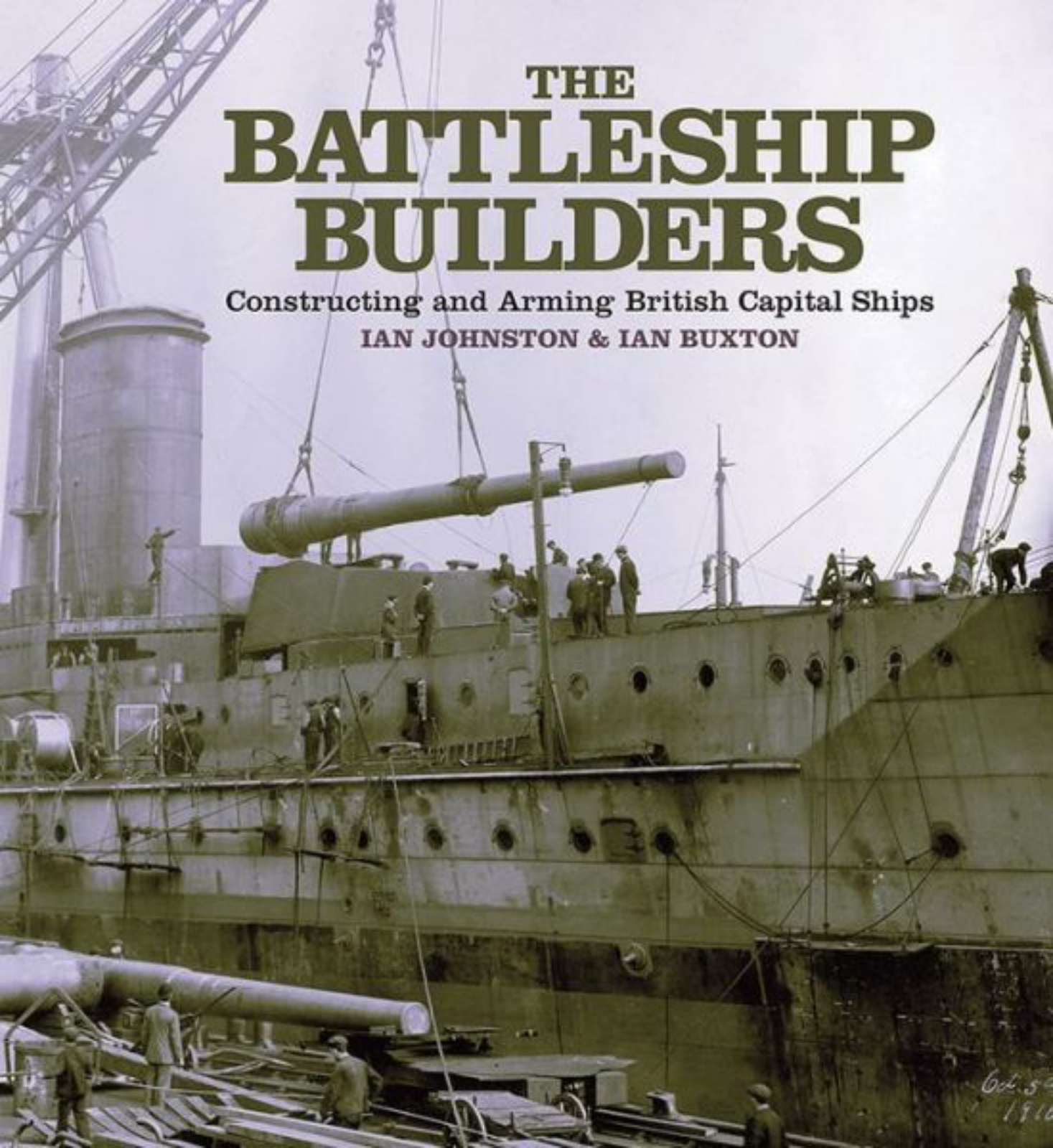
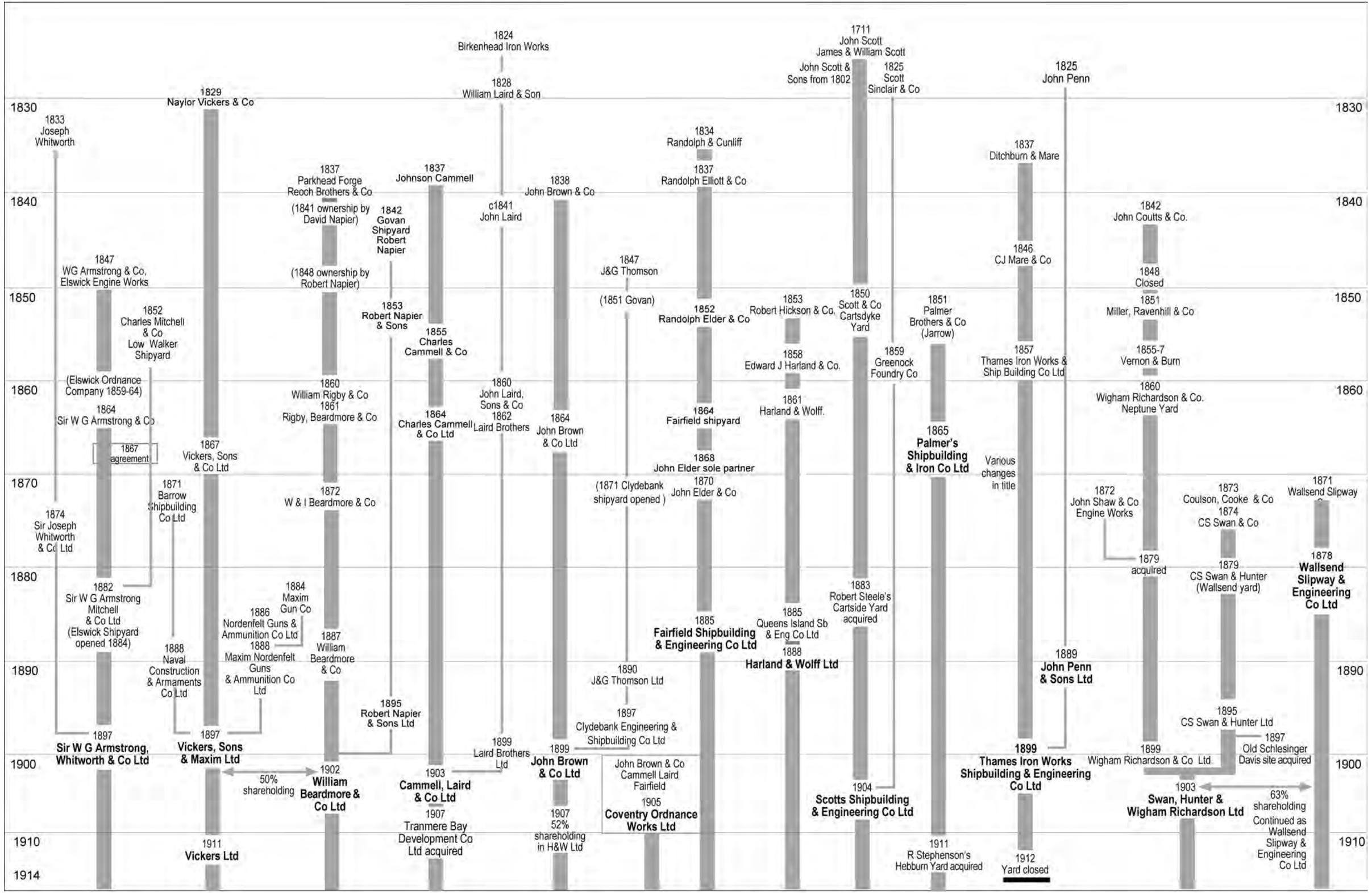


THE BATTLESHIP BUILDERS

Constructing and Arming British Capital Ships

IAN JOHNSTON & IAN BUXTON

THE BATTLESHIP BUILDERS. The development of the firms associated with battleship construction until the First World War.



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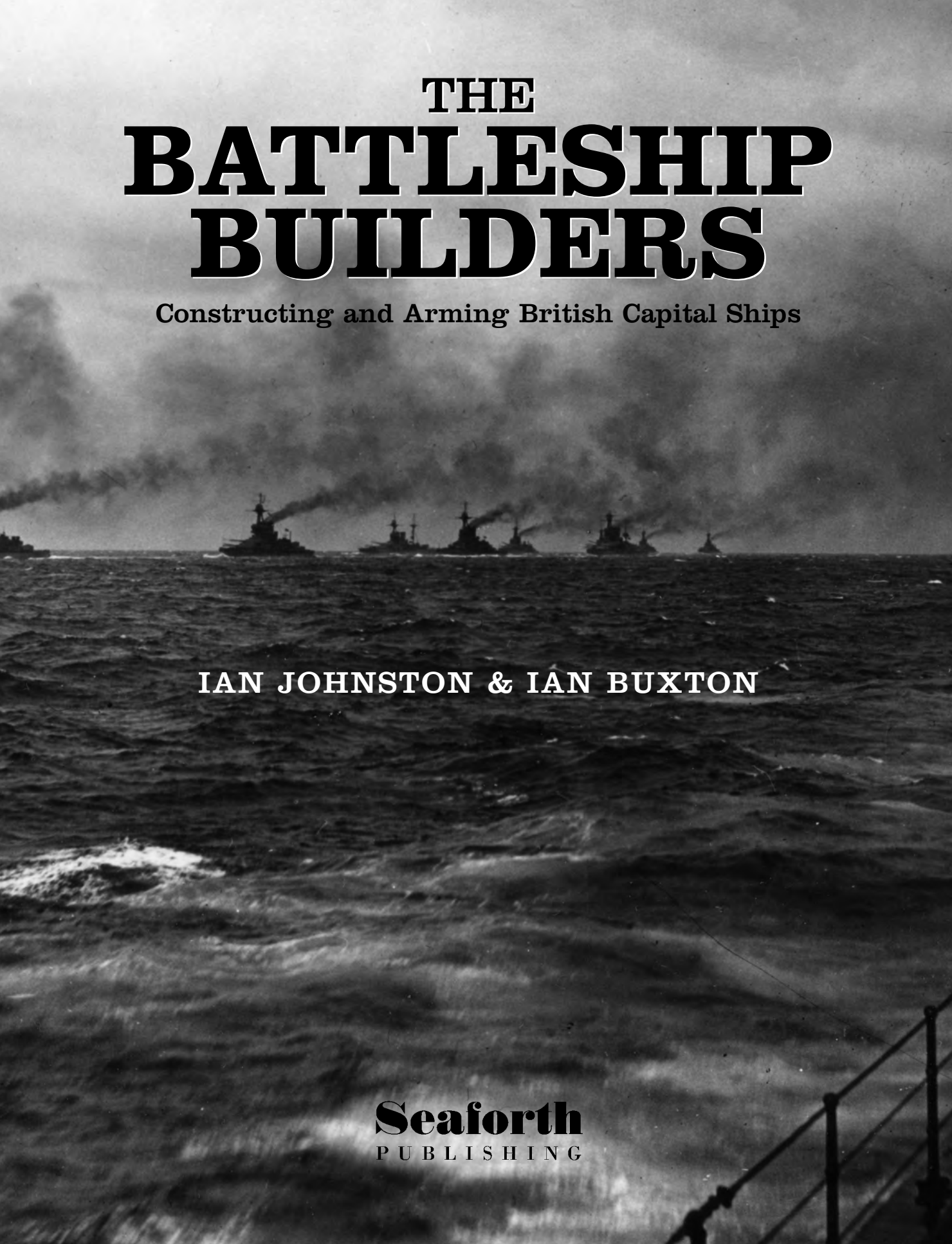

