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Port Development and Technical Change C.1700-1900. Outline Summary
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PORT DEVELOPMENT AND TECHNICAL CHANGE C.1700-1900 – OUTLINE SUMMARY

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A number of modern dock engineers have been interested in the history of early harbour works since the Ancient Cretans and Egyptians built them c. 6,000-5,000 BC, and much is known of their construction, on river-banks (in Egypt, with the Nile) and seashores (on Crete, which had no serviceable rivers).[2] For the first millennium A.D. economic life in Northern Europe was simple, and raiding and folk-migration was perhaps more common than trading. Mediæval ports were still, on the whole, simple constructions on river-banks or bays. Their working areas were quays of wood or stone, with storage and living space behind the quays, the whole sheltered by walls to protect the valuable goods inside from marauders outside. Vessels were still small, and any increase in numbers was accommodated by extending quays, doubling or trebling vessels moored parallel to quays, or presenting them end-on. Mixed cargo was usually in bales or barrels – the ship ton was the space occupied by a 'tun' – and handling was a matter of simple cranes and strong muscles, often those of the crew. With few – and dangerous – roads, goods were best received and despatched by inland waterways, often the rivers on which ports were located.

Although some favoured ports expanded with pressure of business, it was not until international developments in oceanic trade and shipping in the sixteenth and seventeenth centuries that facilities in old ports were seriously stretched, and some new ones appeared, especially, in Britain, for the mineral trades. In the general commercial ports lengthening the water-site was often impossible. In Britain the solution was to expand the water area into the land area by building wet docks. Docks were not unknown. The alternative to shipbuilding and repairing on a tidal shore or riverside was a *dry* dock, which many ports had, especially London, with its congested river. However, constructing deep *wet* docks, requiring substantial walls and double lock gates (to accept tidal variations and avoid water loss), was more difficult, depended on the ability of engineers to enclose water. This probably owed more to naval than to mercantile demands. Naval dockyards grew in the seventeenth century as seaboard nations took their battles to sea, and several British docks were subsidized at various times if they

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2 See, for instance, Sir C.R.S.Kirkpatrick 'The Development of harbour and dock engineering' and Sir L.H. Saville, 'Presidential Address to the Institution of Civil Engineers 1925-6', both reprinted in A Jarvis (ed.), Port and Harbour Engineering (Ashgate, Aldershot, 1998), numbers 1 (pp.1-44) & 2 (pp.45-74). Jarvis' collection is the best source for a diversity of British, Continental and imperial port works in all periods.

could accommodate battleships. Another source of expertise was bridge-building for which the sinking of water-proof caissons was an essential art, while others came from various backgrounds: Swann lists eight 'engineers' known to be active in England between 1660 and 1700, including Sir Christopher Wren, better known for building St Paul's Cathedral.[3]

The first recognizable dock in Britain appears to have been London's 'Howland Great Wet Dock', a landowner speculation designed and supervised by a local shipbuilder, John Wells,[4] possibly with Thomas Steers as assistant. Interestingly, it was built by the same noble family (Earls/Dukes of Bedford) who had employed the Dutchman Cornelius Vermyuden to drain the Bedford levels in the East Anglian fens, and was intended to shelter ships, not handle cargoes, which still passed over the city's river quays around the Custom House.

The first British commercial dock to handle both ships and cargo was built in Liverpool, a small creek on the Mersey estuary which was turned into a wet dock around 1715 when Thomas Steers designed a water-encroaching sea wall and lock. With the growth of Lancashire trade two more docks followed, and the gated dock appeared firmly established. All subsequent Liverpool docks were water-encroaching, but most harbour work elsewhere involved the construction of piers and quays in sheltered mineral ports, and when congestion hit Bristol the first (unsuccessful) reaction was to build an up-river dock for *empty* ships. The same thing was nearly true of Hull, when industrialization in its huge hinterland brought chaos to its Haven (the mouth of the river Hull) around 1750 and a dock for empty ships was envisaged, to protect the value of Haven-side quays. It was the British Treasury which forced the issue by offering to subsidize a dock containing Legal quays for Customs Business and able to shelter a battleship.[5]

