a paper on the use of electricity for transmitting and receiving speech, while in the same year the Italian-American inventor, Antonio Santi Giuseppe Meucci (1808-89), produced the first device to demonstrate this.

Six years later, the German inventor, Johann Philipp Reis (1834-74), built a device that could transmit musical notes and indistinct speech. He called his device the 'telephone'. In 1871, Meucci set up an electrical communications system between rooms within his Staten Island home in New York and submitted a patent caveat to the United States Patent Office. He renewed this twice, but by 1874 lacked the funds for a further renewal and the caveat lapsed.

Meucci's lack of funds allowed Scottish-born scientist, Alexander Graham Bell (1847-1922), to be awarded his infamous patent 174,465 on 7 March 1876. Many people still believe that the main idea for Bell's transmitter was stolen from the patent caveat of American engineer, Elisha Gray (1835-1901), which was filed on the same day

Aerial View of the SCL Site, 21 August 1946 as Bell's patent application. Whatever the truth, it was Bell who made the telephone a commercial success. His first telephone exchange was opened in New Haven, Connecticut, in 1878 and over the next decade, the telephone spread across America and Europe.

In Britain, the government-owned General Post Office (GPO) had a monopoly over domestic telegraph networks, and in 1891, the GPO laid the first subsea telephone cable of any note across the English Channel. This system was supplied by Siemens Brothers from its Woolwich factory and used a telegraph cable design that was limited to transmission over relatively short distances due to the distorting effects of the cable's capacitance.

Telcon's first subsea telephone cables were laid across the Solent and then the Irish Sea in 1896. They were manufactured at Enderby Wharf – the Morden Wharf site having been run down and abandoned at the end of 1895.

Coaxial Cable

To overcome the capacitance problem, two technological breakthroughs were required. The first was the research of British physicist and engineer, Oliver Heaviside (1850-1925), into the 'skin effect' of telegraph signals, leading to his patent of the coaxial cable in 1880.

Telcon was granted a patent for a subsea telegraph cable with a copper helically-wrapped outer conductor in 1895. However, this idea was not exploited until 1921, when Telcon made three coaxial cables and laid them between Havana, the capital of Cuba, and Key West, Florida.

Before the advent of coaxial cables, the problem of cable capacitance was overcome by a technique known as 'loading', which involved the inclusion, in the cable construction, of an alloy tape with special magnetic properties. Telcon supplied the first cross-channel telephone cable of this type in 1912.

This same technique was also applied to telegraph cables. In 1924, Telcon supplied the huge US telegraph operator, the Western Union Telegraph Company, with a transatlantic cable between New York and Horta in the Azores, which was capable of a transmission rate of 1,500 words a

1947 SCL 1.7" Coaxial Cable Sample

minute. Further developments involving the use of Mumetal in the cable increased this capability to 3,000 words a minute by 1928.

The second technological breakthrough came in 1933, when scientists at the Northwich, Cheshire, laboratories of ICI discovered polyethylene, solving the problem of high capacitance in gutta percha insulated cables. This material had a lower dielectric constant than gutta percha; it was tougher, more easily processed, non-hygroscopic and most importantly, cheaper to manufacture.

Polyethylene became available for experimental cable manufacture in 1938, but its use was restricted to military cables during the Second World War. The first coaxial subsea cable to use polyethylene was made by SCL and was laid across the English Channel between Cuckmere and Dieppe, in 1945.

The French manufacturing capability in Calais, established in 1891, had been destroyed during the Second World War. The manufacture of submarine cables in Japan, which had started in 1915, had grown steadily, based on the needs of its domestic market. In 1941, a major factory had been opened by the Nippon Submarine Cable Company, but as a result of the Second World War, this facility was also out of action. The Americas had yet to fully enter the industry and so, once again, subsea cable manufacture was a British monopoly.

Until this point in time, subsea telephone cables were capable of carrying only one telephone call at a time. After the Second World War, polyethylene was made available for civilian use and this allowed Telcon to develop a revolutionary 1.7 inch (4.3cm) air and polyethylene spaced coaxial cable. The size of a coaxial cable is defined by the diameter of the dielectric between the inner and outer conductors. This coaxial design was first deployed in a new cable system between the UK and Holland in 1947, and was capable of carrying 84 voice channels.

The Introduction of Repeaters

Low-loss polyethylene cables allowed submarine telephony over medium distances but to cross oceans, amplification of the signal was essential. The idea of including housings in the subsea cable had first been patented in 1865, but the technology had not been forthcoming. To insert an amplifier into a subsea housing raised a number of major technical problems, such as how to enclose the amplifier in a water-tight casing but still get access to the transmission path, how to integrate the housing into the cable, how to provide power to the amplifier and, because it had to be based on thermionic vacuum tubes (valves), how to dissipate the heat. Most importantly, all the amplifiers had to be reliable, so that they would not have to be recovered and replaced. These problems took time to resolve, but the first submerged amplifier housing was introduced into the already laid Anglesey to Port Erin coaxial cable in 1943. By 1947, a new coaxial system containing a submerged amplifier had been laid between the United Kingdom and Germany, and shortly afterwards other systems followed to the Netherlands and Denmark. Because the North Sea was relatively shallow, the effects of hydrostatic pressure were not overly significant. However, to lay a system across the Atlantic presented far greater problems.

In the USA, Bell Laboratories developed a flexible housing that could be laid by passing it through the standard cable-laying machinery of the time, and which contained a unidirectional valve amplifier. The amplifier was powered by direct current sent down the cable. Design work was completed by 1941 but, due to the Second World War, a full-scale trial of this repeater design was not conducted until 1950, when twin coaxial cables were laid between Havana and Key West. The cable was manufactured by the Simplex Wire and Cable Company in the United States, which marked the start of significant US involvement in subsea cable manufacture. Each cable contained three flexible housing amplifiers manufactured by Western Union. Between them the two cables provided 24 voice channels. The installation of this system is generally accepted as the event that marked the beginning of the subsea cable telephone era.

In parallel with submerged amplifier development, the ailing subsea telegraph industry was looking for ways to improve the performance of its cables. Western Union developed a submerged housing that contained circuitry to detect incoming telegraph signals and regenerate or 'repeat' them. The first of these regenerators was successfully

Laying a Rigid Housing Repeater

(Courtesy of Alcatel-Lucent)