THE BATTLESHIP BUILDERS

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Abbreviations

ADM	Admiralty series files at The National Archives
AEW	Admiralty Experiment Works, Haslar
AFCT	Admiralty Fire Control Table
APC	armour piercing, capped (projectile)
ASI	Admiralty Supply Items
B&W	Babcock & Wilcox (boilers)
BISCO	British Iron & Steel Corporation
BL	breech loading (gun)
BTU	British Thermal Unit
C	cemented (armour)
cal	calibres
CO	Commanding Officer
COW	Coventry Ordnance Works
CPC	common pointed, capped (projectile)
crh	calibres radius of head (projectile head shape)
DNC	Director of Naval Construction
DNO	Director of Naval Ordnance
efc	effective full charge (gun life)
E-in-C	Engineer in Chief
EOC	Elswick Ordnance Company
ESC	English Steel Corporation
grt	gross registered tons (merchant ships)
H & W	Harland & Wolff
HA	high angle
HA/LA	high angle/low angle (dual purpose gun)
HE	high explosive (projectile)
hp	horsepower
HP	high pressure (cylinder/turbine)
HT	high tensile (steel)
ihp	indicated horsepower (steam reciprocating engines)
IWM	Imperial War Museum
KC	Krupp Cemented (armour)
KCB	Knight Commander of the Bath
KNC	Krupp Non-Cemented (armour)
lb	pound (weight)
LP	low pressure (cylinder/turbine)
MD	Modified (Cordite)
MI	Metal Industries Ltd
MP	medium pressure (cylinder)
NC	non-cemented (armour)
NCA	Naval Construction & Armaments Co Ltd
NMM	National Maritime Museum
NRS	Navy Records Society
NSS	National Shipbuilders Security Ltd
P	pedestal (mounting)
pdr	pounder (gun)
QF	quick firing (gun)
R&D	Research & Development
RGF	Royal Gun Factory (Woolwich)
RN	Royal Navy
RNTF	Royal Naval Torpedo Factory
ROF	Royal Ordnance Factory
rpg	rounds per gun
rpm	revolutions per minute
SC	Solventless Carbamite (Cordite)
SEF	Shipbuilding Employers Federation
shp	shaft horsepower (steam turbines)
SHWR	Swan Hunter & Wigham Richardson Ltd
STAAG	Stabilised Tachymetric Anti-Aircraft Gun
TIW	Thames Iron Works
TNT	Tri-nitro-toluene (high explosive)
V-A	Vickers-Armstrongs Ltd

PREFACE

THE BATTLESHIP WAS FOR LONG considered to be the ultimate weapon of war at sea until technological change rendered the type obsolete. Throughout a century of development, the British Admiralty was responsible for most of the major as well as incremental design iterations of the battleship, notably *Dreadnought* with her all big gun armament and turbine machinery. Britain also constructed more battleships than any other nation and was substantially more dependent on them than any other nation for the defence of the homeland and empire. Although several battleships have survived until the present day, most notably in the USA, not one example of a British battleship survived after 1960. Some compensation for this can be found in the voluminous library of books on the design and operational histories of battleships, an output which shows no sign of stopping. However, none of these books address in any detail the great industrial infrastructure required to build, power, arm and protect these ships. While some economic historians have addressed companies building battleships, such as Vickers and Armstrong, they have understandably concentrated on business aspects rather than manufacturing.

The point driving the production of this work is that the industries that produced these ships have all but disappeared and potentially a remarkable record of achievement with them. These industries employed hundreds of thousands of people in a myriad of concerns big and small in locations spread across the UK. Often household names, these firms were as essential to the defence of the realm as the battleships themselves.

The rapid de-industrialisation of Britain since the 1960s swept all before it and only a few of these industrial sites remain although now in different ownership. The dismantling of individual companies is often an ill-conceived process and many of these companies have sunk almost without trace, at least in the sense that the records describing their activities and achievements that have survived are scant, with very little for notable firms such as Thames Iron Works and Palmers. However, new information, as for example at the Vickers archives in Sheffield where accounting records revealed production as well as financial information, has come to light. Such records have enabled the full story to be told of the armour manufacturers and their profiteering before the First World War – but hidden at the time from the Admiralty.

Inevitably the hit and miss nature of surviving records has resulted in the amplification of some companies over others and this should not devalue the contribution made by companies whose archival legacy is threadbare. This also applies to the present-day understanding of the processes and skills that were required to design and build the large number of components that went into a battleship, most notably from the 1890s when the complex and then state-of-the-art gunnery, protective and propulsion systems evolved rapidly. From the standpoint of the second decade of the twenty-first century, one can but marvel at the scale of resources, organisation, engineering and skill, taken as commonplace in the industrial Britain of 100 years ago.

The authors have endeavoured to bring together as much information as is practically available for this book in recognition of past industrial achievements and the interest that still endures a century later.

Ian Buxton, Tynemouth
Ian Johnston, Glasgow

1: INTRODUCTION

DURING THE LAST HALF OF THE nineteenth century, a number of British industrial concerns involved in the construction of ships and the manufacture of armaments grew substantially in size, mainly through contracts from the British Admiralty and overseas governments. By the early 1900s, through a series of mergers and take-overs, these businesses had coalesced into a formidable naval construction industry comprised of vertically integrated companies employing tens of thousands in their shipyards, engine works, ordnance factories, steel works, armour mills, forges and foundries across the UK.

In 1904, the British fleet was undoubtedly the most powerful in the world, being greater than the combined fleets of the next two largest naval powers, France and Russia. In 1905 the Admiralty decided to proceed with the construction of the revolutionary battleship *Dreadnought*, a stratagem which effectively made their own and all other existing battle fleets obsolete. Much of this 'pre-dreadnought' fleet, as it was rather disparagingly termed, was of very recent construction. Indeed, the very last examples of the type, *Lord Nelson* and *Agamemnon*, were not completed until two years after *Dreadnought*. The eclipse of the pre-dreadnoughts, created at great cost to the country, nevertheless presented an opportunity for the new armaments combines and the Royal Dockyards to construct a new battle fleet.

In many respects there was no alternative to building this new fleet as the concept of a dreadnought type ship was obvious to other naval powers. The Admiralty pre-empted other naval powers and took the initiative to create a new battle fleet comprised exclusively of the dreadnought type battleship and its larger, faster but less heavily armoured variation, the battlecruiser. *Dreadnought* represented a step change in the development of the battleship because of two main technical changes employed for the first time: a uniform main armament of ten 12in guns instead of the mixed calibre armament typical of contemporary battleships, and steam turbine propulsion machinery instead of reciprocating machinery, all of which conferred significantly greater tactical advantage in the design. These developments like many others associated with armament design and manufacture were pioneered by private industry.

At a different level, the decision to proceed with *Dreadnought* brought with it the risk that British battleship numbers might soon be matched by rival powers. Such risks were not hard to identify as the old order of established naval powers, Britain, France and Russia, was challenged by Germany, the USA and Japan, each of which had emerged at the end of the nineteenth century as industrialised powers with worldwide political ambitions. German naval intentions to build a major surface fleet declared before the construction of *Dreadnought* had begun, represented the most serious political and naval challenge.

Germany had grown rapidly in industrial and economic power since unification in 1871 and by 1900 had overtaken Britain in key industrial measures, such as steel production. Whilst previously British shipbuilders had constructed many merchant ships for German owners, now a large and technically advanced shipbuilding industry, coupled with a system of naval Dockyards and the Krupp armaments firm, had been created in Germany. This challenge had already been demonstrated in the mercantile marine by the construction of large, fast Atlantic liners which had, by 1902, pushed British ships into second position in terms of size and speed on the prized North Atlantic crossing. The architect of Germany's rise as a sea power was Admiral Alfred von Tirpitz whose ambitions mirrored the grandiose impe-

Above: The private firms that contributed towards the construction of the battle fleet were household names as well as major employers in districts throughout the UK. *(Author's collection)*

rial aspirations of Kaiser Wilhelm II. In 1897 the enactment of the first of Tirpitz's naval laws made it clear that Germany was determined to challenge British hegemony of the seas.

To make *Dreadnought*'s appearance on the world stage an unchallenged *fait accompli*, she was built in the record time of fourteen months at Portsmouth, drawing on the collective experience of that Dockyard, the armaments industry and turbine manufacturers to create this apparently effortless demonstration of British industrial expertise. A race had begun, later referred to as the Anglo-German naval race, which was as much to do with industrial capacity as it was with political aspiration and domination of the high seas.

The subsequent construction of the battle fleet in just ten years demonstrated the resourcefulness and capacity of British industry. Including *Hood*, laid down in 1916 but not completed until 1920, this totalled fifty-one ships, a remarkable total considering the great volume of merchant and other naval ships produced by the same yards in the same period. This achievement was made possible by the collective efforts of shipyards, engine works, armour and steel works, ordnance factories and a myriad of other manufacturers which drew deeply from the heart of industrial Britain. The advertisements in any pre-First World War *Jane's Fighting Ships* bear witness to these now long gone businesses.

During this period, when the naval race was underway, industrial capacity was continually extended to meet the unprecedented demands placed upon it. Investment was made in new tools and plant by the companies and later by the Government in the form of munitions factories and finance during the war. By 1918, the scale of British capacity to construct warships stood at an all-time high and one that it would never reach again. At the same time, the need to construct battleships became less important as it was clear that Britain had a significant lead over German numbers.

The end of the war brought with it a wholly understandable but abrupt end to naval contracts. The political map was redrawn and the German fleet, interned at Scapa Flow, was soon to disappear in an act of self-immolation. There was to be no respite for the Admiralty however, as a new naval race between the USA and Japan demanded a response. Since the middle of the First World War, both the US and Japanese governments had backed major fleet construction programmes which by 1918 were

well established. Compelled by its strategic outlook and with the world's largest navy, the Admiralty was obliged to consider a new round of capital ship construction.

The rapid development of capital ships from *Dreadnought* to *Hood* resulted in ships of exceptional offensive and defensive capabilities on hulls of great length and displacement. Size alone brought an end to the Royal Dockyards' role in the construction of capital ships, no longer able to accommodate such large hulls. Henceforth, the requirement for capital ships would have to be met exclusively by private industry. The same constraints applied also to the private yards however, and those capable of constructing these very large warships were reduced to a handful. Contracts for the first of these ships, four G3 battlecruisers, were placed in 1921 and offered a lifeline to the armaments companies for whom times had become lean with survival threatened. Political intervention in the form of the 1921 Washington Treaty of Limitation prevented this new arms race from continuing and placed a ban on the construction of new capital ships for ten years, subsequently extended for another five. Despite the political and economic wisdom of this initiative, the cancellation of the G3s in February 1922 was a severe blow to a British armaments industry with a capacity now grossly in excess of demand.

In addition to halting new construction, the Washington Treaty required the reduction of fleets to agreed numbers which meant reducing the size of the British fleet to that of the US Navy. And so began the scrapping of much of the battle fleet on which so much effort, material and expenditure had so recently been spent. Only the most modern classes of battleship and battlecruiser were retained as shipbreaking yards extracted monetary values from ship material representing the merest fraction of original construction costs.

Inevitably, the industry that had produced the battle fleet was subject to a fate not dissimilar to that of the once nationally revered ships themselves. Despite attempts at diversification into peacetime production, plant lay idle or underutilised, while many companies haemorrhaged financially throughout the depressed years of the 1920s and early 1930s, forcing rationalisation and restructuring, notably the merger of Vickers and Armstrong at the end of 1927. This period saw the most significant contraction of British heavy industry in modern times and importantly the loss of skilled manpower to other industries and emigration. Efforts were made to retain key technologies and core manufacturing capacity as strategic assets such as armament design and heavy armour manufacture for which there was little demand in the 1920s, by rationalisation and a trickle of orders for cruisers.

The armaments industry, which had become inextricably linked with the shipbuilding industry through vertical integration, was subject to accusations of fomenting wars and anti-competitive practices in pursuing self-interest at various periods during the history described here. This came to a head in 1935 with the appointment of a Royal Commission on the Private Manufacture of and Trading in Arms to examine such accusations. The Commission came to the realistic conclusion that private manufacture was necessary, and indeed the overwhelming need to re-arm the country in the face of rampant militarism abroad had, by the time the Commission reported in 1936, made it a somewhat moot issue in any case.

Re-armament in 1936 assisted in pulling industrial Britain out of recession. With few if any profits generated during the depressed years, little had been invested on industrial infrastructure, plant and machinery and thus Britain approached the Second World War with an armaments and shipbuilding industry little changed from 1918 in type of facility, albeit smaller in capacity. While the global strategic role of the Royal Navy had not changed, as a consequence of Washington, it was now equal first with the US Navy and battleships, although even then considered by some as an endangered species, were still the primary unit of offensive power. In 1936 after the eclipse of the limitation treaties, and the resumption of battleship building by the leading powers, the Admiralty moved as quickly as possible to place contracts for five units of the *King George V* class. These 35,000-ton ships which had been designed in accordance with Treaty conditions were followed in 1938 and 1939 by four larger *Lion* class battleships. However, the limited resources available to complete these ships meant that two of the *King George V* class were completed late while the *Lion* class, although ordered, could not be built at all because of limitations in main armament construction, other wartime priorities and a lack of shipyard labour. *Vanguard*, last of the British battleships, was made possible only because of the availability of existing but modernised 15in main armament mountings.

