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The Transfer of Shipbuilding Knowledge
Reconstructing HMAS Warrego (Part 1)

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By the end of the nineteenth century Glasgow had become one of the world’s centres of naval and marine engineering. Engineers on the Clyde had managed to establish a culture of scientific engineering, drawing on both theory and experimentation. When in 1909 the newly established Australian Navy commissioned five torpedo-boat destroyers, it was not surprising that shipbuilders from the Clyde successfully tendered for the contract. However, the Australian Navy did not simply want to acquire modern warships; they also wanted to learn how to build them. Therefore, two destroyers were built in Glasgow, one, the HMAS Warrego, was built, taken apart and rebuilt in Sydney, and two more were built in Sydney, using the experience acquired from reconstructing HMAS Warrego. This first part of the paper looks at shipbuilding on the Clyde and tries to understand the Australian Navy’s reasoning behind the rebuilding of HMAS Warrego; a second part, which will be forthcoming, aims to examine the shipbuilding and yard practices and their appropriation in Australia.

In 1901 Australia’s six colonies received federal status and the Commonwealth of Australia was formed. As much as independence was welcomed by the Australians, feelings in London were more cautious, especially when Australia announced its plans to build its own Royal Navy. An important part of Australia’s plans for independence was to build a fleet of naval vessels as effective for its purposes as possible. When the Australian Navy was established in 1909, the Australian Government was well aware that its existent fleet would be insufficient for protecting a country of its size. Putting its emphasis on coastal defence, plans were developed for a fleet of

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one 1st class destroyer, one 2nd class destroyer, six torpedo-boat destroyers, and two torpedo boats.¹ At this time Britain was the main supplier of such naval ships, and its designs had been widely standardised by the Admiralty, and fleets around the world, from Asia to South America, and supplied by the British.²

With Australia’s extensive coastline and many rivers, the majority of the fleet would be composed of fast and well-armed boats – criteria met by Britain’s established torpedo-boat destroyers. The two large destroyers would act as the Navy’s flag ship vessels and the two torpedo boats could be employed for harbour defence.³

Building a fleet was not an easy task. Australia was keen to become independent in naval shipbuilding but had little experience in this type of work. As the Australian Prime Minister, Scottish-born Andrew Fisher, to whom the project was so important that he personally oversaw it, was keen to point out, that even if the government would be able to obtain designs and plans from the London Admiralty, knowing how to build the ships would still be ‘a question entirely of experience’.⁴

Not surprisingly, the Admiralty in London was not very forthcoming with sharing their guarded knowledge, and was quick to let the Australian government know it was not them who produced the designs but their British contractors, who – of course – wanted to sell ships and not designs. But when the Australian Government announced its plans to have the coastal torpedo-boat destroyers designed and built in Britain, the response from Australian trade commissions, labour organisations and learned societies also was far from enthusiastic: they were quick to point out that shipbuilding skills existed in Australia and that British shipwrights could always visit Australia as consultants if required. At the time, Australia was in the middle of building its first iron trawler and fishery vessel, the Federal Trawler Endeavour, a ship of dimensions similar to the proposed coastal destroyers, and skills could be transferred easily. There was no need to have ships built in ‘the old country’ if the same could be achieved by Australian shipyards.

The Australian Government took a slightly more critical view on this matter, compared to the trade industry, and the Prime Minister, when meeting with representatives of local trade and labour organisations, reminded them that Australian shipbuilders had indeed a broad range of shipbuilding skills but that building the destroyers required specialized knowledge still to be acquired in Australia.

The Prime Minister did not doubt that Australian shipbuilders could build the destroyers but argued that valuable time could be saved by drawing on British designs and practices. He proposed to have two torpedo-boat destroyers built in Britain, another built in Britain, taken apart, shipped to
Australia and rebuilt there and three more built in Australia by Australian shipyards. By doing so the government expected to obtain plans and specifications for the ships, to develop a naval dockyard, to build or order all relevant machinery and, most important, to train its own shipbuilders. A crucial part of the project was the Australian Government’s proposal to send leading artisans to Britain to gain knowledge in the specialities in craftsmanship and methods in building destroyers.5