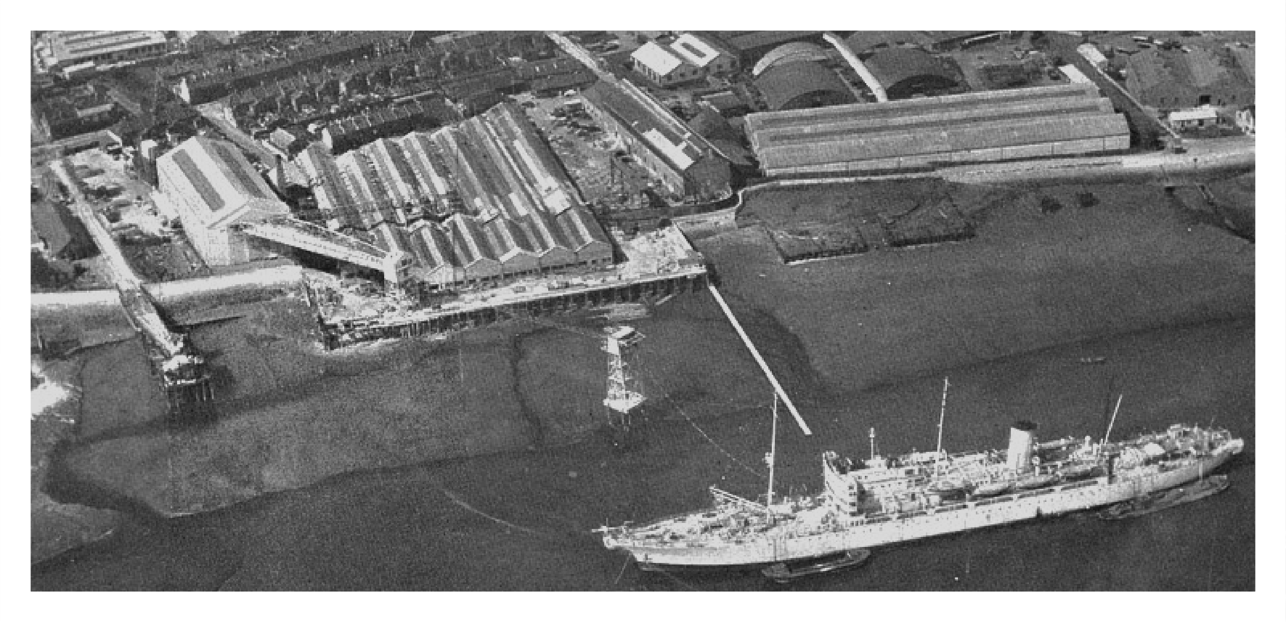
inserted into the 1881 transatlantic American Telegraph cable in 1950. Over the next decade, several more of these devices were inserted into existing subsea telegraph systems. Western Union named these devices *'submerged repeaters'*, and although no new systems were ever installed that included them, for some reason the name for the watertight housing survived the demise of the technology.

In Britain, from 1952 onwards, the GPO and C&W led a design and development programme, in collaboration with SCL and new entrant STC. This programme resulted in an in-line, rigid housing repeater design which had room inside it for filters that allowed bi-directional transmission over a single cable. The British repeater could also provide up to 60 x 4 kHz voice circuits, over twice that of the United States design and, being bi-directional, it only required a single cable. However, because of the rigid housing, it would not pass through the cable machinery used to deploy the cable.

British cableships were fitted with 'V' Sheave cable engines: these comprised a series of six vertically mounted wheels 8ft (2.46m) in diameter; the cable passed over and under these wheels in a serpent. Each wheel had a 'V' shaped slot around its circumference, which meant that increased outboard tension would force the cable deeper into the slots and so provide increased grip on the cable. Because of this cable engine design, the cableship would have to be stopped and manoeuvre each repeater past the cable engine, while managing the outboard cable tension, in order to deploy the repeater. In deep water, this procedure was viewed as having a high risk of throwing cable loops on the seabed, thus increasing the risk of cable faults, and so was not considered viable for trans-oceanic cable systems.

The first transatlantic subsea telephone cable was TAT-1, laid in 1955-56, and was capable of 36 simultaneous phone calls, which was much more capacity than the restricted radio-telephone service could offer. Once again subsea cable technology was in the ascendancy.

TAT-1 comprised two cables, using American-designed unidirectional valve amplifier repeaters, between Oban in Scotland and Clarenville in Newfoundland, Canada. For this system, SCL made 7,739 kilometres of cable at its Greenwich and Erith factories and only 616 kilometres was made in the USA by Simplex Wire and Cable Co. TAT-1 went into service in 1956.



C S *Monarch* (4) Loading TAT-1 at SCL, Erith

(Courtesy of Alcatel-Lucent)

Before TAT-1, all cables across the Atlantic carried telegraph messages — written text only. From 1926, it was possible to connect telephone calls between Europe and North America but only by long-distance radio, which had very limited channel capacity. The cost of a three-minute call was £9 – the equivalent of around three weeks' wages for most working people. TAT-1 reduced the cost of a three-minute transatlantic call to £3.

The British joint development team continued to work with the rigid housing and by the time the first transatlantic cable between Britain and Canada, CANTAT, was installed in 1961, the problem had been resolved. The solution was a by-pass rope attached to the cable in front of and behind the repeater. The by-pass rope passed through the cable machinery and the repeater was carried past on a trolley. Because of this innovation the British in-line rigid repeater housing became, and still is, the de facto industry standard.

The by-pass rope remained the method for deploying repeaters until the introduction of the Linear Cable Engine (LCE) in 1971. The LCE was developed by the British company, Dowty Boulton Paul Ltd, in collaboration with the GPO and C&W. It comprises a number of pairs of wheels (typically 18) mounted in a line, vertically, above and below the cable. Each wheel has a pneumatic rubber tyre with a concave tread to keep the cable centred. The wheel pairs apply pressure to the cable, while also providing hold-back tension. Each set of wheel pairs can adjust automatically to any change in diameter of the cable and so will open to allow a repeater or joint housing to pass through the LCE, while maintaining the required hold-back tension. The LCE remains the industry's standard cable laying engine on today's cableships.

CANTAT also presented another problem for the rigid housing design. CANTAT was the first system to use in deep water (>1000 m) lightweight (LW) cable that had the strength member in the centre of the cable structure and which had no external protection. Until then, the strength of the cable had always been provided by external armour wires but due to benign nature of the seabed in very deep water, external protection was unnecessary. This design had first been proposed by the GPO in 1951 and it was included in the joint development programme. Prototype cables were successfully manufactured and trialled by SCL and STC in 1956 and 1958 respectively.

At that time, the size of this coaxial cable design was 0.990" (2.51cm) and it was believed that supporting the weight of the repeater housing in the catenary to the seabed would cause excessive strain on the cable or cause cable run-away.

C S *Alert* 'V' Sheave Cable Engine with Repeater By-pass Trough, 1966

Linear Cable Engine

(Courtesy of Alcatel-Lucent)

A method was needed to relieve this additional strain. The answer was to attach parachutes to the repeaters when they were deployed, the theory being that the parachute would open in the water column and bear some of the weight of the repeater during its descent to the seabed. These parachutes, made of silk, were successfully trialled in Loch Fyne in 1960 and were used on all British manufactured repeaters, deployed in deep water, until the introduction of a new, stronger, 1.47" (3.37cm) coaxial cable design in 1968, after which time the practice was abandoned.

The Commonwealth Cable Systems

In June 1958, a Commonwealth Telecommunications Conference was held in London. The main agenda item was how to extend telephonic connectivity around the Commonwealth. The conference recommended that the CANTAT concept should be extended to develop a round-the-world network of large capacity cable systems. The eastern routing suggested was UK, South Africa, East Africa, Colombo (with spurs to Karachi and Bombay), on to Penang (with a spur to Chittagong) and finally, to Australia. The western route would comprise CANTAT, micro-wave across Canada to Vancouver and then by submarine cable to Australia and New Zealand.