2: AN UPWARD TRAJECTORY, 1860 TO 1919

IT IS PERHAPS UNSURPRISING THAT the British shipbuilding industry was for over 100 years the world's largest, given Britain's position as the first developed industrial nation. The rising demand for manufactured products of all kinds, made accessible by the development of railways, stimulated trade and encouraged the rapid growth of industry across the UK. The creation, protection and maintenance of the British Empire and worldwide trade was made possible by the twin elements of seapower, the Royal Navy and merchant marine, and therein lay the foundation and success of the modern private shipbuilding industry from the mid-1800s onwards. This success was based on steam power as a prime mover and iron, later steel, as a constructional material. Prior to this, Britain was a leading builder of wooden ships and it was in this tradition that the Royal Navy's ships were constructed in a number of Royal Dockyards concentrated around the southern half of the country.

However, in the modern era of steam and iron, the Admiralty began to place orders with the new private shipyards which, driven by commercial considerations, were pioneering the latest methods of construction and propulsion in the highly competitive building of merchantmen. By contrast, the Royal Dockyards were steeped in traditional ways of working and much slower to react to change. This was most obviously the case with the ground-breaking, all-iron, steam-propelled warship *Warrior* which entered service in 1861. Her construction was in response to the French *Gloire*, the first seagoing armour-clad, which created great unease at the Admiralty when they were made aware of her construction in 1858. The contracts for *Warrior* and her near sister-ship *Black Prince* were given to private yards skilled in iron construction and steam propulsion, as such sophisticated ships could not have been built by the Royal Dockyards in the time required, still building only in wood. In making such a swift and decisive response to the French ship, the Admiralty was making use of the already significant resources that private British industry offered.

As the private shipbuilding industry began to expand during the last half of the nineteenth century, more commercial shipyards were encouraged into warship construction, including exports, although the Royal Dockyards retained a major share; figures in early 1890s suggest about 60 per cent. During this period the battleship as a distinct warship type began to emerge through a series of design iterations where various new technologies, armament and protective systems were tried out. This process resulted in the fundamental characteristics that would define the battleship as the ultimate seaborne weapon of offence and the measure by which all navies would come to be assessed.

In 1884 concerns over the preparedness of the navy, its organisation and equipment, began a process of naval reform which reached its climax in 1889 with the passing of the Naval Defence Act. In addition to providing for a large increase in the size of the navy, the Act formalised the 'Two Power Standard' which required the navy to be maintained at a size equal to or greater than the combined strength of the next two largest navies, at that time

Above: The main centres of battleship production in the UK, giving some idea of the distances to be covered when transporting machinery, mountings and guns from the point of manufacture to the shipyards. While material such as steel plate and armour could be moved by rail, coasters were especially adapted to transport gun mountings from Barrow and Newcastle to shipyards and Dockyards. All material and manufactures had to be shipped to Belfast. Chatham and Pembroke are included for pre-dreadnought output and Rosyth for its role in completion work on First and Second World War battleships.

France and Russia. Although this had been the *de facto* ambition for many decades, it had not always been met. Enshrining the Two Power Standard in law effectively committed the Admiralty to a continued process of ship construction. The Act planned ten new battleships and sixty other warships costing £21.5 million, with £11.5 million or 53 per cent planned for the Royal Dockyards.[1] This was complemented by the Naval Works Act of 1895, which financed a large expansion of the Dockyards, including extensions at Portsmouth and Devonport.

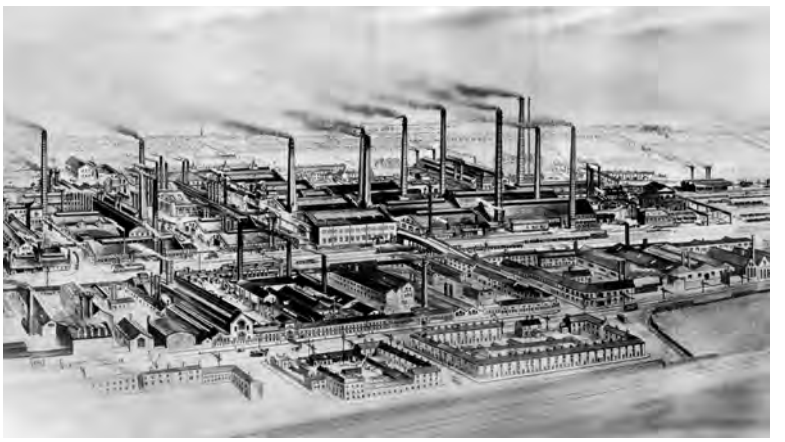
A little over a decade after the formal adoption of the Two Power Standard, Germany, unified in 1871, emerged as a significant industrial power, determined to exert political influence worldwide and take what it regarded as its rightful place in the world, as had the British, French and other colonial powers before it. The key to achieving this was seapower and, conveniently, a handbook for how this should be done entitled *The Influence of Seapower Upon History* had been published in 1890 by Alfred Thayer Mahan, a captain in the US Navy. This study used the example of Britain and the Royal Navy in the creation of political influence and empire through seapower. Hitherto the German Navy, or Prussian Navy until unification, had been small, concerned only with the protection of the relatively small coastline on the North and Baltic Seas. While there was debate about how the German Navy might be utilised to support the German Emperor, Kaiser Wilhelm II, in his foreign policy ambitions, it was with the appointment of Admiral Alfred von Tirpitz to the position of Naval Secretary in 1897 that a policy embracing these aims was formed. The essence of the Tirpitz plan was that the navy should be greatly expanded through the construction of a large fleet, the core of which would be battleships. This plan accorded well with the Kaiser's fascination for battleships and ambition for a battlefleet similar to that of the Royal Navy which, as Queen Victoria's grandson, he had seen and been greatly impressed with on many occasions.

To ensure implementation of the Tirpitz plan, it was passed into the Naval Laws, thereby circumventing the vagaries of an annual parliamentary vote, as was normally the case with the annual British Navy Estimates. In total, five laws were passed by the Reichstag between 1898 and 1912, the first of which envisaged a fleet that included sixteen battleships to be constructed over three years. On completion this would bring the German fleet to a size equivalent to that of France or Russia. The second naval law, passed in 1900, caused unease in Britain as it approved the doubling of the battlefleet to thirty-eight battleships over seventeen years making the German Navy second only to the British. Tirpitz recognised that to achieve German political aims, the British fleet must sooner or later be challenged, if not from a position of overwhelming strength then from one of comparative strength, in which an encounter was bound to cause significant losses in the British fleet thus eroding British seapower and influence.

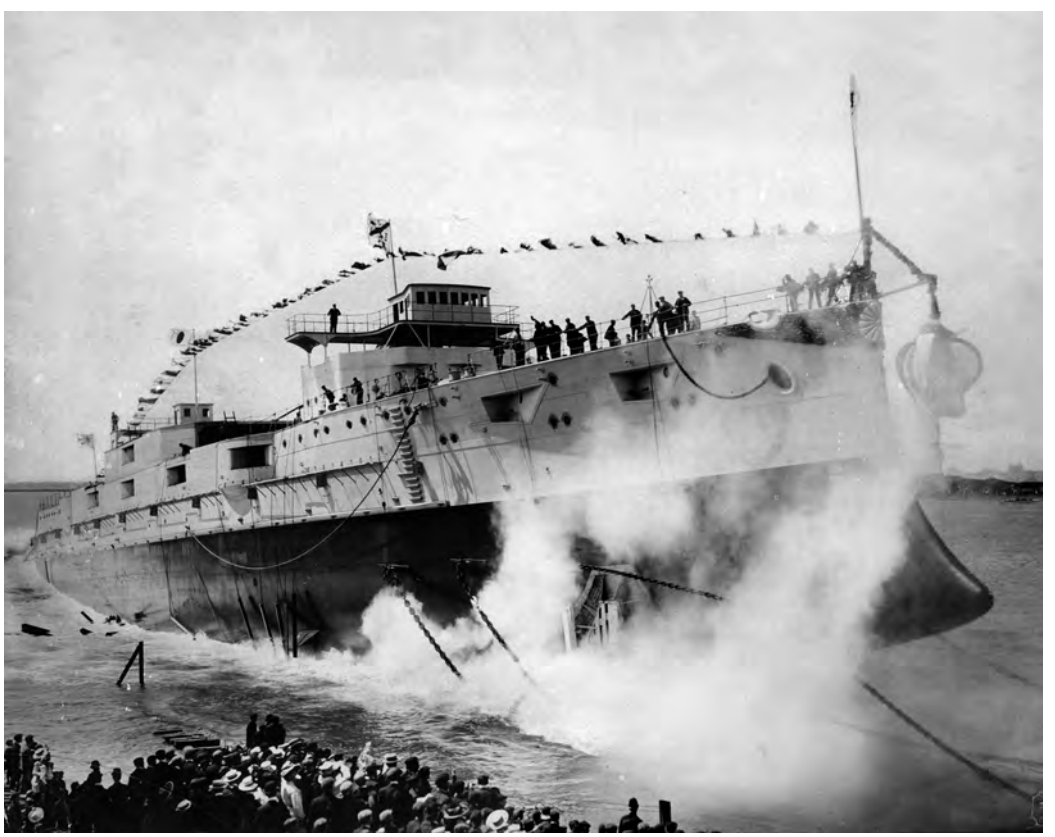
The German challenge brought with it significant political ramifications in the form of international agreements designed to provide a bulwark against German intentions. The first was the signing of the Anglo-Japanese Alliance in 1902, renewed in 1905, which among other key points stipulated that an attack on one signatory obliged the one to come to the assistance of the other. In time this alliance enabled the British to transfer its Far Eastern Fleet to home waters to counter the German threat. The second was the signing of the Entente Cordiale in 1904, settling many areas of disagreement with Britain's traditional enemy,

France. To this declaration was added the Anglo-Russian Convention, signed in 1907, forming the Triple Entente, the countries that would face the Central Powers, Germany and Austro-Hungary, in the First World War. But Britain recognised that a formal Two Power Standard was no longer affordable, especially as that would now include the United States, although not seen as a threat, so in 1909 changed it to a 60 per cent superiority over the next largest fleet, i.e. Germany.[2]

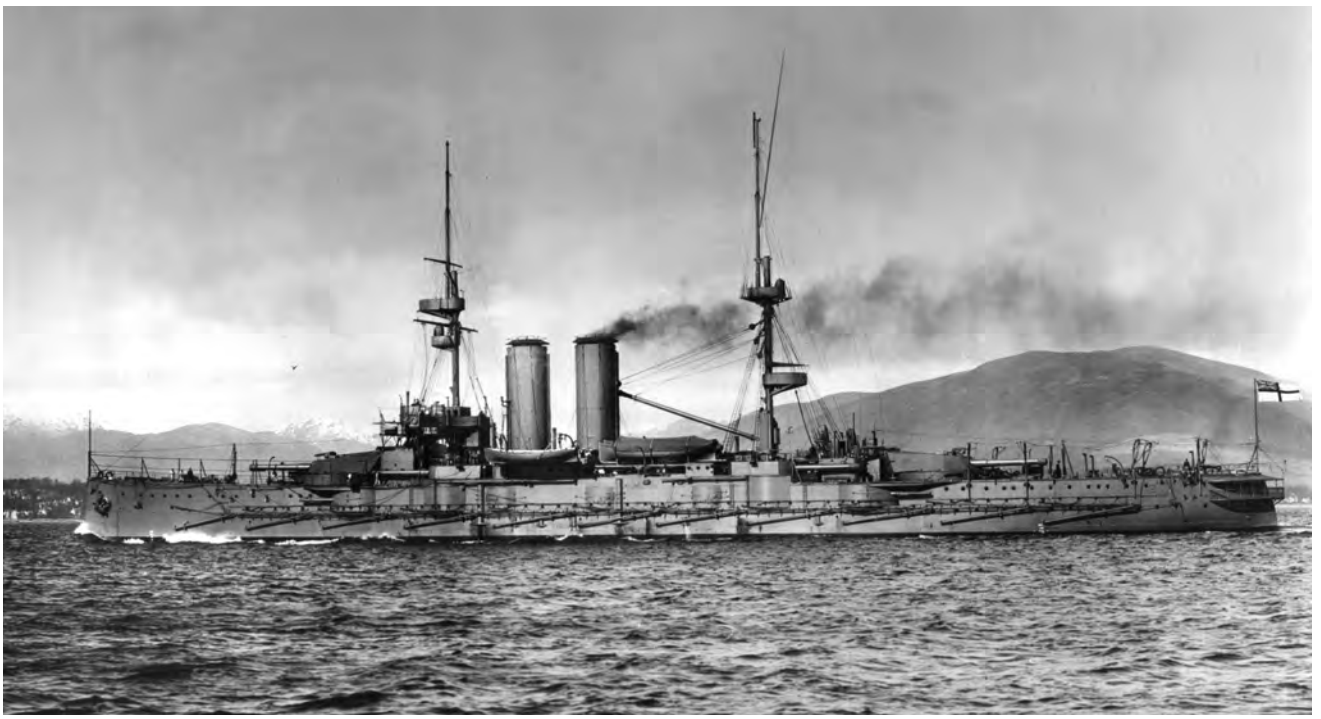
All of the above events did much to raise awareness of the crucial role that the Royal Navy performed in defending the nation and Empire and underlined the context in which the shipbuilding industry was seen as a vital national resource. As a result of the 1889 Naval Defence Act, primarily intended to counter the growth of the French and Russian fleets, and the Spencer Programme of 1894 of £21.26 million with seven new battleships, the Admiralty had begun a major fleet expansion programme which resulted in thirty-one battleships being launched during the 1890s alone. After 1900, with the threat implicit in the German Naval Laws, a further twenty battleships were launched before the great succession of dreadnought types began in 1906. To achieve this level of output the Admiralty relied not only on the Royal Dockyards but ever more on private industry. To that extent the Admiralty encouraged the growth of the private shipyards, rewarding additions to plant and capacity with orders. Such orders were prestigious and generally, but not always, profitable, and carried with them that patriotic chauvinism with which the companies were happy to be identified in defence of the nation. The substantial commitment to new ships in the 1889 Act and 1894 Programme, compared with the normal trickle of annual orders, had persuaded many compa-