The role and importance of skills in naval shipbuilding had been well understood by the turn of the nineteenth to the twentieth century. The Glasgow naval architecture professor and Admiralty consultant, John Harvard Biles, who became responsible for overseeing the building of the Australian torpedo-boat destroyers in Britain, identified three professions that were crucial for the successful design and construction of modern battleships. First, there were the scientists, such as the chemists and metallurgists, who developed the materials required for building light, stable ships. Then, there were the naval architects, who designed the ships. Finally there were the craftsmen, who turned the materials and designs into a completed naval ship. As Biles summarised it in his James Watt anniversary lecture given to the Greenock Philosophical Society in 1911: ‘The design and construction of a modern battleship is seen to be a matter requiring great skill and experience on the part of many men of different professions.’6

From the outset of the project it had been clear that a professional skill transfer could only be successful if parts and components were interchangeable, a common requirement for Admiralty ships and in Australia already widely practised, for example, in locomotive building. The design for the ships was to be based on the River Class destroyer, a highly successful British export item at the time, with deliveries to countries as far as Brazil and Chile. However, the successfully tendered design had to meet Australian coastal requirements, including stability, operational radius and long-range wireless.

Of the some eight British shipyards that tendered for the contract, a joint venture of Fairfield’s and Denny’s in Glasgow was selected. Fairfield had an excellent reputation for its work in thermodynamics and engine design and Denny for its work on hydrodynamics and hull design. Furthermore, Denny maintained a test tank on the river Leven (that meets the river Clyde) which enabled it to put the Australian Government’s design specification to test before the ships were built, thereby trying to ensure that especially the Australian speed requirements were met.7 As Biles informed the Australian Government, Fairfield’s and Denny’s tender was the lowest; with design, strength, stability, price and delivery superior; and with expected time of delivery the shortest. Furthermore, the tender included up to 20 Australians
to be trained on the Scottish yards and the induction of Scottish men to work in Australia and eventually settle there.

Professor Biles supervised the project and work closely with Commander Clarkson, who had been delegated by the Australian Government to supervise the work. Four Australian engineers and 12–18 workmen would come to Scotland. The shipyards would also train Australian naval staff for actual service on the ships. The Australian workers going to the Clyde yards would be paid by the yards but have their salaries topped up to Australian levels by their government.8

Further contract arrangements included that speed trails would be performed on both shallow and deep water and that the ship to be rebuilt in Australia would only be dismantled when the test trails on the two Scottish-built ships were completed. The names chosen for the first two ships were HMAS Yarra and Paramatta, the third ship to be rebuilt in Australia would be named Warrego, all named after Australian rivers.

The Australian Government still had to decide where to establish its new naval shipyard. Several locations along the coast were investigated and surveyed but finally proposals only sought from Sydney and Victoria. Victoria could draw on its vast experience and machinery in locomotive building.
Sydney, however, had suitable machine and fitting shops, a foundry, pattern-making shops, and a sufficient labour supply. Finally, it was the fact that the Sydney yard, located on Cockatoo Island, built its own machinery that turned the scales.9

Still, Cockatoo Island was far from perfect: Yes, there were machine tools but many of them would be too small for the work to be done, such as turning large propeller shafts. And as the yard was on an island it would be difficult to provide an iron and steel supply. But of all Australian dockyards, Sydney was the most developed. The yard’s managers felt confident that they could supply the 150 men required for the seven-months rebuilding of Warrego. Labour organisations were keen to point out that they had some 400 apprentices available in relevant crafts. And the Australian Association of Ship Joiners produced a list of skills and work they were able to provide to ensure there was no overlap with British suppliers.

Delivering ships and boats abroad in parts and reassembling them was not new and had been done many times before, for example with paddle steamers, an experience the Glasgow yards could readily draw on.10 The hull of the ship destined for Australia would be framed and planked, the boiler and machinery would be assembled and all structural parts put together. The ship would then be taken apart again, to be delivered in sections for completion in Australia. As a local witness put it, it would be: ‘erected, marked,
bundled, and packed (including) propeller machinery, fittings and equipment, index and other plans, rivets and bolts."\textsuperscript{11}

Prior to shipment, the naval architect would examine all parts, and Australian workmen would supervise the packing in Scotland so they would be able to identify all parts upon arrival in Sydney. The several hundred sections, crates and packages for rebuilding the destroyer would then be shipped in several loads by steamships on route to Australia. Some items were to be delivered directly from suppliers in Britain, such as the water tank coating from its London manufacturer, together with instructions on how to apply it.