In 1959, the Australian Government invited Commonwealth countries to a conference in Sydney, where it was agreed that, on completion of CANTAT, a new system called COMPAC would be laid across the Pacific from Vancouver to Australia and New Zealand. The eastern route was dealt a severe blow when, on 31 May 1961, the Union of South Africa declared itself a republic outside the Commonwealth and withdrew from the project. As a result, nine representatives of Commonwealth countries met in Kuala Lumpur, hosted by the Government of the Federation of Malaya, to discuss a coaxial cable to connect Australia to South East Asia, to be called SEACOM. It was agreed that the project would be jointly funded by the UK, Canada, Australia, the Federation of Malaya, Hong Kong and Singapore. In 1962, these six countries reconvened in Kuala Lumpur, where they agreed their respective contributions and the final routing, which included a landing in Guam, agreement for which was to be obtained by the Australians.

SCL and STC jointly supplied the three Commonwealth subsea telephone cable systems, CANTAT, COMPAC and SEACOM. These all included British designed bidirectional repeaters.

CANTAT: Oban, Scotland, to Corner Brook, Newfoundland, 3,864 kilometres. Cable made by SCL (Greenwich and Erith) and STC (Southampton). Repeaters made by SCL (Greenwich) and STC (North Woolwich). The system was inaugurated by Queen Elizabeth II on 19 December 1961.

COMPAC: Five segments — Vancouver to Port Alberni, 150.28 kilometres; Port Alberni to Keawaula Bay, Oahu 4,723 kilometres; Keawaula Bay to Suva, Fiji 5,701 kilometres; Suva to Auckland, New Zealand 2,337 kilometres; Auckland to

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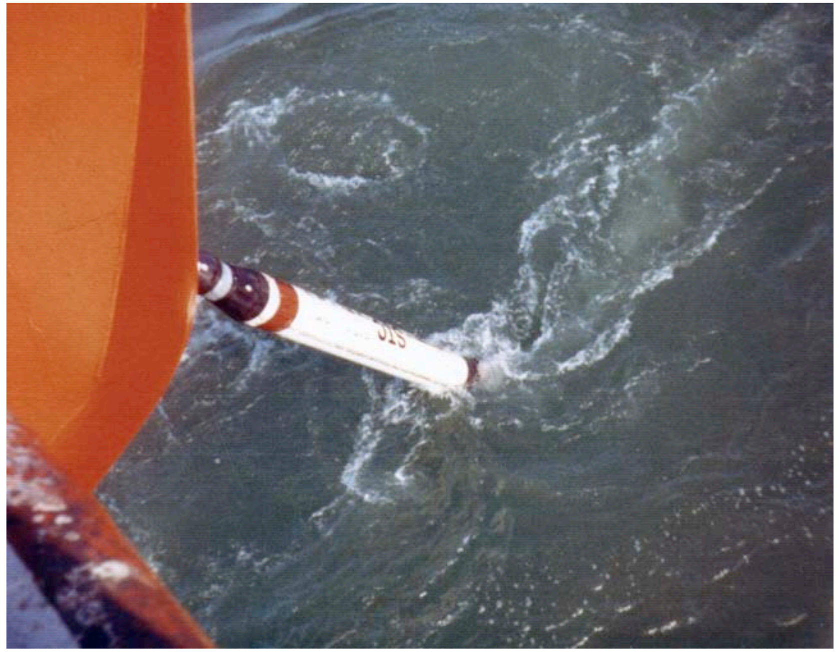
Sydney, Australia 2,361 kilometres. Cable and repeaters made by SCL and STC. The system was inaugurated by Queen Elizabeth II on 2 December 1963. It was described, at the time, as 'the world's largest telecommunications project'.

SEACOM: Five segments, installed in two phases: Phase one: Katong, Singapore to Kota Kinabalu, Malaya 1,608 kilometres; Kota Kinabalu to Deep Water Bay, Hong Kong 2,044 kilometres; Deep Water Bay to Tumon Bay, Guam 3,916 kilometres. Cable and repeaters made by SCL and STC. Phase one was opened to the public on 31 March 1963. Phase two: Cairns, Australia to Madang, Papua New Guinea 2,994 kilometres; Madang to Tumon Bay 2,580 kilometres. Cable and repeaters made by SCL and STC. Repeater spacing 48 kilometres; initial system capacity 160 voice channels, each of three kilohertz, later upgraded to 166 voice channels. The entire SEACOM network was formally inaugurated by Queen Elizabeth II on 31 March 1967.

C S *Mercury* Loading SEACOM at SCL Greenwich, 23 August 1965



STC Repeater being deployed from C S *Alert,* 1974

(Courtesy of Dave Watson)

STC Stands Alone

STC took over SCL in 1970, thus becoming the sole supplier of subsea systems in the UK, and establishing a subsidiary company, STC Submarine Systems, with its headquarters on the Enderby Wharf site. It closed its North Woolwich site in 1976 and during this same period, the SCL factory at Erith was also shut down.

Production of subsea cable on the Greenwich site ceased in 1975, after 124 years, and all cable manufacture was shifted to Southampton. The Greenwich site then focused on marketing, project management, engineering and the manufacture of repeaters, power feed and transmission equipment. The last cableship to be loaded at Greenwich was the C S *John W Mackay.* This was for a system between Cairns, Australia and Port Moresby, Papua New Guinea, called APNG, in 1976.

From 1970, silicon semiconductor transistors began to replace values in repeaters, reducing line current and allowing the design of amplifiers with much wider bandwidth. The voice channel carrying capability of subsea telephone cables was gradually increased and it peaked at 5,680 channels, with the PENCAN 3 system, between mainland Spain and Gran Canaria in the Canary Islands. This system was designed, manufactured and installed by STC Submarine Systems in 1977. Unfortunately, the increase in capacity could only be achieved by bringing the repeaters closer together and so significantly increasing the cost of the systems. For PENCAN 3, repeater spacing had to be reduced to just 2.7nm (5.01km).

Satellite Communications

The launch of communications satellites, Telstar and Relay, in 1962, was the start of real completion for long-distance telephony. Then, in 1963, the first successful geosynchronous communication satellite, Syncom II, was launched. Despite the fact that subsea cables offered a better quality of service, with no perceivable delay or echo and infinitely better security because the signals were not airborne, satellites offered more voice channel capacity and a cheaper service. This put pressure on the subsea cable industry and by the mid-1970s satellite systems had become the dominant service for transoceanic telephony.

In 1964, the US Navy set up the first transit satellite navigation system NAVSAT. Then, in 1973, the US Department of Defense started work on the geostationary satellite Global Positioning System (GPS), and the experimental Block-I GPS satellite was launched. After a Russian SU-15 Interceptor shot down Korean Air Lines Flight 007, on 1 September 1983, US President Reagan announced that GPS would be made available for civilian use, and almost immediately cableships were fitted with GPS receivers.