Hull's first commercial dock was the largest so far constructed in Britain. Its engineer, Henry Berry, trained by Steers and now Liverpool's dock engineer, used crushed Pozzellana stone in the mortar which produced unusually stable walls on relatively poor foundations.[6] Berry had no experience of its use, and obtained the recipe from John Smeaton, well known in Hull for building a steam-powered oil mill, and an interesting example of dock engineers passing information between themselves; indeed one could almost construct a genealogical table of engineers and knowledge was gained through apprenticeship and 'Resident Engineer' posts. However, the dock was still an up-river one, to the north of the Haven, and with the Industrial Revolution in full swing it was too small before it opened. Moreover, Hull soon found it had made a serious mistake which haunted the place for a century. The traditional control of the port by the City Council ended with the creation of a private monopoly company regarding its income as reward for building the dock and refusing to build any more. Private enterprise was not usually the best way of securing port interests. In fact the Hull company was again

3 D. Swann, 'The engineers of English Port Improvements, 1660-1830', in *Transport History*, vol.I, No.2, pp.153-168, and No.3, pp.260-276. Kirkpatrick refers to British, French and Italian harbour and dock engineers op.cit.

4 Ibid, p.157. The name of Sorrocold is associated with Howland, but no evidence supports this.

5 Hull was the only port exempt from a 1559 Act of Parliament (I Elizabeth, c.II) establishing Legal Quays.

6 Wooden Piles in Hull could not reach rock bottom.

subsidized to produce two more docks, but the problem remained: there was a struggle every time fresh works were required.[7]

There was one final problem to be solved before docks were the ready answer to British ports' problems: how to overcome the silt or sand which besieged or invaded many of them. John Rennie was the first engineer known to solve the problem, firstly by introducing steam dredgers in Hull and Grimsby and secondly by building a 'floating lock' for the new dock in Grimsby in the 1790s. Based on deep mud this was anchored by very elaborate piling and the stone walls were hollow (part of the arcading is still visible!).[8] Rennie later built a lock on the Humber at Hull, again on mud, and the way was now clear for the heavily silted ports to build sea-locks, though in truth there were few of them on the muddy east coast, and river ports such as Bristol and London were more easily served. South and West coast ports were more likely to find rocky foundations.

By 1830 most of the major ports had acquired docks of medium size with locks for the standard ship up to *c.*400 tons. But already ports were discovering that advances in dock engineering had been overtaken by advances in mechanical engineering. Steam had been applied extensively to cotton factories and forges, and the result was accelerating trade and increasing shipping. The logical way forward was for mechanical engineers to adapt steam engines to shipping. This happened in both London and Glasgow, though Glasgow's first attempt, which steamed down the Clyde in 1812, was rapidly followed by a fleet of coastal vessels increasing in size and power until by the 1840s the port was turning out transatlantic steamers for what became Cunard, and the Clydeside steam-shipbuilding industry was already flourishing.

The advantages of paddle-steamships for traders were soon outweighed by their disadvantages for dock engineers: they were too wide for existing locks and for manoeuvring in docks full of sailing vessels.[9] Valued for speed, owners demanded fast turn-round at wide quays with adjacent water and coal supplies. Coasters in Glasgow city harbour arrived every half-hour and expected to turn-round in the same time. [10] Its new steamship harbour was soon followed elsewhere by steamship locks, then steamship docks in the 1830s and 1840s — just in time to be overtaken once more by mechanical engineers. Steam had revolutionized sea-born movements; now it was the turn of inland trade to be revolutionized by steam. Hinterlands were changed; new trades developed, especially in minerals which demanded bulk-loading facilities. Unwieldy goods could now be transported and required open quays. Worst of all was fitting railway lines round square docks, especially when transit sheds with rail access and upward movement to railway warehouses were preferred to old-fashioned warehousing. Railway docks and feeder systems of various size and complexity now appeared in almost

7 The sordid details are in G. Jackson, *Hull in the Eighteenth Century* (London, 1972), chap. X, and Jackson, 'Shipowners and private dock companies: the case of Hull, 1770-1970, in L.M. Akveld & J.R. Bruijn, *Shipping Companies and Authorities in the 19th & 20th centuries* (Amsterdam, 1989), pp.47-61.