Above: Like Vickers and Cammells, John Brown was drawn into naval construction as an extension of their forging and armour plate business. This drawing shows the extent of the Atlas Works in Sheffield as they were in 1903. Further extension was made before and during the First World War. *(Author's collection)*



Left: A substantial overseas market existed for British shipbuilders more than happy to construct battleships at lucrative prices for minor navies and emerging navies such as the Japanese. Here the Japanese pre-dreadnought *Katori* is launched at Vickers Sons & Maxim's Barrow shipyard on 4 July 1905, the drag chains about to tighten. *(Author's collection)*



Above: The *King Edward VII* class battleship *Commonwealth* running trials in 1905. By this time, at fifty-two units, Britain had twice as many pre-dreadnought battleships as any of the other major powers. *(Author's collection)*

nies to make major investments in their production facilities in the 1890s. Throughout this period, the private shipbuilding industry had developed a thriving business building warships for governments worldwide. This worked to the benefit of the Admiralty as the differing tactical requirements of foreign governments encouraged new and sometimes better design solutions than those required by the Admiralty thus allowing greater design expertise to be developed by the shipyards, as well as spreading overhead costs – see also Chapter 10.

In step with the events of the 1890s, the companies that would form the core of future armaments production in Britain began a process of amalgamation and linkages to form the great armaments complexes that would bear the brunt of war production in both World Wars. Companies such as Armstrong Whitworth, Vickers Sons & Maxim, John Brown, Beardmore and Cammell Laird, entered the pantheon of British industrial giants, as major producers and employers as well as household names.

There was one final and enormously significant twist in the development of the battleship which would deliver an order bonanza to the new armament companies. In 1904, Britain had a massive modern battlefleet of over fifty battleships, created at great cost, which meant that industry could expect new construction to be modest in extent based on replacing the oldest units. However, in the same year, the Admiralty dared to overturn the *status quo* by establishing a Committee on Designs to investigate the construction of a radically new design of battleship and cruiser. Central to these types was the introduction of a uniform main armament of 12in guns in contrast to the then standard mixed-calibre armament. It was also proposed that the propulsion of these ships would be equally radical, utilising new steam turbine technology in place of reciprocating machinery. The 'cruiser', it was envisaged, would be a completely new type, later known as the battlecruiser, where battleship main armament would be placed on a lightly armoured cruiser hull of great length to provide high speed. The idea for an all big gun battleship was not entirely new and other navies, notably the US Navy, were already well advanced in designing such ships. The result of these deliberations by the Committee on Designs was the battleship *Dreadnought* and the three armoured cruisers of the *Invincible* class, all ordered in the 1905–06 Programme.[3]

Often presented as a revolution in battleship design, this development undoubtedly represented a significant leap forward in the evolution of the battleship and rendered the existing battleship fleet obsolete, which were henceforth called pre-dreadnoughts. Moreover, there was a high risk that building these ships would

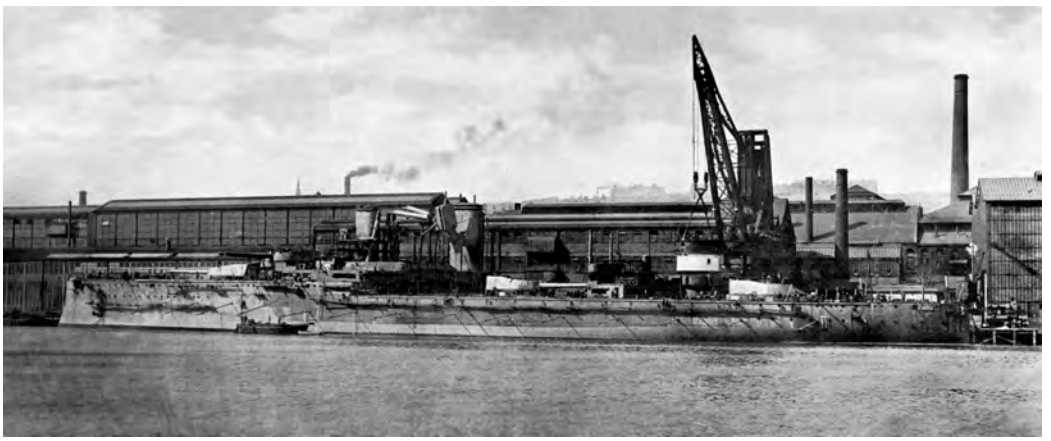
Left: Many of those involved in the design, building and commissioning of *Dreadnought* signed this photograph of the completed ship. Among the more senior were:
(above waterline): Rear-Admiral Henry B Jackson, Third Sea Lord and Controller of the Navy; Engineer Rear-Admiral Henry J Oram, Deputy Engineer-in-Chief; Captain Reginald G O Tupper, Captain of HMS *Excellent*; Philip Watts, Director of Naval Construction; William H Gard, Assistant Director of Naval Construction; Charles A Parsons, turbine pioneer; Fleet Surgeon Frederick Fedarb, *Dreadnought*; Lieutenant Bertie W Bluett, *Dreadnought*.
(below waterline): Captain Reginald H S Bacon, *Dreadnought*; Engineer Commander William Onyon, *Dreadnought*; Lieutenant Frederick P Loder-Symonds, *Dreadnought*; Lieutenant Norton A Sulivan, *Dreadnought*; Lieutenant Nigel K W Barttelot, *Dreadnought*; Lieutenant Bertram H Ramsay, *Dreadnought*; John H Narbeth, Constructor; Thomas Mitchell, Manager Constructive Department, Portsmouth; E J Maginnes, Constructor, Portsmouth; James McKechnie, Director of Vickers, Sons & Maxim; James Dunn, Director of Vickers, Sons & Maxim; ? Noble (possibly Saxton or John, directors of Armstrong, Whitworth). *(World Ship Society D K Brown Collection)*

precipitate an arms race by compelling other navies to build ships of this type. At this time the number of pre-dreadnought battleships built by the three largest navies was Britain fifty-two, the USA twenty-six, Germany twenty-four and France nineteen. The Russian fleet was all but annihilated by the Japanese at the Battle of Tsushima in 1905, while the latter's fleet was growing rapidly but still much smaller than the three largest. Whatever the political and military implications, there can be little doubt that the introduction of *Dreadnought* was interpreted as a very lucrative commercial opportunity by the armaments companies who would be required to build the battlefleet all over again.

Dreadnought did introduce a new era of construction for the fleets of the world and none more so than for a Britain and Germany already sensitised to future conflict and for whom the foundations for an arms race had been laid. To get ahead of the competition, the Admiralty built *Dreadnought* at Portsmouth in secrecy and at great speed. She was presented to the world as a *fait accompli* in December 1906 and thereby accelerated the Anglo-German naval race, a boom in battleship building that would last for the next ten years. By the time the German Imperial Navy had commissioned its first six dreadnought battleships and battle-cruisers in 1909/10, the Royal Navy had completed ten.

When the need for such vessels was most urgent, the Admiralty was able to rely on a vast industry which it had carefully nurtured over preceding years. As before, the Royal Dockyards played a major role in the construction of battleships, although production was now concentrated at just two, Portsmouth and Devonport, both of which had been recently extended and modernised. During the first decade of the century major investment by the private firms had brought several large new shipbuilding facilities into existence such as Beardmore at Dalmuir, Cammell Laird at Tranmere Bay and Armstrong at Walker Naval Yard, as well as considerable new investment at existing yards such as at Vickers, John Brown and Fairfield. During the same period new armour plant was laid down in Manchester and Glasgow, while the Coventry Ordnance Works was established to compete for a share in the construction of heavy naval guns and mountings currently the exclusive domain of Armstrong and Vickers.

Central to the operation of this vast network of manufacturing capacity was the Admiralty which, through the Director of Naval Construction's (DNC) department aided by the Engineer-in-Chief, the Director of Naval Ordnance (DNO) and Director of Contracts, drove the process of ship design, tendering, allocation of contracts, as well as supervision at the shipyards, engine works, armour mills,



Right: The *Orion* class battleship *Monarch* nearing completion at Elswick on 26 July 1911. The turntable and working chamber of her twin 13.5in X mounting, the last to be fitted, is being lowered into position over the barbette by the 150-ton hydraulic crane, at near its maximum capacity. All five mountings and their guns weighing 2800 tons were installed in only five days. The tripod foremast with the fighting top has been hinged downwards to permit passage under the Redheugh, King Edward and High Level bridges at Newcastle. The large gun mounting shops behind are No 24 (right), 7 (centre), 6 (left). *(Author's collection)*

ordnance factories and a myriad of other equipment suppliers. By this means the ships that formed the Grand Fleet of 1914–18 were constructed. Between 1906 and the end of the First World War, fifty-four capital ships were laid down in British yards, of which three were cancelled and one completed in 1920. In the same period, thirty-five were laid down in Germany of which twenty-seven were completed. British fears that they would be out-built by Germany were groundless given the capacity of the British armament industries, the priority that Germany gave to its army and, of course, the political will to finance their construction by successive Governments determined to remain rulers of the waves. At this time, Britain's financial position was relatively healthy from tax revenues and the ability to borrow money, unlike some of its rivals.

BATTLESHIPS AND BATTLECRUISERS ORDERED UNDER NAVY ESTIMATES PROGRAMME YEARS

1893–4	*Majestic, Magnificent*
1894–5	*Prince George, Victorious, Mars, Jupiter, Caesar, Hannibal, Illustrious*
1896–7	*Canopus, Ocean, Goliath, Glory, Albion*
1897–8	*Vengeance, Formidable, Implacable, Irresistible*
1898–9	*Bulwark, London, Venerable, Duncan, Russell, Exmouth, Cornwallis*
1899–1900	*Albemarle, Montagu*
1900–01	*Queen, Prince of Wales*
1901–02	*King Edward VII, Commonwealth, Dominion*
1902–03	*Hindustan, New Zealand*
1903–04	*Britannia, Africa, Hibernia* [*Triumph, Swiftsure*]
1904–05	*Lord Nelson, Agamemnon*
1905–06	*Dreadnought, Invincible, Indomitable, Inflexible*
1906–07	*Bellerophon, Temeraire, Superb*
1907–08	*St Vincent, Collingwood, Vanguard*
1908–09	*Neptune, Indefatigable*
1909–10	*Hercules, Colossus, Orion, Lion, Monarch, Thunderer, Conqueror, Princess Royal,* [*Australia, New Zealand*]
1910–11	*King George V, Centurion, Audacious, Ajax, Queen Mary*
1911–12	*Iron Duke, Marlborough, Benbow, Emperor of India, Tiger*
1912–13	*Queen Elizabeth, Warspite, Barham, Valiant,* [*Malaya*]
1913–14	*Royal Sovereign, Royal Oak, Revenge, Resolution, Ramillies*
1914–15	*Renown, Repulse* (both as battleships), *Agincourt, Resistance* (both cancelled). (*Erin, Agincourt, Canada*)
1915–16	*Renown, Repulse* (both as battlecruisers), *Courageous, Glorious, Furious.*
1916–17	*Hood, Anson, Howe, Rodney* (last three cancelled)

Ships in brackets were paid for by other governments or taken over and paid for by the UK government.
Ship construction dates are given on p.133.