From the beginning of the telegraph era, the length of subsea cables had been measured in nautical miles; however, the nautical mile is actually a unit of distance that is approximately equivalent to one minute of arc along any meridian. This means it is a slightly different length, depending on the latitude. The nautical mile was and remains in use by navigators worldwide because of its convenience when working with charts. Most nautical charts use the 'North Up' Mercator projection, where the scale varies by roughly a factor of six from the equator to 80° latitudes, so charts covering large areas cannot use a single linear scale. As the nautical mile is nearly equal to a minute of latitude on these charts, a distance measured with dividers can be roughly converted to nautical miles using the chart's latitude scale. For cable manufacture in Britain, the length of a nautical mile had been set at 6,086 feet. By international agreement the nautical mile is now 6,076 feet or 1,852 metres.

With the increased accuracy of ships' positioning through GPS navigation and the introduction of computer-aided chart plotting, the subsea cable industry was forced to abandon the nautical mile as the standard measurement of cable length and replace it with the kilometre.

End of an Era

Despite competition from subsea system manufacturers in France, Japan and the USA, STC Submarine Systems remained the leading supplier of subsea cable systems during the telephone era and supplied the last subsea coaxial telephone system to be installed, India to the United Arab Emirates, in 1986. This marked the end of the Telephone Era.

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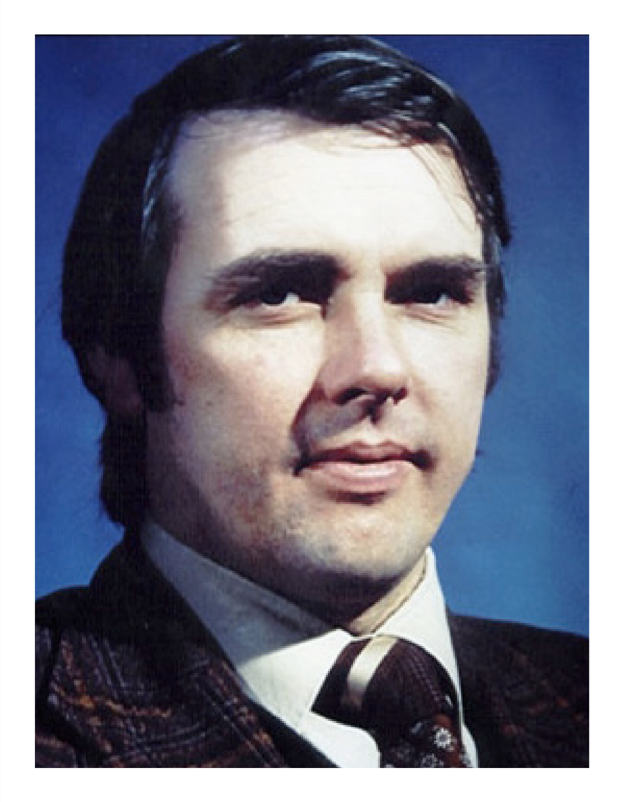
The Optical Era

In 1953, just downstream from Enderby House, Charles Kuen Kao, a young student from Hong Kong, born in Shanghai in 1933, enrolled at Woolwich Polytechnic to study for his A-level exams. He stayed on at Woolwich to take his bachelor's degree in electrical engineering, graduating in 1957. Some years after Kao left, Woolwich Polytechnic became Thames Polytechnic, and in 1992 it became the University of Greenwich. Today, the university's headquarters are at the Old Royal Naval College, just upriver from Enderby House, although the engineering department is at Chatham in Kent.

After graduation from Woolwich Polytechnic, Kao crossed the river to work for STC at its North Woolwich factory, in the microwave division.

A few years later, Loughborough Polytechnic (today, Loughborough University) in Leicestershire offered him a lectureship. However, STC persuaded him to stay within the group by offering him a research position at its R&D centre, Standard Telecommunication Laboratories (STL) in Harlow, Essex.

Theodore Harold Maiman (1927-2007), the American engineer and physicist, was the first



George Hockham

(Courtesy of Alcatel-Lucent)

Charles Kao

(Courtesy of Alcatel-Lucent)

to demonstrate a working (ruby) laser, in 1960. By 1962, the first coherent light emission from a semiconductor laser had been produced by research teams at both General Electric and IBM, in the USA.

At STL, Kao and his colleague, George Alfred Hockham (1938-2013), developed the idea that information could be carried, not as radio waves or by electric currents but in beams of laser light carried down thin fibres of glass.

'A fibre of glassy material constructed in a cladded structure with a core diameter of about λ and an overall diameter of about 100λ represents a practical optical waveguide with important potential as a new form of communication medium … compared with existing co-axial cable and radio systems, this form of waveguide has a large information capacity and possible advantages in basic material cost.'

They published their proposal in 1966, a research paper that started the optical fibre communication revolution.

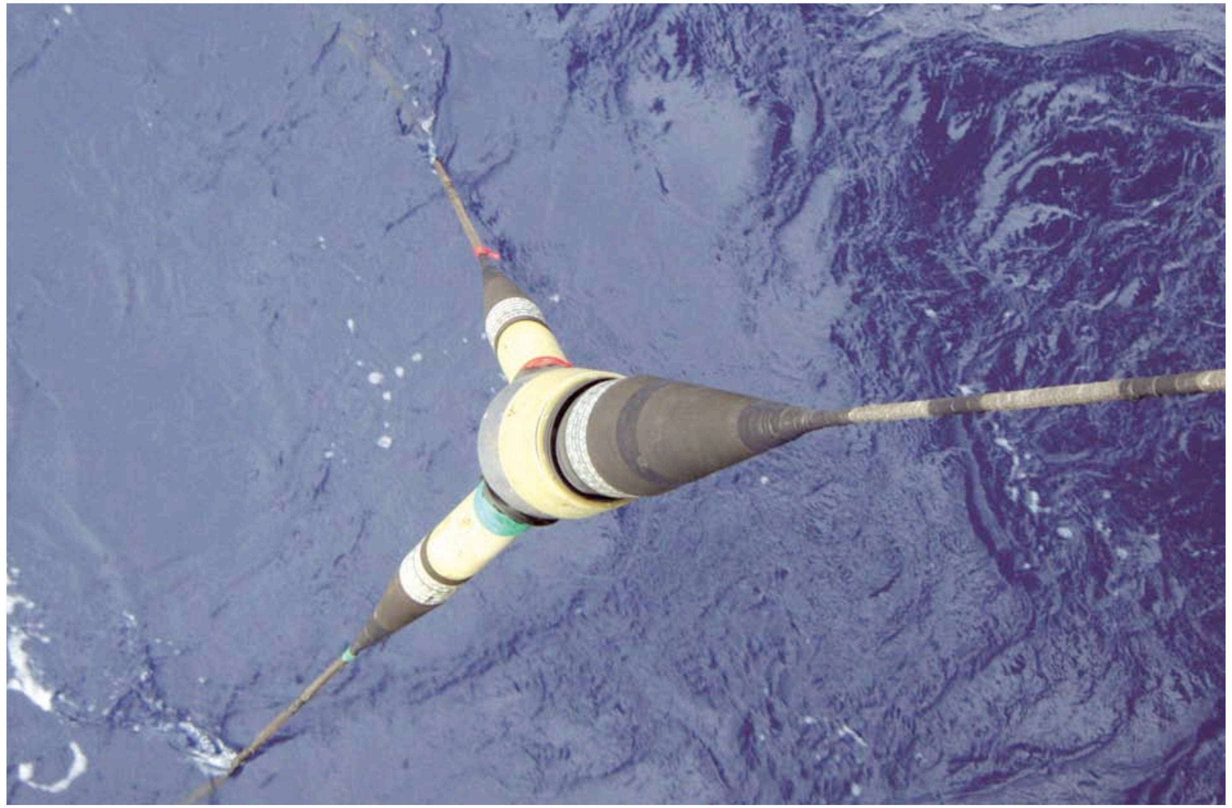
As we will see later, 'large information capacity' proved to be a massive understatement. What Hockham and Kao had established was that the attenuation of glass fibre was not a fundamental property of the material but was caused by impurities. If a sufficient number of these impurities could be removed, then attenuations could be reduced to a few decibels per kilometre or even less. However, this was easier said than done and it was not until the late 1970s that experimental and then commercial terrestrial fibre optic systems went into operation. Development work continued and by 1980, the first sea trial of a fibre optic submarine system containing an optical repeater was conducted by STC in Loch Fyne, Scotland.