8 For Grimsby lock, see *Grimsby & the Haven Company, 1796-1846* (Grimsby, 1971), chap. 2.

9 Steamship owners in Aberdeen voted against a gated dock there because it took too long to get into and out of docks.

10 Glasgow had no gated docks: the Clyde had been canalized in the late C18th, so the chief problem was the separation of sail and steam in the city-centre harbour. See G. Jackson & C. Munn, 'Trade, commerce and finance' in W.H. Fraser & I Maver (eds), *Glasgow, Volume II: 1830-1912* (Manchester, 1996), chapter 2.

every port, and new works increased the size of the ports' water sites. In fact the work was partly wasted, since the early steamers were very quickly overtaken by larger iron square-section steamers which were not worried by paddles but were too long and deep for many of the old locks. The next generation of docks were therefore deeper, wider (to permit manoeuvring of larger vessels), and equipped with much bigger locks. This in turn demanded not only more work for the docks engineers in providing deeper walls and bigger locks, but the involvement of mechanical engineers. Steam at sea and on land only worked with the medium of hydraulic power in the ports. Perfected by W.G. Armstrong in the 1840s, hydraulic power facilitated very large lock gates (and therefore deeper docks) and the first really effective heavy duty cranes, which enabled the export of further products of the mechanical engineers - steam tractors, locomotives, and even 'tin tabernacles' - to the New World, and powered the coal hoists supplying coal to both the New and Old Worlds.

Although the developing railway network around mid-century served the established ports, rivalry between railway companies for inland traffic encouraged the latecomers to avoid ports already served by rivals and at the same time avoid the problems of inserting railways into established ports by building their own Railway Ports, especially for coal exports. However, one of the first, Grimsby, a decayed port, was built by the Manchester, Sheffield and Great Grimsby Junction Railway to divert goods from one of the great industrial areas away from the port of Hull and ensure greater activity for its own lines. Birkenhead, on the Mersey was also a railway creation, to divert trade from Liverpool.

This combination of ever larger steamers and docks, and the expanding railway network was also important for enabling the changing scale and nature of industry as the 'Second Industrial Revolution' introduced the 'heavy industries', dependent on coal and metals, which joined textiles as the foundation of the international trades of the British ports, and played an important part in the opening up of the new lands of the British empire and also the vast expanses of the USA and South America.

Inevitably, the growing pressure of trade growth and advances in nautical engineering such as the Froude Model Ship Tank, which, with elaborate mathematics, allowed him to predict the performance of full sized vessels from models, thus encouraging changes in the size and shape of steamships.[11] With the emergence of very large steel vessels in the 1880s the ports were once again required to improve their facilities in terms of lock size and water depth. When Hull's version was opened its triumphant telegraphic address was 'Deep Dock Hull'. Ports now competed for the larger vessels – especially the Cunarders and other passenger liners – though in truth their chief cargo was usually coal. With the economic development of Australia, New Zealand, USA and Argentina the ports were now required to invest in refrigerated warehouses, vast granaries, and, for a time, special facilities for the handling of live animals before refrigerated vessels became widely available in the 1880s and 1890s. But above all, the major ports were forced to start work on yet another set of even bigger and deeper docks. Not only were they hugely expensive; they also took years to build, and most if not all of them enjoyed little active life before the Great War of 1914-18 undermined the inter-

11 The Denny version of this important tank is preserved (and operating) as a Museum in Dumbarton on the Clyde.

national trades for which they had been built, and the industries of their hinterlands began to decline. Many ports found themselves with very large debts to cover work which had failed to earn its keep. Most ports marked time until WWII introduced new and more economical working of vessels (copied from methods used to ship war supplies from the USA), with Ro/Ro, Containerization and Bulk carriers, vessels demanding a new set of very deep water quays and no docks, while globalization meant that computerized vessels would only call at a handful of select ports, which would then distribute or collect goods by smaller vessels calling at the once great ports which are busy converting their dock areas to 'land-sea interfaces' where the only trade is in 'fast food' and souvenirs.

For most of the history of European ports the chief worry was how to shelter relatively small vessels from a hostile coastal environment, and the chief skills required were the selection of suitable bays or harbours and the erection of simple quays and piers that did not fall off their rock foundation or sink into mud. Only rarely did the change in the structure of vessels cause much trouble for what would now be called civil or dock engineers. Despite changes in trade, tensions in Britain between the work of an assortment of engineers arose because of a wide range of advances around the middle of the eighteenth century. While the inventors and innovators in the textile, metals, chemicals and mineral extraction industries are generally remembered by economic historians, little attention has been paid to the impact of these innovations on the transport sector, and the interlocking reactions of nautical, dock, mechanical and railway engineering has generally been ignored. It is time that port historians redressed the balance a little, away from the easy veneration of well-known names to the work of engineers who more or less invented their wide-ranging professional skills without which the Industrial Revolution would have been a short-lived affair.:::