Building Programme Years

The political, military and financial imperatives of the day determined how many battleships would be built in each financial year. The last phase of battleship construction produced the *Queen Elizabeth* and *Royal Sovereign* classes, destined to be the longest-serving of all the modern British battleships. In both classes a greater number of ships were intended than actually built. Originally there were to have been six *Queen Elizabeth*s but one, to have been named *Agincourt*, was cancelled in 1914 and the name subsequently allocated to the Turkish battleship *Sultan Osman I* under construction at Armstrong's yard when that ship was taken over by the Royal Navy. Eight *Royal Sovereign* class vessels were originally planned; however, as discussed below, two of them, *Renown* and *Repulse*, were cancelled late in 1914 and the names given to two battlecruisers while a third, *Resistance*, was cancelled outright in 1914.

This highly concentrated period of capital ship construction, lasting a little over ten years, accelerated the development of battleship design at an astonishing rate. Where pre-dreadnought battleships had remained at between 14,000 to 18,000 displacement tons for the last ten years of their development, under the impetus of the Anglo-German naval race, dreadnought battleships in the same time scale increased displacement by 50 per cent. Battlecruisers doubled in displacement.

Battleships Built by Private Yards and Royal Naval Dockyards 1860–1904

These charts show numbers of battleships built by yard over the period 1860–1904, i.e. from *Warrior* until the advent of the dreadnought.

Private Shipyards

At the beginning of this period the private yards on the Thames are most numerous yet by the end of the century, only one of these yards was still in business. This was largely because shipbuilding on the Thames was increasingly displaced by competition from the shipbuilding centres emerging in the north, especially on the Clyde and the North East coast. These centres enjoyed numerous advantages, especially plentiful, cheaper labour and materials as well as better access to steel supply and a multitude of ancillary industries that had grown up around these new areas of production. A good example of the redistribution of naval shipbuilding in Britain was made over the years 1905/7 when Yarrow & Co, builders of destroyers and torpedo boats, moved their works at Poplar on the Thames to Scotstoun on the Clyde to be part of the shipbuilding industry there.

British Battleship Construction 1860 - 1904 (Iron and steel)
Private Yards

Company	Location	1860-64	1865-69	1870-74	1875-79	1880-84	1885-89	1890-94	1895-99	1900-04
Armstrong (Elswick)	Tyne							1		
Fairfield	Clyde									1
Laird Brothers	Mersey		2	1				2	1	2
Thames Iron Works	Thames	2			1		1	1		3
Palmer	Tyne	1		2				1		1
Napier	Clyde	2	2							
Thomson - Clydebank - John Brown	Clyde							1	1	
Vickers	Barrow									1
Westwood & Baillie	Thames	2								
Millwall Iron Works	Thames		1							
									Total	33

The names most readily associated with battleship construction in the twentieth century such as Armstrong, Beardmore, Brown and Vickers appear late in the period because, with the exception of Armstrong, they were new entrants in the field of naval construction having recently expanded from their core business of steelmaking.

Royal Dockyards

The main trend marking the performance of the Royal Dockyards over this period was the decline of Chatham and Pembroke at the turn of the century despite a consistently high output. The eclipse of these yards as battleship builders was almost certainly because investment required to construct vessels of increasing size then under consideration was concentrated at Portsmouth and Devonport. After the last battleship to be launched at Pembroke, *Hannibal* (1896) of the *Majestic* class, the yard continued to build smaller classes of warship and survived until 1926 when it was closed being surplus to requirements. Chatham launched its last battleship, *Africa*, in 1905 with larger vessels precluded from construction there because of site restrictions. Chatham nevertheless continued in an important role building submarines until 1984 when it was closed. Deptford and Woolwich Dockyards were early casualties closing in1869, building only in wood. Devonport, with little or no contribution throughout much of this period, emerges strongly from 1895 onwards to become the main Admiralty construction site along with Portsmouth.

British Battleship Construction 1860 - 1904 (Iron and steel)
Royal Dockyards

Dockyard	1860-64	1865-69	1870-74	1875-79	1880-84	1885-89	1890-94	1895-99	1900-04
Chatham	1	3	2	3	1	2	2	3	5
Devonport									5
Pembroke			2	1	3	2	3	2	
Portsmouth			1	1	1	1	3	4	2
								Total	53

Overseas Construction

The overwhelming trend in the construction of battleships for overseas governments during the 1860–1904 timeframe, was the early domination of this market by British builders, especially those on the Thames, owing to their mastery of steam and iron construction. However, as other nations industrialised, they too developed shipbuilding industries where, over time, they began to build naval vessels for their own governments. Some of these countries, such as France, Germany and the USA then began to compete against British yards for overseas orders. The loss of markets over this period was also mirrored in merchant ship construction where British yards, although collectively still by far the largest shipbuilders in the world, gradually lost overseas market share to competing countries.

Table excludes wooden hulled ships, coast defence vessels, cruisers, frigates and monitors.

Overseas Battleship Construction by British Firms 1860 - 1904 (Iron and steel)

Company	Location	1860-64	1865-69	1870-74	1875-79	1880-84	1885-89	1890-94	1895-99	1900-04
Armstrong (Elswick)	Tyne								1 Japan	1 Japan 1 Chile*
Millwall Iron Works	Thames		1 Italy							
Thames Iron Works	Thames	1 Russia 1 Turkey	1 Spain 1 Germany	1 Turkey					1 Japan	1 Japan
Napier	Clyde	2 Turkey								
Samuda Brothers	Thames		1 Germany	2 Germany	1 Brazil	1 Brazil	1 Brazil			
Thomson - Clydebank - John Brown	Clyde	1 Denmark								1 Japan
Vickers	Barrow									1 Japan 1 Chile*
									Total	23
									Grand Total	109

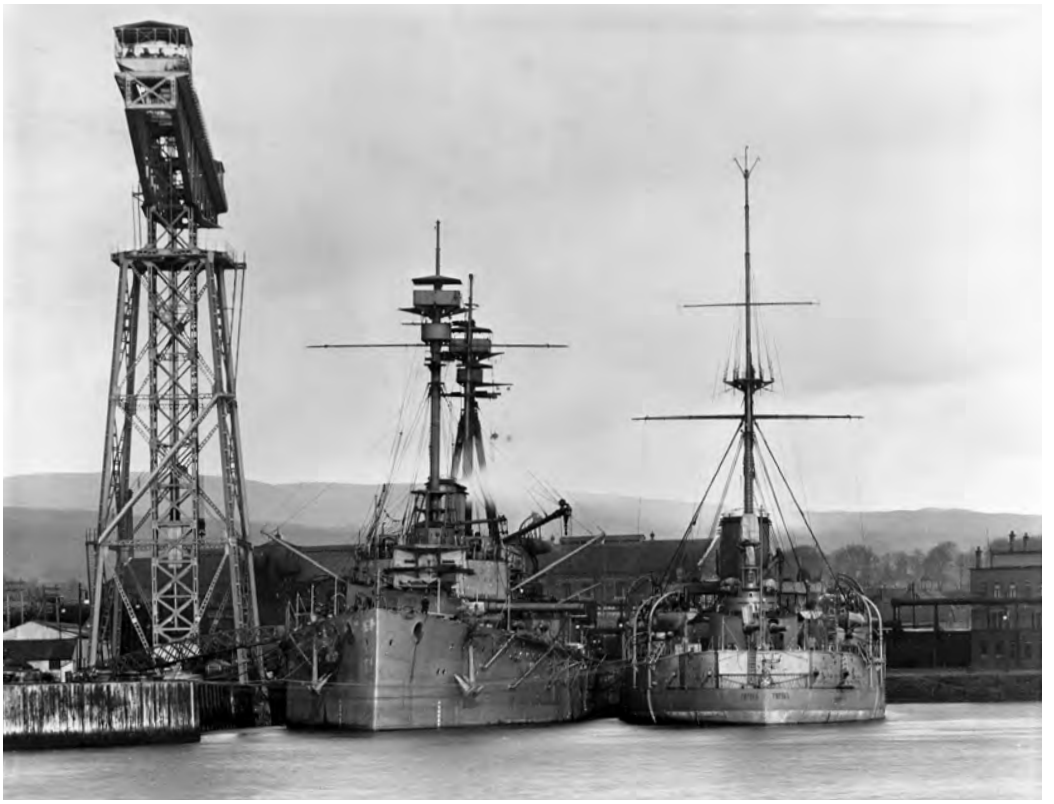
*To RN on completion

Battleships delivered almost twice the weight of broadside through increases in main armament calibre from 12in to 15in while the power of propelling machinery increased from 23,000 to 75,000 shp in the case of battleships and from 41,000 to a staggering 144,000 shp in the case of battlecruisers. All of this was delivered at great cost to the country but the evidence suggests this was done with the bulk of the population in support and who, moreover, took enormous pride in the Royal Navy as defender of the nation.

Right: The prestige associated with naval construction is reflected through money spent on stone carvings and the Italianate design of the portico at Beardmore's new shipyard offices in Dalmuir. *(Author's collection)*

However, during this period of intense construction, the 'battleship industry' revealed a less than savoury side to its activities, accused of anti-competitiveness, of making excessive profits out of a nation soon to be at war and of fanning the flames of jingoism at home and abroad in the service of shareholders. Procurement operated on a regulated basis where the Navy's governing body, the Board of Admiralty, presented an annual budget (the Navy Estimates) to Parliament each March for approval. This budget covered the costs of the naval establishment, a major part of which was the requirement for new vessels. Then as now, Parliament took a balanced view of competing demands on the public purse, allocating funds accordingly. Through its own Dockyards, the Admiralty had a fair estimate of the cost of ship construction and could use this information to

Below: The battle-cruiser *Queen Mary* fitting out at Palmers' yard at Jarrow on 18 March 1913. Her four twin 13.5in turrets have just been installed by Elswick, while her forward boilers appear to have steam up. She left in May for drydocking at Devonport. *(NMM)*



Left: Such were the commercial opportunities for private shipbuilders that many invested heavily in new facilities and plant while other firms already established in armour and ordnance manufacture entered the market by building shipyards. William Beardmore & Co Ltd of the Parkhead Forge in Glasgow constructed a large new shipyard and engineworks at Dalmuir. In this photograph, the last pre-dreadnought battleship, *Agamemnon*, is nearing completion in 1908 in the new fitting-out basin commanded by a 150-ton hammer-head crane. The armoured cruiser *Rurik*, built at Barrow by Vickers Sons & Maxim who had an interest in the Beardmore company, is having final adjustments made prior to delivery to the Russian Navy. *(Author's collection)*

gauge the competitiveness of private tenders. However, in other areas of production such as armour manufacture, the Admiralty had few means of comparing prices, so the opportunity for manufacturers to charge excessive prices existed, as is discussed in Chapter 9.

The system of tendering for hulls and machinery used by the Admiralty ensured that excessive profits could not be made, as there were around a dozen bidders and in most cases the lowest tender won the contract. However, this did not prevent collusion between some companies and the forming of cartels or rings to fix prices, such as was the case in armour manufacture. The five armour manufacturers, Armstrong, Vickers, John Brown, Beardmore and Cammell Laird, all had Krupp licences and agreed a collective price in negotiation with the Admiralty. The surviving financial records show that these companies grossly inflated the price for armour in the years before the First World War, in the knowledge that the Admiralty had virtually no means of establishing the true cost of manufacture. This issue was brought into focus and public attention when an enquiry took place in a House of Commons Select Committee in 1913, as discussed more fully in Appendix 2.

Once the war had started, the time-consuming process of tendering was dispensed with and contracts were placed directly by the Admiralty wherever suitable capacity existed. This method was facilitated by the introduction of the Munitions of War Act in July 1915, which declared all factories associated with war work as 'Controlled Establishments', thus providing a higher level of scrutiny to the Government, including direction of labour. Beginning with the Finance Acts of 1915, the Government introduced an Excess Profits Duty, backdated to the start of the war, intended to stop businesses enriching themselves from the vastly increased volume of Government contracts. The tax on excess profits above pre-war levels was set at 50 per cent at the start of the war and was subsequently raised to 60 per cent and from 1917 onwards to 80 per cent.

False alarm bells were rung on one notable occasion to stimulate orders in a furore about battleship contracts involving the Coventry Ordnance Works. As described on p.76, the Coventry Ordnance Works had been set up by John Brown, Cammell Laird and Fairfield to construct naval guns and mountings in an attempt to break the duopoly enjoyed by Armstrong and Vickers in this complex but lucrative manufacturing business. Naturally, the

Above: With war only days away, the Fleet Review and mobilisation of July 1914 was visible evidence that Britain had a large margin of superiority in battleship numbers over Germany. *(IWM Q220494)*

latter firms were highly resistant to this challenge and, moreover, had reached accommodation with one another regarding the distribution and pricing of contracts. In addition, they held a number of patents covering the design of these mechanically sophisticated mechanisms which they were reluctant to share with what they regarded as the unwelcome Coventry upstart.