Twenty years after Kao and Hockham's pioneering paper, STC supplied the first international, repeatered subsea optical fibre system, UK-Belgium No. 5. This system was 113 kilometres long and contained six optical fibres that provided three separate transmission systems. Fibre optic transmission is unidirectional, so two fibres (a fibre pair) are required for two-way transmission. The system contained three optical repeaters that were manufactured at Greenwich and the cable was manufactured in Southampton.

Unlike previous eras, the manufacturers had set out from the start to develop systems that could cross the deepest oceans, so the subsea cable and repeater designs were already in place for the next step, a system across the Atlantic Ocean. The first

Sea Trial in Loch Fyne

(Courtesy of Alcatel-Lucent)



ASN Branching Unit being deployed

(Courtesy of Alcatel-Lucent)

transatlantic system was TAT-8 and involved a number of new technological challenges. Because two fibres are required for two-way transmission and a cable can contain more than two fibres, it is possible to split transmission paths into different cables. This required a new submerged housing called a branching unit (BU). The BU can separate the fibre paths and also contain switching circuitry to manage the configuration of the system power feed. Later designs of BU now allow individual wavelengths to be extracted from or inserted into the main path from a spur cable. This new BU add/drop technology was first developed by Alcatel Submarine Networks (ASN) for subsea scientific arrays, and is now being deployed for networks to connect offshore oil and gas platforms and is also used in some telecommunications cable systems by both ASN and TE Subcom the US system supplier.

STC went on to be one of the major suppliers of optical subsea systems in the world. This included the UK leg of the first transatlantic fibre optic system, TAT-8, in 1987, and all of the first transatlantic and transpacific private optical systems, PTAT-1 and NPC, in 1988 and 1990 respectively.

The History of STC

STC started life in the UK as Western Electric Ltd in 1883, a wholly-owned subsidiary of Western Electric USA, through the purchase of part of the declining subsea cable factory of W T Henley's in North Woolwich. STC was founded in 1925, when the infant ITT Corporation purchased Western Electric Ltd.

Between 1979 and 1982, as part of its restructuring, ITT sold off all but a minority shareholding in STC and in 1982, STC was launched onto the London stock market as STC plc. In 1987, ITT divested most of its remaining telecommunications businesses by forming a joint venture company named Alcatel, with France's Compagnie Générale d'Electricité. Although STC Submarine Systems continued to be successful, STC plc did not prosper and it was bought, in 1991, by a Canadian company, Northern Telecom - usually abbreviated to Nortel. A few years later in 1994, the subsea systems businesses were brought together again, when Alcatel Alsthom bought STC Submarine Systems from Nortel to form ASN, with its headquarters in Villarceaux, near Paris in France.

ASN closed the Southampton cable factory in 1996, in favour of its Calais cable factory. This brought to an end 146 years of subsea cable manufacture in the UK. However, the Greenwich site was retained for the design, development and manufacture of repeaters, power feed equipment and other subsea network equipment, together with project management and marine services.

Optical System Capacity

The optical era can be subdivided into two technology generations.

First generation optical repeaters operated through a process of detecting the incoming signal and then regenerating it as a new laser light pulse. They initially worked at a transmission wavelength of 1310 nanometres and a digital line rate of 280 megabits per second. By 1990, technology had advanced and the transmission wavelength had moved to 1550 nanometres with a digital line rate of 565 megabits per second, providing 80,000 separate voice channels, each operating at 64 kilobits per second over one fibre pair.

The ability to transmit speech as a digital as opposed to analogue signal is yet another British invention. The technique of sampling voice frequencies and converting them into a digital code was conceived and patented in 1938 by Alec Harley Reeves (1902-71). However, the required circuitry was complex and was not commercially viable until after the invention of the transistor in 1947.

Reeves joined Western Electric Ltd in 1923, thus becoming an STC employee in 1925. After the Second World War, Reeves went to work for STL, initially at Enfield in North London and then at Harlow, where he managed the team led by Hockam and Kao.

This transmission capability was now in excess of the capacity available via satellite and, once again, by the end of the 1980s, subsea cables became the dominant international telecommunications medium. This must have been beyond Hockham and Kao's wildest dreams; but more was to come.

The development of the second generation of optical repeaters can be traced back to 1986, when the erbium-doped fibre amplifier (EDFA) was first demonstrated by Professor David Payne and his team at Southampton University in the UK. In simple terms, the EDFA consists of a length of optical fibre, doped with the rare earth erbium which, when excited by a pump laser, amplifies the incoming transmission signal. The EDFA is much simpler and more reliable than regenerative circuitry and offers direct amplification independent of the signal line rate. It also allows for greater spacing between repeaters, reducing system costs.

From its initial invention, it took several years for Payne's group and a parallel development team at Bell Laboratories in the USA, to produce an

EDFA that could be manufactured in volume with sufficient reliability for subsea repeaters.

The first transatlantic optically amplified systems were TAT-12 and TAT-13, creating a ring network; these systems used a transmission wavelength of 1550 nanometres with a line rate of 5 gigabits per second (5 billion bits of data per second) on two fibre pairs. They went into operation in 1996.

Around this time, the amount of data transmitted on subsea systems began to exceed voice traffic and the convention of expressing system capacity in 64 kilobit voice channels was abandoned.

During early experiments it was found that the EDFA could simultaneously amplify signals at two or more wavelengths, wave division multiplexing (WDM), something that was not possible with the first generation regenerative systems. WDM was quickly developed to offer 16 wavelengths per fibre pair.

The ability to reduce the spacing between wavelengths was then developed for terrestrial systems, giving birth to dense wave division multiplexing (DWDM), which was quickly taken up by the subsea cable industry. This gave suppliers the opportunity to develop and offer systems with even more capacity on a single fibre pair.

Because of the EDFA, the concept of the 'transparent pipe' became popular - the idea that the capacity of a fibre system is limited only by the equipment connected to each end. This is, of course, an over-simplification, as system design is always contingent on current knowledge and the available technology.

All subsea systems were, and still are, designed to have a specific 'design capacity' which is based on the technology available at the time. Generally they are equipped at a lower capacity, allowing for growth over their theoretical 25-year design life. However, in a relatively short timescale, the available capacity on a fibre pair for an optically amplified system had moved from one wavelength (λ) at 5 gigabits per second in the mid-1990s to an industry standard offering of 64λ, each carrying 10 gigabits per second - making 640 gigabits per second - by the year 2000.

The total capacity of a submarine cable is a function of line rate, wavelength, and the number of fibre pairs in the cable. For repeatered systems, the number of fibre pairs is constrained by the number of amplifiers that can be accommodated in the repeater housing and that can be powered through the cable. From its inception, the repeatered system model had been built around a maximum of four fibre pairs per system but, during

ASN Optical Cable Set

(Courtesy of Alcatel-Lucent)

ASN Optical Repeater Being Deployed

(Courtesy of Alcatel-Lucent)

the 'dotcom' boom, design and development was undertaken for six and eight fibre pair repeaters. However, even greater increases in line rates, plus advances in coherent and DWDM technology have rendered these bigger repeaters unnecessary for most modern systems.

Today's subsea cable systems can support more than 100λ, each carrying 10 gigabits per second, multi-wavelengths at 40 gigabits per second, or a combination of the two on a single fibre pair. 100 gigabits technology has already been deployed to upgrade existing systems - and 100 x 100 gigabits per second per fibre pair is now available as a commercial offering for new systems.

Reliability & Cable Burial

Subsea cable systems are designed to work effectively for at least twenty-five years. Extensive research, development and qualification programmes ensure that component failures in the submerged plant are almost unheard of. Therefore, the major threat to subsea cable systems comes from external aggression, whether this is natural or man-made. The risks of cable damage from natural phenomena, such as mobile sea bed sediments, bottom currents, seismic activity, turbidity currents, ice scouring and the like, can be avoided by judicious route selection. The risks of cable damage from anchors and trawls are mitigated again by route selection, as well as cable armouring and most importantly, cable burial.

Since the beginning of the optical era, the burial of submarine systems on continental shelves to protect against external aggression has become ubiquitous. However, in an industry that is over a 160 years old, simultaneous lay and plough burial of cable is a relatively young technology. For the majority of the telegraph and telephony eras, cables were surface laid and external aggression faults were managed by heavy armour cable protection and network diversity.

Although a number of attempts to bury subsea telegraph cables on the UK continental shelf were made in the early part of the 20th century, it is general accepted that the Western Union Telegraph Company was the first to develop a viable, ship-towed cable plough. By the end of the 1930s, Western Union had completed development of its design and concluded that a trench depth of no more than 10 inches (25cm) would be practicable, given the tow forces that would be necessary. In 1938, this plough was deployed from the British cableship *Lord Kelvin* off the coast of Ireland to bury sections of three of Western Union's transatlantic telegraph cables.

Another 20 years were to pass before, due to the number of faults caused by fishing to TAT-1 (1956) and TAT-2 (1959) on the eastern continental shelf of the USA, it became apparent to the system owners that some improved form of protection was necessary. From the early 1960s, Bell Labs, on behalf of the American Telephone & Telegraph Corporation (AT&T), developed a series of plough systems (Sea Plow I to V), which were used in the '60s and '70s to bury AT&T's transoceanic telephone cables. These plough designs owed much to the work of Western Union; they produced an open trench depth of 24 inches (60cm), and could operate to a water depth of 500m.

In the Far East, the first ploughing of a long-haul submarine cable took place in 1976, with the installation of the East China Sea Cable (ECSC). The equipment used was a multi-blade plough, developed by the Japanese Kokusai Denshin Denwa (KDD) group and towed by the cableship KDD Maru. It could achieve a burial depth of 60 - 70 cm, in water depths down to 200 metres.

By the early 1980s, as we have seen, fibre optic technology was promising subsea cable system owners an unheard of increase in traffic carrying capacity. At the same time, commercial fishing was becoming more intensive; trawlers were getting larger and were operating in greater water depths. This combination made system security an increasingly significant consideration. In the UK, British Telecom International (now BT), privatised from the GPO by the Thatcher government in 1981, conducted a thorough investigation into the risks to submarine cables from external aggression in the English Channel, North Sea and on the Atlantic Continental Shelf. The study concluded that:

1. It was uneconomic to bury cable to protect it against anchor faults.

2. Subject to soil strength, a burial depth of 600mm was sufficient to give good protection against all known fishing techniques.

3. Burial should be carried out down to the 1,000m contour.

Based on this study, BT, in collaboration with Soil Machine Dynamics (SMD), developed a new design of ship-towed plough. This plough was successfully sea trialled in early 1986 and was first used to install the historic UK-Belgium No. 5 system that same year. The plough design was a major step forward from the AT&T Sea Plow designs, solving a number of technical drawbacks, such as cable residual tension, catenary management, ability to steer and self-loading/unloading of the cable without cutting it. In the same year, KDDI modified its existing PLOW system, in order to increase its burial depth capability to 1.5 metres.

From 1987, BT Marine and C&W Marine were equipped with SMD ploughs and in 1992, KDDI introduced to its fleet the SMD designed and manufactured PLOW-I. All these companies were then capable of 1 metre burial depth in water depths up to 1,000 metres. By 2000, this British plough design had become the de facto industry standard and remains so today.

Over the last 15 years, through SMD in the UK and companies like Perry Tritech Inc. in the USA, development of plough technology has advanced even further. Today we have 1, 1.5, 2 and 3 metre burial depth ploughs, plus jet assisted and rock ripping ploughs. Ploughing on the edge of continental shelves regularly takes place in water depths of 1,500m and, where seabed conditions allow, ploughing in even greater water depths has been achieved.

Low Latency Routes

Today, the world's oceans are spanned by in excess of 900,000km of operational subsea fibre optic cable systems, which carry over 95% of all international telecommunications traffic. This traffic comprises a mixture of voice, text, pictures, video and commercial data. By far the greatest concentration of this traffic is across the Atlantic between Europe and the Americas.

Advances made in system design capacity through DWDM, combined with the 'dotcom' boom of the late 1990s, led to an unprecedented build of new transatlantic cable systems. The system owners were all chasing an over-optimistic forecast of massive growth in traffic. However, in reality, it was the supply of new capacity and not the demand for it that was spiralling. This meant that, on transatlantic routes, there was significant overcapacity and this drove prices down. The low capacity first-generation systems quickly became uneconomic to operate and were decommissioned. In addition, due to their inability to achieve predicted revenues, a number of the surviving second-generation optically amplified systems changed hands at fire sale prices.

Today, there are seven transatlantic systems in operation, all competing for the available market.

Heavy-Duty Plough Being Deployed

(Courtesy of Alcatel-Lucent)

These are: AC-1 that went into service in 1999, AC-2 [formerly Yellow] in service in 2000, FA-1 North/South [formerly Flag Atlantic] in service in 2001, Hibernia Atlantic [formerly 360 Atlantic] in service in 2001, TAT-14 in service in 2001, TGN in service in 2001 and Apollo North/South in service in 2003.

Although demand has grown steadily in the last decade, no new transatlantic cables have been built since Apollo. This is because of the unused capacity that was already available in the market at the beginning of the century. In addition, the advances in transmission technology since then have enabled the existing systems to first absorb the traffic growth and then be upgraded, well beyond their original design capacity, to accommodate further increase in demand.