Nevertheless, John Brown, Cammell Laird and Fairfield had laid out considerable sums in setting up new works and plant for this enterprise. From the outset, the trading position was woeful, resulting in losses year on year, requiring repeated subventions from the parent companies to the new business. In 1908, the press caught a whiff of concern that the German naval building programme was being greatly accelerated through the commissioning of new plant at Krupp's works in Essen. The managing director of the Coventry Ordnance Works, H H Mulliner, was the source of this information which implied that a greatly increased number of mountings and guns for German dreadnoughts could be built, resulting in Germany eclipsing Britain in battleship numbers. During 1908 this information was taken up by the Parliamentary opposition and the press and came to a head in the following year as the Naval Scare of 1909. The issue compromised the Liberal Government elected on a mandate of defence cuts in favour of social reforms. On 16 March, the First Lord of the Admiralty, Reginald McKenna, introduced the Navy Estimates in the House of Commons and, using Mulliner's information, made a strong case for increasing the number of dreadnoughts to be built. The Prime Minister, H H Asquith, and others, including Winston Churchill, refuted the notion that Germany had embarked on an accelerated shipbuilding programme. Nevertheless, such was the sentiment in the country that it was decided that four dreadnoughts would be laid down in 1909 and that four additional or 'contingent' ships would follow if warranted by subsequent events in Germany. This compromise proved unpopular and the Government remained under continued pressure to build all eight ships. The campaign for more battleships was taken up by the press and characterised by the slogan 'We want eight, and we won't wait'. On 26 July, the Government relented and announced that the four 'contingent' dreadnoughts would be built. This issue prompted the Australian and New Zealand Governments to offer finance for the construction of two further ships, the battlecruisers *Australia* and *New Zealand*. Although Mulliner's information was found to be incorrect and he was replaced as managing director of the Coventry Ordnance Works later in 1909, the outcome was the first of a series of contracts for heavy gun mountings for the Works starting with the five 13.5in twin mountings for the *Orion* class battleship *Conqueror*.

As events would prove, British preparedness and capacity to build battleships outstripped that of Germany. However, during the last years of the naval race, two examples stand out that illustrate what could be achieved by a finely tuned procurement process and, conversely, how labour shortages and wartime priorities prevented the Admiralty from having all the ships it wanted.

The first concerns the construction of the

battlecruisers *Renown* and *Repulse* which had initially been ordered as battleships under the 1914–15 Programme. Under the direction of the newly re-appointed First Sea Lord, Admiral Fisher, this change was made in December 1914 and demanded that both ships were to be constructed in just fifteen months. For vessels of this size and complexity such a demand was without precedent, the best previously achieved being twenty-four months. Even the record construction in fourteen months of the much smaller *Dreadnought* had benefited from a considerable amount of steelwork preparation and her gun mountings were prioritised over and used material from earlier contracts. Although Fisher's demand on building time was grossly optimistic for such large ships, it did set up an example of superb cooperation and rapid shipbuilding. From the main Admiralty departments concerned, to the armour and gun mounting contractors and the ship-builders, down to the manufacturers of the smallest item, the entire system was pressured to good effect. In 1915, with so many battle-ships recently built or building, all concerned in the procurement-construction pipeline knew exactly what to do and how it worked. Even though Fisher resigned in May 1915, it took his pugnacious style to iron out the last vestiges of inertia and deliver these ships in record time.

In contrast to the above, the last capital ship contracts of the First World War proved impos-sible to complete because the shipyards were short of labour, occupied as they were with work of a higher priority, including merchant ships after the serious losses to U-boats in 1917. Of the four ships of the 'Admiral' class ordered in April 1916, only one, *Hood*, was completed, although the other three survived on the stocks until 1919 in the hope of resumption. Their progress from keel laying in 1916 to suspension in 1917 and outright cancellation in 1919 explains much about a naval construction industry, large as it was, being unable to satisfy all of the demands placed upon it in time of war. That the three sister vessels lingered on the stocks so long highlights a change in Admiralty focus from war with Germany to a post-war world in which Britain would only have one post-Jutland capital ship, *Hood*, against the many new American and Japanese capital ships then under construction. No more battleships were ordered during the First World War, the last of the pre-war orders, *Ramillies* only being completed in 1917.

Below: A midships view of the Fairfield-built *Valiant* passing Clydebank shipyard in January 1916. Large numbers of people, crew and civilian workmen, have moved to the star-board side of the ship to-look at ships in the fitting-out basin including the recently launched battlecruiser *Repulse*. *(NRS)*

The Three 'Admirals'[4]

Approval to proceed with contracts for the four 'Admiral' class battlecruisers was given on 11 April 1916 when the First Lord met the Chancellor of the Exchequer to approve the new shipbuilding programme including the 'Admirals' or *Hood* class.[5] One each of the new ships went to John Brown, Cammell Laird and Fairfield. A fourth, to be placed with Armstrong Whitworth, was delayed for two months. In the letter sent to each of the yards on 19 April authorising construction, it was noted that work should: 'proceed at first only at such a rate as will employ a nucleus of men accustomed to heavy frame work, involving the least call on labour and material required by them for the war vessels being rapidly completed for the war and for merchant ships urgently required for carrying cargo.'

The emphasis on warships and merchant

An Example of Rapid Shipbuilding

Fisher had decided in December 1914 that the last two of the *Royal Sovereign* class battleships, on order at Palmers and Fairfield's shipyards, should be redesigned and completed as battlecruisers to take part in his 'Baltic Project'. It immediately became clear that Palmers largest berth was not long enough for the additional 174ft length of the battlecruiser so would have to be re-allocated. It did not take long for Fisher to find that a suitable berth was available at John Brown's Clydebank shipyard and thus the contract for the ship that became *Repulse* was switched there.[6]

To expedite construction Fisher delivered his customary shock to the system by summoning both shipyard managing directors, Thomas Bell and Alexander Gracie, to the Admiralty at the end of December to press the urgency with which these ships were to be built, emphasising this with an interesting turn of phrase: 'I am going to have these ships delivered on time and if you fail me your houses will be made a dunghill and you and your wives liquidated'. He added 'I expect to hear tomorrow that you have started preparations for these ships.'[7] For both shipbuilders and the Admiralty constructors alike it was a cold start with no design, no building drawings, no specifications and just a handful of preliminary calculations. Moreover, any material suitable for the battlecruiser gathered at Palmers had to be transferred to Clydebank and a whole range of contracts made to the order of Palmers similarly transferred to John Brown's name.

Everything that could be done to build the ships in the shortest possible time was investigated. The main armament mountings, now six in total rather than eight for the battleships, had been ordered but had not been started. As they took as long to build as the ship itself, mountings from other ships previously ordered, e.g. *Resolution* and *Ramillies*, were switched to the battlecruisers and newly ordered monitors. To save time designing new machinery, the arrangements for the battlecruiser *Tiger*, also built at Clydebank, were largely duplicated to make use of existing patterns and jigs while the engine and boiler room layout of the new ships would also be broadly similar to *Tiger*. The keels were laid on Fisher's birthday, 25 January 1915, although serious steelwork could not proceed beyond that for some weeks afterwards because of the lack of drawings. Work proceeded on the drawings at the DNC's department at great speed to enable the bottom sections of the hull to be erected but it was not until 12 April that enough drawings, specifications and calculations were completed, with formal Admiralty approval being given on the 22nd.

On 12 March Fisher wired John Brown: 'I hear you have nothing like the number of men on *Repulse* that are required to complete her by the desired date. I had hoped that you would let nothing whatever prevent your pushing her on with the utmost speed possible. Please reply'. When the company replied that labour directed to other naval contracts was partly to blame, this resulted in a determined effort by the Admiralty to concentrate as much labour on the two battlecruisers as possible. This included taking 500 men of the steel trades from *Ramillies* at Dalmuir and splitting them between the battlecruiser contracts at John Brown and Fairfield. This indicates that the Admiralty was already intervening in the direction of labour prior to the passing of the Munitions of War Act in which shipyards and other essential industries were declared Controlled Establishments, enabling the Admiralty to formally direct labour as it saw fit in the national interest.

Despite Fisher's resignation, work continued at great speed with *Repulse* and *Renown* completed in August and September 1916 respectively. While they were not built in the fifteen months demanded, at nineteen and twenty months it was a remarkably short time for ships of this size. Their rapid construction had demonstrated what could be achieved by the collective efforts of the Admiralty and industry, particularly when the process was driven as hard as it was in the initial stages by Fisher, and money was no object allowing a great deal of overtime to be worked. Both ships cost about 40 per cent more than *Tiger*. On 25 September 1916, their Lordships forwarded a letter to the DNC expressing and conveying to him and to the members of his staff concerned, 'their appreciation of the highly satisfactory and expeditious manner in which the work of designing, building and completing the *Repulse*, had been carried out'.[8]

ships already under construction reflected the most immediate demands of the war at sea and ensured a low priority for the *Hood*s. Nevertheless, in the normal manner of working, drawing office workload was shared between the three, later four, yards with expected completion dates for all four ships of 1918/19. The first significant delay affecting construction was the Battle of Jutland which showed fundamental weakness in the protection of British battlecruisers following the catastrophic loss of three.

As recasting the design would take many months, work continued at low priority while the order for the fourth ship of the class was placed with Armstrong Whitworth on 13 June with the machinery sub-contracted to Hawthorn Leslie. However, on the same day, the Admiralty wrote to John Brown to inform them that the low priority given to their ship, No 460, had been removed and that work 'should be fully proceeded with under ordinary conditions, no special steps being taken however to work under accelerated conditions'. Why John Brown's ship was chosen is unclear as no keels had been laid – perhaps because *Repulse* was due to complete shortly. The principal effort so far affected only the drawing office, mould loft, and the advanced ordering of material. On 26 June, the Admiralty placed provisional orders for the 15in main armament for all four ships of the class:

Company	*Sets*	*Condition*
Vickers	1 (4 turrets)	Peace condition (*Hood*)
Vickers	1 "	Slow condition (probably *Howe*)
Armstrong	1 "	Slow condition (probably *Anson*)
Coventry OW	1 "	Slow condition. (probably *Rodney*)

Hood's main armament was accelerated to 'peace conditions', matching the pace of construction given to her hull and machinery.

Below: *Repulse* with two destroyers, probably *Romola* and *Rowena*, and the submarine *E35* in the fitting-out basin at Clydebank in August 1916. *Repulse* and her sister-ship *Renown* were built at great speed demonstrating what could be done by the DNC, shipbuilder and suppliers when it mattered. *(Author's collection courtesy of NRS)*

By 5 July 1916, the DNC's department had produced the first of a series of proposed modifications to the protection of the new battlecruisers while on the 14th, the Ship Branch announced that the new ships were to be named after Admirals: *Anson* (Armstrong), *Hood* (Brown), *Howe* (Cammell Laird) and *Rodney* (Fairfield). With sufficient drawings prepared to permit construction of the portions of the hull unaffected by the armour scheme under revision, material began to flow from the shops to the building slips. All four ships were laid down within nine weeks of one another:

Hood	(Ship No 460)	1 September 1916
Howe	(Ship No 834)	16 October
Rodney	(Ship No 527)	9 October
Anson	(Ship No 909)	9 November

The situation at the beginning of November noted by shipyard staff at Clydebank was that: 'sufficient information is gradually being obtained from the Admiralty to enable more material to be ordered for this vessel and to employ a few more men on her construction, but in view of the alterations in her design, comparatively slow progress can only be made until the beginning of next year'.[9]

The original design for a ship of 36,300 tons as approved by the Board on 7 April 1916, had by 13 September grown to a ship of 40,600 tons while a re-arrangement of their protection scheme was approved on 2 October. However, it was not until 20 August 1917 that the design was finalised, and only then could the sheer and structural section drawings be completed.

The new armour scheme was sufficiently fixed to permit placing the first orders on 16 December 1916 for bulkhead and lower tier barbette armour with Vickers' River Don Works. On 10 February 1917 the Admiralty decided to further accelerate *Hood* with the

Below: *Resolution* substantially complete at Palmers' Jarrow yard on 16 August 1916. B turret roof plates remain to be fitted for which the floating crane alongside, probably the 60-ton *Sarus*, might be preparing to lift. Her two forward turrets had been ordered for *Repulse* in 1914 but in order to complete the latter more quickly, two of *Resolution*'s more advanced turrets ordered in 1913 were diverted to *Repulse*, delaying the Palmers ship. *(NMM)*

Left: 16 October 1916. The clock is showing 5.14, one minute before the working day is over and the gates will be opened by the gatemen. Tramcars would have been lined up on the main road not far from the yard to deal with this mass exodus. Young boys in the employ of local newsagents wait to sell evening newspapers to the men. During the First World War employment at the Dalmuir works peaked at over 13,000 people. *(Author's collection)*

proviso that merchant shipbuilding and anti-submarine vessel construction was not impeded. At this stage a completion date of November 1918 was theoretically possible. In the same month, progress on the new armour layout enabled contracts for the bulk of the remaining ship's heavy armour to be placed:

Company	*Armour*
John Brown	480lb (12in) belt armour lower tier starboard side. Total 1130 tons.
Vickers	Upper tiers of barbettes.
Cammell Laird	480lb lower tier belt armour port side. Total 1130 tons.
Beardmore	Middle and upper tiers of belt armour starboard side and belt forward and aft of the main belt. Total 946 tons.
Armstrong	Middle and upper tiers of belt armour port side and belt forward and aft of the main belt. Total 946 tons.