Because of the large number of cable systems and the available capacity, the transatlantic market is one of the most competitive in the subsea cable telecommunications industry. Connections between the USA and Europe are critical to financial markets. In particular, fast connections between London and New York are important for a small number (15-20) of banks that engage in 'high frequency trading'. For these companies, a few milliseconds difference in transmission rates can make a huge difference. They will always look for the quickest connection and if one bank has it, then the others must follow; so it is an all-or-nothing market where the customer is prepared to pay a significant premium. Therefore, in this segment of the market, achieving the lowest latency connection between principal global financial centres provides a competitive advantage to the cable owner.

Latency, or round trip delay (RTD), is a measure of the time required to transmit a data packet between two locations and back. Latency is a function of route length and system design. Currently, AC-1 offers the lowest RTD connection across the Atlantic.

With such large data carrying capacity already available on both transatlantic and transpacific routes, the business cases that have emerged for the construction of new cable systems across both these oceans have largely been built on securing this low latency market.

Availability & Reliability

When purchasing capacity on the Atlantic route, for other than high frequency traders, there are a number of aspects besides latency that will have to be taken into account. For these buyers, price will always be a primary consideration; however, availability/reliability will probably be the other significant decision factor. The fault history of a system will be a major concern, as disruption of the service, if too great, will require a high level of investment in restoration capacity on other transatlantic cable systems; but more importantly, interruptions to service could alienate customers who have the option of going elsewhere for their service. Across the Atlantic, the fault history of Apollo, supplied by ASN, stands head and shoulders above the competition, having had only one fault in ten years on each of its two cables. This is set against a global industry average, for a single cable, of one fault every 2.5 years.

Industry Consolidation

In a further reorganisation of the telecommunications manufacturing industry in 2006, Alcatel merged with US company Lucent, and ASN became part of Alcatel-Lucent, today one of the world's five big makers of equipment and systems for telecommunications networks. Three, including Alcatel-Lucent, are European and two are Chinese. ASN is one of only three turnkey suppliers of subsea systems in the world; the others are NEC in Japan and TE Subcom in the USA, although NEC does not have its own in-house marine installation capability. Subsea fibre optic telecommunications cable is now only manufactured by ASN in France, Hexatronic in Sweden, Nexans in Norway, Norddeutsche SeekabelWerke (NSW) in Germany, OCC for NEC in Japan and TE Subcom in the USA. The major manufacturers of repeaters and BUs are ASN at Greenwich, NEC and Fujitsu in Japan and TE Subcom in the USA.

The Riverfront Refurbishment

In 1995, £230 million was allocated by Central Government to London as part of its Regeneration Challenge Fund, aimed at creating and safeguarding some 40,000 jobs and generating 2,400 new businesses. Forty-one local authorities and organisations received grants; amongst these was an £8,175,000 award to Groundwork Trust in London's 'Vital Centres and Green Links' programme. Perhaps better known as a Single Regeneration Budget (SRB) programme, it was a tripartite programme encouraging local authorities, businesses and community organisations to work together to deliver a variety of projects.

In 1999, The Deptford Discovery Team (TDDT), commissioned by Groundwork Trust, produced the 'Green Links Initiative Report for the East Greenwich Industrial Waterfront'. The report identified a portfolio of environmental and artistic interventions along the industrial waterfront to provide a programme of public space and access improvements. This included the renovation of disused piers, foreshore ecological clean-up activities, conservation and interpretation of Greenwich's industrial heritage, including some new innovations. It was planned that the programme would be delivered in partnership, initially between Groundwork Thames Gateway London South (GTLS), Amylum UK Ltd, ASN and TDDT. It was subsequently expanded to include Greenwich Council, The Environment Agency, and Thames 21.

Projects relating to the Enderby riverfront included the development of the main Enderby Wharf jetty as a public open space with information panels, the retention of the cable winding gear, display of a subsea repeater and seating. The adjacent Enderby steps and causeway had originally been used to ferry personnel between the shore and the cable ships. These cable ships were moored to dolphins (now removed) that were set in deeper water to the side of the main traffic channel of the River Thames. The steps and causeway were restored, providing safe pedestrian access to the beach at low tide and as a visual account of the history of the industrial Greenwich peninsula.

The Enderby Steps refurbishment was an initiative of Greenwich Mural Workshop (GMW), originally conceived as a permanent marker for their *'Hysterical Walk'* event, along the East Greenwich path, in December 1999. It was presented as part of the Greenwich Arts Forum's 'In the Meantime' project, a programme of art projects in the lead-up to the Millennium celebrations.

Enderby House c.1999

(Courtesy of Alcatel-Lucent)

Steps and Causeway at Enderby Wharf, 2001

(Courtesy of Carol Kenna)

Due to restricted funds for the Millennium projects, the Enderby Steps refurbishment was temporarily shelved and then proposed to GTLS, in July 2000, as a stand-alone project to sit within their wider East Greenwich waterfront programme. The funds for the project were awarded by GTLS in early 2001. Replacement steps were carved, installed and the project was completed by June 2001.

GMW commissioned Deptford-based sculptor, Richard Lawrence, to undertake the carving and installation of the new steps. Following research aided by Alcatel, consultation with local people, Dr. Mary Mills and Carol Kenna, Richard Lawrence produced designs that were agreed by the East Greenwich Steering Group. Richard undertook the carving in his studio and the installation on site.

The 29 new steps and 25 replacement supports were constructed from Opepe wood, an African hardwood chosen to withstand the strictures of Thames tides. The project restored pedestrian access to the beach and created a new relationship with the river. The carvings made reference to the various industries that have existed on Greenwich peninsula, from the early farming of reeds for basket making through to the development of rope manufacture, iron and steel cable production, and the 160+ years of the subsea telecommunications industry's tenure.

In September 2002, a number of projects that had been identified in the 1999 TDDT report had been achieved and were highlighted in Jonathan Cook's report, *East Greenwich Waterfront Recent Environmental Improvements*, together with a programme of future activities. Completed projects included a ceramic mural along the boundary wall of Greenwich Power station, a metal wave mural along the side wall, a garden and seating in front of ASN's river boundary, the restoration of the corner gardens adjacent to Primrose Pier, reed beds established alongside the pier, some foreshore cleanup and graffiti removal. This report was publicly launched in March 2003 at a celebration of the completed projects, held on Enderby Wharf jetty.

Twelve additional projects were identified as suitable for public consultation. It was considered that these could be achieved within the final two years of the programme and completed by 2005. Key projects included the installation of a lit Zero Meridian line, development of Dead Dog Bay/ Parish Dock as an ecological site, the restoration of Bendish Sluice and the creation of a River Warden.

Changes in the ownership of the riverfront properties, previously owned by ASN and Amylum UK Ltd at Enderby and Morden Wharves, have restricted the steering group's ability to move these

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projects forward. Although it was believed that the steering group should maintain its presence as the champions of the East Greenwich riverfront, this has been difficult to achieve and attention gradually moved away from these sites, and the proposed projects.