By the beginning of 1917, progress had been made on all four ships on the building slips with many thousands of tons worked into the hulls. However, on 9 March 1917 it was decided to suspend work on *Anson*, *Howe* and *Rodney*. The reason often quoted for this was that the construction of the *Mackensen* and *Ersatz Yorck* battlecruisers in Germany had been abandoned and that accordingly the need for the other three *Hood*s had been significantly reduced. This, however, was not strictly correct, as the German battlecruisers were not cancelled until the end of the War. Like their British counterparts, German shipbuilders suffered from labour shortages and had to prioritise competing wartime construction programmes. The unrestricted U-boat war required additional concentration on U-boat construction. Construction of the German battlecruisers continued although at a slower rate. *Mackensen* was launched on 21 April and *Graf Spee* on 15 September 1917 and by the end of December 1917, 10,850 and 11,590 tons of material had been worked into their hulls respectively.[10]

The reason for suspension was lack of skilled labour, allied to which was the pressure on ordnance factories, as the most likely bottleneck was the priority for army guns and ammunition. While the hulls of the three *Hood* class battlecruisers were suspended, revisions to the design continued while those for *Hood* were close to being fixed. Although from this point onward efforts were made to expedite *Hood*, her three sisters were not entirely ignored and, despite suspension, contracts for their auxiliary machinery were issued in March while evidence suggests that work on main machinery continued at a slow rate.[11]

To hasten construction of *Hood*, the

Controller, Rear-Admiral Frederick Tudor, wrote to all Admiralty departments on 17 March:

> In view of the fact that *Hood* is to be completed as quickly as possible, steps should be taken by the departments to ensure that full information is furnished to the contractors so as to enable work to proceed at full dispatch: it is also most necessary that no alterations in the gunnery, torpedo, electric etc. fittings should be introduced in this ship with consequent risk of delay.

The evidence of John Brown's manning returns however, suggests that no significant expansion in production occurred in February/March 1917 beyond a gradual incremental increase in labour allocated to this contract.

With pressure from the C-in-C Grand Fleet, now Admiral Sir David Beatty, to restart the three suspended ships, the Controller, now Rear-Admiral Lionel Halsey, considered that no action could be taken to hasten their construction and proposed that the only alternative way of meeting the need was 'that most energetic action be taken to induce the Japanese to help us by letting us have some of the Kongo Class'.

On 15 October 1917 the First Sea Lord, Admiral John Jellicoe, wrote:

> In regard to the question of battlecruiser construction and expediting the completion of HOOD, the Naval Staff is unable to suggest any items in the shipbuilding programme which could be sacrificed for this purpose, unless it is possible to suspend work on the light cruisers RALEIGH and EFFINGHAM and to transfer the labour and men to the HOOD. The Commander-in-Chief, Grand Fleet, who discussed this matter with the Deputy First Sea Lord, expressed the view that the completion of the HOOD should be expedited, whatever the sacrifice.

The above gives some insight into the seriousness of the situation. Transferring labour from *Raleigh* was a straightforward matter as the Beardmore shipyard was adjacent to John Brown's. However, *Effingham* was under construction at Portsmouth with the altogether more troublesome issue of relocating hundreds of Dockyard workers to Clydebank. In a meeting held between the Controller and the Deputy Controller of Dockyards and War Shipbuilding (Sir Thomas Bell) on 4 October 1917, the acute shortage of labour was discussed, with one suggestion briefly considered being to recruit miners into the shipbuilding industry. This proposition had been seriously considered in a meeting on 28 September between the Controller and the Minister for National Service, Auckland Geddes (brother of Eric Geddes, First Lord of the Admiralty in 1917). It was recognised, however, that this would result in miners wanting to retain their existing wage levels, and thus being paid more than a plater's helper or even platers themselves 'resulting in serious demands for wage increases by the whole of the ironworkers in existing shipyards with consequent unrest and loss of production all over the Country.' With regard to *Hood* it was decided that:

> If it is decided that the position of HOOD was the same as that of steel and other raw materials, acceleration is only possible at the expense of other shipbuilding. If it be decided that acceleration of the HOOD is of prime necessity, the preferable way of effecting this would be to delay the construction of the oilers, standard ships and destroyers building in the same yard and thereby confine the disturbance of shipbuilding production to one yard.

Bell pointed out that both the DNC and DNO considered that *Hood* could be completed by December 1918 provided an early decision was made to accelerate her construction. On 25 October 1917, despite their best efforts to push *Hood* forward, the Board of Admiralty decided that it was not advisable to accelerate *Hood* given the effect this would have on the shipbuilding programme.

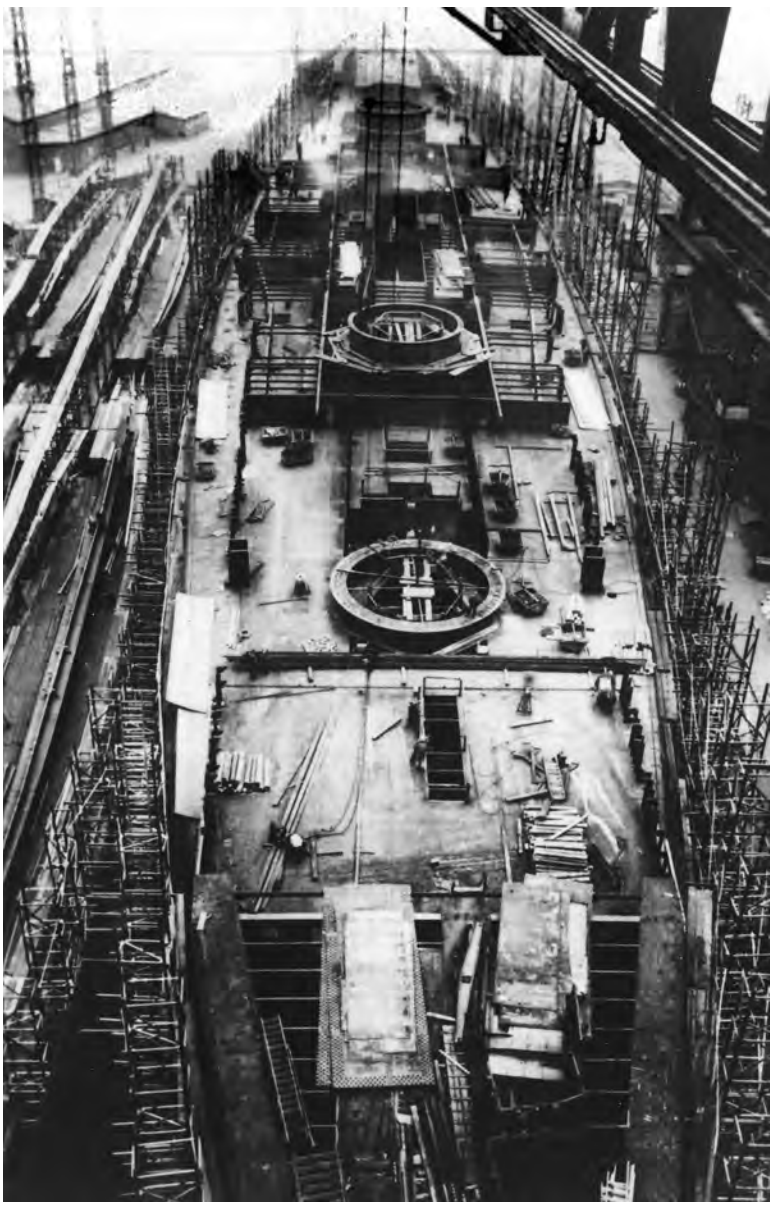
In April 1918, the War Cabinet decided that under the shipbuilding programme for 1919, work on *Howe* should proceed but that work on *Anson* should be deferred. This was ratified on 15 May when the Naval Expenditure Emergency Standing Committee stated that the Lords Commissioners of H M Treasury were pleased to sanction 'the continuation of work on HMS *Howe*, one of the three battle cruisers for which £10 million was sanctioned by the Treasury in 1 April 1916, instead of on HMS *Anson*'. There was no mention of *Rodney* at this stage. However, the Admiralty was pressing for two of the battlecruisers to be resumed at the normal rate, but the War Cabinet decided to defer a decision until the end of the year. In December, Fairfield was advised by the Admiralty that 'as regards *Rodney* it should be

Opposite: The battlecruiser *Mackensen* seen from under the top of the shipbuilding gantry at Blohm & Voss in Hamburg at the beginning of 1917. Laid down on 30 January 1915, work proceeded slowly until launching on 21 April 1917. Although fitting-out began, this was secondary to other warship programmes such as U-boats and *Mackensen* was still incomplete at the end of the war. A second ship of this class was laid down at the same yard while two others were under construction, one at Wilhelmshaven and the other at Danzig. *Mackensen* was broken up at Kiel in 1922. *(The Groener Circle)*

assumed, in making the future programme for the work in your yard, that this vessel will remain as at present, i.e. no expenditure for labour or material is to be incurred on her'.

At a meeting of the War Cabinet on 4 September, the issue of progressing two of the battlecruisers at the normal rate in addition to *Hood* was proposed but after discussion it was agreed a decision on this should wait until the end of the year. The Controller was of the view that this delay would not prevent these ships being completed in the first half of 1921. With the end of the First World War in November 1918, the urgency that surrounded *Hood*'s completion evaporated. However, *Hood* and her three sisters did represent the latest British capital ships and viewed against the large warship building programmes being undertaken by the Japanese and US navies, the issue was of importance. At the Board of the Admiralty meeting of 26 December 1918, the three sister-ships were discussed within this broader political context as well as noting the implications for large warship construction at home if they were cancelled:

> Question of completing *Anson*, *Howe* and *Rodney*.
>
> It has been pointed out by Messrs Cammell Laird & Co in whose yard *Howe* is laid down, that the berth on which she has been commenced was specially equipped at a large cost and is the most important in their yard, that it is a serious matter for the berth to continue to stand idle now that ample labour is available, and that unless the work on *Howe* is proceeded with, compensation will be claimed until the berth is available for merchant shipbuilding.
>
> The First Sea Lord informed the Board that the Chancellor of the Exchequer had intimated that it was assumed that the Admiralty would not proceed with new construction at the present time. He pointed out the difficulty in coming to any decision with regard to completing the three battle cruisers until more definite information is available as to the intentions of the United States of America in regard to their naval programme.
>
> It was generally agreed that, but for the United States programme which had been foreshadowed, there would not be any strong argument for proceeding with the construction of these ships, and it was felt that in any case until the exact nature of any international arrangements that may be made at the Peace Conference are ascertained, it would be impossible to obtain Cabinet approval to proceed with the construction of ships each of which will cost not less than £5,750,000. The view was expressed that in any event it might be better to take up the ships at once in order to set free the berths and so that, should it be necessary to lay down other ships of this Class, a fresh design embodying the results of recent experience might be adopted. On the other hand it was pointed out that this would leave a gap of practically five years in the construction of large ships. It was agreed that a memorandum should be forwarded to the War Cabinet setting forth the whole position in order to obtain a cabinet decision as to the policy to be adopted.



Right: Looking over the berths and platers' shed at the Fairfield shipyard during 1918. The suspended *Hood* class battlecruiser *Rodney*, to be broken up in the following year, is at left with a succession of vessels beyond. The liner *Ormonde*, serving as an Armed Merchant Cruiser, can be seen on the opposite side of the river. See drawing on page 121 showing vessels in the yard at this time. *(IWM Q18506)*

As late as February 1919, the contracts were still in the balance and on the seventh of that month the DNC wrote to Cammell Laird and Fairfield:

> I am commanded by My Lords Commissioners of the Admiralty to inform you that the question of proceeding with work on HMS *Howe*/ HMS *Rodney* has again been under consideration and it has been decided that all hull work including work on hull-subcontracts is to remain stopped for the present. It has also been decided that work on the main and auxiliary machinery and all work in connection with the main and auxiliary machinery for this ship is to be stopped for the present.