Cable Machinery at Enderby Wharf, 2004

View of Enderby House in May 2014

Enderby House is Sold

Two years after the merger between Alcatel and Lucent, ASN sold the waterfront real estate at Greenwich — including Enderby House — to a property developer, West Properties. This reduced the ASN facility to an approximately 5 acres (2.023 hectares) site. However, ASN retained responsibility for the two jetties, the refurbished steps and causeway, in front of Enderby House, under its licences with the Port of London Authority.

Due to the global recession, which also started in 2008, West Properties went into administration. It is understood that the debt was initially picked up by the Irish government before the land was sold to a fund managed by Morgan Stanley Real Estate Investing. A 50-50 joint venture between Morgan Stanley and UK property company, Barratt Developments, to redevelop the site was announced in July 2013.

Unfortunately, between 2008 and 2013 significant damage was done to Enderby House. Thieves stole all the lead from the roof and apparently lived in Enderby House, while they stripped out all the wiring from the other buildings on the rest of the site, for its copper content. Since Barratt has been in control of the site, it has been mindful of its responsibilities to the Grade II listed building. It has made it waterproof and is now working on drying out the interior.

Barratt makes a point of stressing the importance of Enderby House, as part of its development plans for the site, in its press releases. This is encouraging, although detailed plans have yet to be forthcoming.

Alcatel-Lucent Submarine Networks Today

ASN and its predecessors have been associated with major subsea cable systems since before the world's first transatlantic cable was armoured on the Enderby Wharf site, in 1857-58. The remaining site currently houses modern production and clean room facilities for the manufacture of repeaters, BUs and power feeding equipment. It also contains office facilities for project management and marine operations teams.

ASN is currently in the process of redeveloping the site in collaboration with the Cathedral Group. Cathedral is also the company that is redeveloping the adjacent 19 acre (7.689 hectares) Morden Wharf site. Under this arrangement, the ASN facility will be further consolidated into 3 acres (1.214 hectares). The work will comprise refurbishment and modernisation of the business workspace, while giving a facelift to the exterior of the existing buildings. On the remaining 2 acres (0.809 hectares), Cathedral will carry out a regeneration project that is called the 'Telegraph Works'. This will be a mixed usage development, involving the construction of 272 new homes, a series of play spaces, commercial units and a new public realm.

Through leveraging its heritage as a pioneer and an innovator in subsea cable systems, ASN continues to set new standards in system performance and reliability. It is proud of its long history and is committed to maintaining in-house manufacturing on the Greenwich peninsula, as is confirmed by this investment in the modernisation of the Greenwich site.

The Future of Enderby House

Though not an architectural masterpiece, Enderby House is of significant local historical importance. It became a Grade II listed building in June 1973 and is the only building on the riverfront site that has survived the re-development. It has one unique architectural feature and that is the first floor Octagon Room, where Charles Enderby used to entertain members of the Geographical Society and other distinguished guests at dinner parties. It then became a board room where many major decisions, concerning subsea telegraph cable systems, must have been made over a period of more than 150 years.

Charles Enderby, for whom the house was built, only lived in it for three years. His family did live in the Greenwich area for almost 100 years and went from rags to riches and back to rags in three generations. Their association with Enderby Wharf spanned 27 years, during which time they brought a large number of jobs to the local population. Latterly, Enderby House was a prominent landmark on the site of the world's leading subsea cable system manufacture for over 150 years.

The ASN site behind Enderby House is the oldest subsea system manufacturing site in the world and the last remaining in the UK, an industry that the British dominated for over 130 years. It is almost certainly the oldest continuously operating telecommunications factory of any kind in the world.

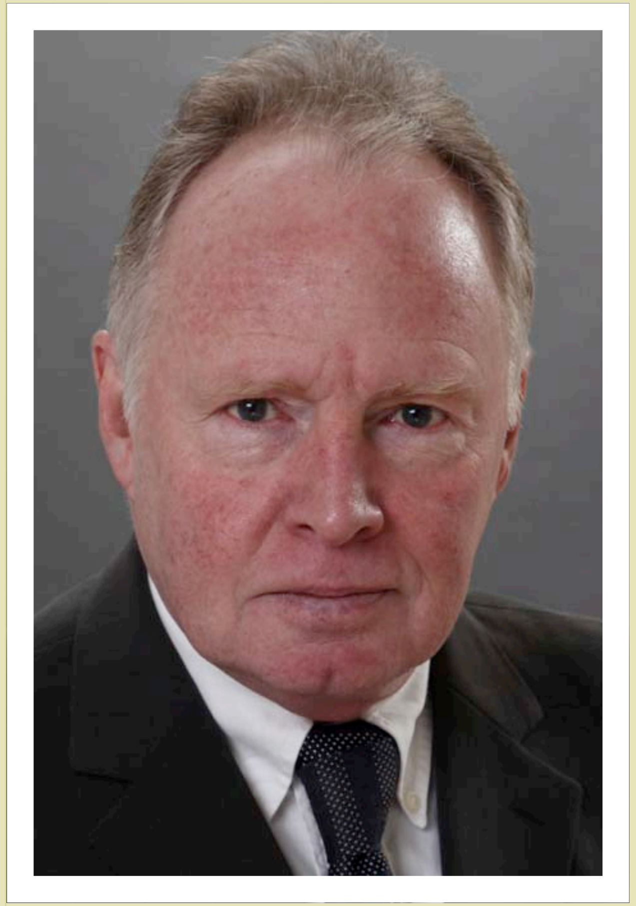
Most people today consider internet access to be a right and the economies of many countries are virtually dependent upon it. Therefore, the subsea fibre optic cable systems that enable global internet access – including the history, heritage and future of this industry in the UK – must be worthy of recognition, preservation and celebration. The Enderby Group believes it is a story worthy of telling and where better to do so than on the site that has been linked with it for over 150 years?

With this in mind, the Enderby Group has been formed with the objective of saving Enderby House for posterity and providing it with a sustainable future. Over the last few months the Enderby Group has been in consultation with ASN, Barratt, Cathedral, Morgan Stanley and Westcourt, the company that is building the Cruise Liner Terminal that will sit alongside Enderby House. These discussions have informed the development of a presentation package, entitled the 'Greenwich Telecommunications Heritage

The Octagon Room c 1999

(Courtesy of Alcatel-Lucent)

Centre', to showcase our vision and better explain our ideas for the regeneration of Enderby House and its environs. The Enderby Group is currently developing a business plan to present to Barratt, Morgan Stanley and other interested parties to attract investors and other potential sources of funding.



About the Author

Stewart Ash is an independent consultant who now specialises in assisting oil and gas companies in the design and procurement of subsea systems for offshore facilities. His career in subsea systems spans 45 years, working first for STC Submarine Systems, then Cable & Wireless Marine and Global Marine Submarine Systems Ltd, before setting up his consultancy in 2005. From 1976 to 1993, he worked on the Enderby Wharf site. In 2000, he co-wrote and edited a book on the first 150 years of the submarine cable industry, *From Elektron to 'e' Commerce*. He also wrote Chapter 1: *The Development of Submarine Cables* of the ICPC sponsored book, *Submarine Cables, The Handbook of Law and Policy,* published in 2013. Stewart writes a bi-monthly article on the history of the subsea cable industry for SubTel Forum http://subtelforum.com/articles/. He has written a companion booklet to this called ***The Eponymous Enderbys of Greenwich***

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