However, the fate of these ships was close to resolution as the Board meeting of 27 February made clear:

> …having regard to all the circumstances the Board agreed that the construction of HM ships *Anson*, *Howe* and *Rodney* should forthwith be cancelled and the slips set free for merchant ship construction, and that in communicating this decision to the War Cabinet it should be made clear that the question of building additional battle cruisers will be reconsidered at the earliest possible moment after the terms of peace are finally settled; as unless further battle cruisers are built in the near future we shall before long fall behind the United States Navy in ships of that class…

The 'Admirals' had begun life in the summer of 1916 as urgently required units to face expected German equivalents. Three years later, with the German threat gone, the Admiralty had refocused on the consequences of a post-war world where the Royal Navy would be at a considerable disadvantage to US and Japanese new construction. However, when the decision was finally taken in February 1919 to break the *Hood*s up on the slips, it was in the knowledge that far superior designs were under development and that future construction was in any case likely to be the subject of a peace conference and calls for disarmament.[12]

Final invoices were submitted by the three shipbuilders for a price covering work done together with a cancellation fee. Fairfield submitted the sum of £321,978 for *Rodney*, covering work on hull and machinery, that being their outlay including profit. However, the Admiralty's Dockyard Expense Account for 1919–20 lists a total figure of £614,852 for this ship which probably accounts for work done on armour and armament in addition to the shipyard's costs. The Dockyard Expense Accounts list expenditure of £315,732 on *Anson* and £470,521 on *Howe*, the latter about 8 per cent of expected final cost.

3: RETRENCHMENT AND REVIVAL, 1920 TO 1945[1]

Post-war Plans and the Washington Conference

In early 1918, in anticipation of a successful conclusion to the war, the Government advised the shipbuilding industry that the present level of warship contracts would come to an end and that they would thereafter have to rely substantially on merchant tonnage.

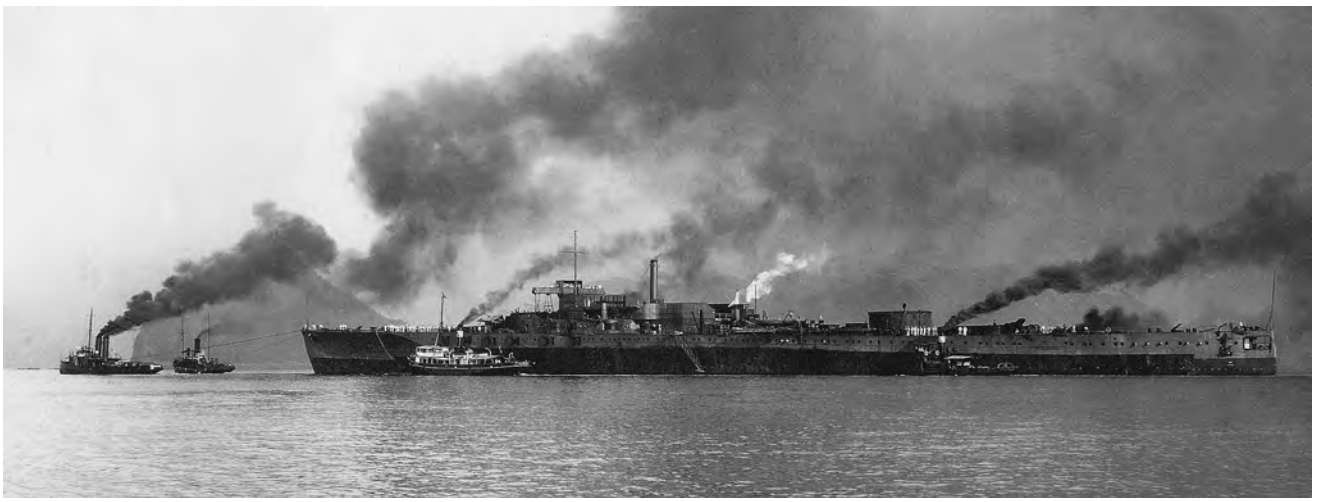
The cancellation of the three *Hood* class battlecruisers in 1919 ended the immediate prospect for manufacturing heavy armour and gun mountings and placed the armaments industry on the edge of a precipice. Having steadily built up capacity to handle unprecedented capital ship construction, it now seemed certain that there was no alternative to closing or 'moth-balling' much of this recently acquired capacity.

However, if armaments production was understandably about to collapse, such was the optimism that the end of the war engendered, that for shipbuilders at least, it was thought that a prolonged period replacing the ships lost to enemy action during the U-boat campaign was in prospect. So certain were they of this that some major shipbuilders, such as Beardmore and Fairfield, invested in additional capacity, adding new berths and steel working shops to their existing organisations.

The switch from war to peace production was structural in nature and had to be accomplished in a very short space of time as the orders for ordnance, warships and tanks etc, came to an end. It was thought that some of the heavy plant associated with armaments production could be utilised in the construction of civilian transport-related products such as locomotives, and as a consequence Armstrong Whitworth, Vickers and Beardmore established locomotive departments. One captain of industry, Sir William Beardmore, summarised the challenge facing the armaments industry in the following manner:

> It was as though in 1914 when the war commenced, we had to create nationally a huge wheel. We had to set it in motion, gradually getting up the speed for a considerable time, and by this huge store of energy overcome the munitions shortage. Since the Armistice, we have had to take the energy out of the wheel and gradually reverse its direction of motion. That you will agree is no easy thing to do – to reverse a wheel of such gigantic proportions as we were running during the war. We now have a big task in front of us, and I think history will relegate to us for the manner in which we have reversed this wheel and turned it into peace products.[2]

Other companies wasted no time in divesting themselves of what was now excess capacity. The pursuit of naval contracts which had brought John Brown, Cammell Laird and Fairfield into alliance no longer applied and they moved quickly, at the end of 1918, to divest themselves of the Coventry Ordnance Works which had struggled throughout its short life, which with the exception of the war years had been a serious drain on resources. A new firm, the English Electric Co Ltd, established in December 1918 by John Brown to manufacture electric motors and transformers, took over the Coventry works. However, the



Above: The consequences for Japan and the USA following the signing of the Washington Treaty was the commitment to dispose of battleships and battlecruisers then under construction. Here the incomplete battleship *Tosa* is being moved from her builders at Nagasaki, Mitsubishi, in August 1922. She was sunk as a target in 1925. *(Author's collection)*

Scotstoun gun mounting branch did not fit easily into this arrangement and was sold separately to Harland & Wolff in 1920 who used the works to manufacture marine diesel engine components. Other alliances borne out of the Anglo-German naval race broke down at the same time: Cammell Laird and Fairfield disposed of their joint shareholdings in one another to concentrate on core activities.

However, all hope of a future capital ship building programme had not receded. In fact, while the First World War raged in Europe, the first steps in a new naval race had already been taken by the United States and Japan who were looking afresh at their wider interests in the Pacific region. In the United States, a naval expansion Bill was passed in 1916 under which terms a battlefleet comprising ten battleships and six battlecruisers were to be built providing the United States with, in the words of President Wilson, 'incomparably the greatest navy in the world'. The Japanese response to what was perceived as a direct threat to their areas of influence in the Pacific, came in the form of the so-called 8-8 programme which envisaged a battlefleet equal to that of the US Navy comprising eight battleships and eight battlecruisers to be completed by 1928.

In the United States, between 1917 and 1921, four *Colorado* class battleships, *Colorado*, *Maryland*, *Washington* and *West Virginia*, six *Lexington* class battlecruisers and six *South Dakota* class battleships were laid down. The first two battleships of the 8-8 programme, *Nagato* and *Mutsu*, were laid down in 1917 and 1918. These were followed by two further battleships, *Tosa* and *Kaga*, both laid down in 1920 and four battlecruisers, *Amagi*, *Akagi*, *Atago* and *Takao*, laid down in 1920 and 1921.

At the end of the First World War, the Royal Navy, with the largest but ageing battlefleet in the world, had to reconcile the fact that the planned US and Japanese capital ships would inevitably be superior. *Hood*, the most modern British capital ship, did not fully embody the lessons of the recent war and there were no capital ships under construction or planned with the exception of the three *Hood*s, the design of which was still rooted in pre-Jutland thinking.

Rapid advances made during 1905–20 meant that the oldest ships armed with 12in and 13.5in guns were markedly inferior to the most recent 15in-gunned ships, while the new Japanese and American ships mounted 16in guns. Despite the exhausting and financially crippling war years, if the British Government was to remain in the forefront of the world's fleets, it had little option but to begin the process of planning a major capital shipbuilding programme of its own.

The G3 Battlecruisers

The Director of Naval Construction, Sir Eustace Tennyson d'Eyncourt, and his team of constructors began work bringing together a wealth of accumulated wartime operational experience as well as feedback from *Hood* which began trials early in 1920. Throughout 1920 and 1921, the DNC's department developed a large number of designs most of which made a radical break from previous design conventions. These designs were evaluated by the Admiralty and from this process a definitive battlecruiser, the G3 design, and battleship, the N3 design, emerged with the intention that four battlecruisers would be laid down in 1922 and four battleships in 1923. The G3 and N3

designs represented the pinnacle of British capital ship design in size, offensive power and protection and were unmatched until the later variations on the *Lion* class twenty years later.

See table at right for particulars of the G3 design as signed off by the DNC in February 1922.

The N3 battleship design mounted 9 x 18in guns on a similar displacement to the G3s but were not as long, reflecting the smaller machinery spaces for a slower speed of 23.5 knots. The N3s were never ordered and the final design was still in gestation at the time of the Washington Conference. With the G3 design complete, drawings were provided and a specification drawn up to enable the tendering process to begin.

Although Portsmouth and Devonport Dockyards would never build a capital ship again, partly because of physical restrictions on larger hulls, the DNC's department was alive to the issue resulting in the following reply written on 19 July 1919 by C L Hutson in response to a question posed by constructor E L Attwood:[3]

> Mr Attwood,
>
> With reference to your query as to the possibility of [building] a warship similar to HOOD at Portsmouth, Devonport or Chatham Yards, the plans have been examined and it is considered impractical to do so with the yards at present equipped for the following reasons.
>
> Portsmouth
>
> The Steam Basin at the head of the building slip does not allow of extension sufficient to take a ship of this length. It is considered that the construction of a ship in either Lock C or D would be objectionable, as it would only leave the other Lock for docking bulged ships; during which the only available entrance for large ships would be M opening from the Fountain Lake (tidal) and then only at light draughts and very small clearances.
>
> Devonport & Chatham
>
> There is room for the necessary extension of the present building slips, but the vessel after launching could not be taken into any of the basins for completion, and there are no docks of sufficient size.

Clearly the same factors applied to some of the private yards, the consequence of which was that Palmers, Scotts and Vickers were also out of the running unless they were prepared to spend large sums reorganising their yards.

BASIC PARTICULARS OF THE G3 BATTLECRUISERS

Length on waterline:	850ft
Length overall:	862ft
Breadth:	106ft
Draught:	32.5ft
Displacement:	48,360 tons. In fighting condition (extra deep), displacement rose to 56,540 tons.
Main and secondary armament:	9 x 16in 45-calibre with 40° elevation in triple turrets; 16 x 6in 50-calibre with 40° elevation in twin turrets.
Protection:	14in belt armour over machinery and magazine spaces, 14in barbettes; 8in and 9in deck armour over magazines, 4in over machinery spaces.
Machinery:	160,000 shp for 32 knots.

While the G3 and N3 designs were carried forward, international consensus was being sought in Washington DC where a conference gathered on 12 November 1921 attended by the leading naval powers. The aims of the conference were numerous although, in the broadest sense, these were to prevent a new arms race which potentially would make Britain, the United States and Japan adversaries. Implicit in this thinking was that the recent Anglo-German naval race had at least contributed to raising the temperature in an increasingly volatile political environment. The growth of the US and Japanese navies in particular pointed to a future conflict in the Pacific, an area also of considerable importance to the British in the maintenance of Empire. At the same time, rivalry between Britain and the US was already manifest in US war planning scenarios against Britain, codenamed War Plan Orange.

Although the thought of a new arms race was clearly abhorrent to governments given recent events, nevertheless this scenario was considered should consensus fail to be reached on these issues. It is against this background that the following chronology charts the events leading to the ordering and subsequent cancellation of Britain's new capital ship programme.

August 1921. Provisional orders placed with Armstrong Whitworth and Vickers for the triple 16in main armament mountings and twin 6in mountings for the G3 battlecruisers. The 16in gun mountings were designed by Armstrong and the total requirement of twelve mountings plus three spares was split equally between the two firms. These complex and large mechanisms had to be ordered first to ensure they would be complete when the hulls were launched and ready for installation.