Shipping a dismantled iron battleship around the globe posed challenges and several frames were damaged in transport — and as Australian workers pointed out with professional pride, repaired quickly. However, a public debate ensued about who was to blame for the more than 500 damaged items. Had it been due to poor packing by British yards or poor handling by the Australians? The debate was covered at great length by the Australian paper \textit{SUN}, which wondered if perhaps the British had supplied the Australians with faulty material. Eventually the Australian Government intervened in order to close the debate and to re-establish public trust in British engineering and workmanship.

But what types of knowledge were transferred during the rebuilding exercise? One must examine carefully what type of training was necessary and useful for what type of activity. A formal training might be useful for the design of a new ship or engine but might not necessarily benefit operating a machine on the shop floor. Also, no strict line between different forms of training can be drawn. For example, a more formally educated engineer could well have received a practical training though an apprenticeship. It would not have been unusual for him to have received training abroad or to have conducted studies or training on his own. A machine operator might have taken evening classes or attended college, which were common ways to acquire technical knowledge in Scotland at the time.

A form of training that has often been neglected by historians but thankfully has received more attention recently is the role of apprenticeships. Apprenticeships, both in Britain and Australia, had a long and established tradition, much longer than formal training, and were widely used for engineering education. An apprenticeship could take several years and was often based on a highly personal work relationship between apprentice and master. One also needs to keep in mind that apprenticeships often extended beyond the work relationship of master and apprentice. Especially in large industrial centres such as Glasgow, the learning of new skills and practices would not end at the factory gates. Skill transfer could for example take place within a
family where family members worked in the same trade, sometimes over generations.¹²

What does technical training include? Reading and understanding blueprints, orders, instruction manuals, and machine charts was essential for any meaningful technical work. Machine tools provide one example: reference lines had to be marked on the work piece. The tools had to be installed and the work piece had to be secured properly in its holder. The lathe had to be adjusted and the speed, feed rates, and depths of cuts to be selected. The flow of coolant had to be controlled and chips had to be removed. Last but not least the lathe had to be maintained and worn out tools had to be replaced. In a larger shipyard an operator could specialize, for example as a set-up or production operator. Other practices were more ubiquitous such as posture (never lean on the lathe, protect your eyes, do not touch moving parts), clothing (wear tightly fitting clothing, roll up sleeves, remove rings and watches), or environment (keep your work-area oil free, earth an electric machine etc.).

A significant amount of technical knowledge can only be experienced and understood through practice itself. This was a well-known fact to shipbuilders both in Australia and Britain at the turn of the nineteenth to the twentieth century. This is why Australian shipbuilders continued to train in Britain and when Denny and Fairfield tendered for HMAS Warrego, the tender included for Scottish shipbuilders such as fitters and turners to settle in Australia.

Was the rebuilding of the Warrego and the envisioned knowledge transfer a success? If a ship launch is an indication of a shipbuilding success then it

certainly was: HMAS *Paramatta* was launched at Fairfield’s in 1909, HMAS *Yarra* by Denny’s in the same year, and the reconstructed HMAS *Warrego* launched in Sydney harbour in April 1911, two years after it had been constructed in Scotland.

However, transferring shipbuilding knowledge had not been free of difficulties and there had been some delays with the *Warrego*’s reconstruction. The seven months anticipated for the completion of *Warrego* on Cockatoo Island had turned out to be too limited. Rebuilding *Warrego* had required considerably more time, labour and skill than the original construction had. Skills and knowledge acquired on the Glasgow yard had to be both transferred and implemented in Sydney. But once *Warrego* had been successfully completed the remaining three Australian-built destroyers were constructed quickly and in 1912 the HMAS *Huon*, the first fully Australian built naval steel vessel was launched. Boiler making might serve as another example here. Based on the boiler received with *Warrego* a new boiler was designed and constructed for *Huon* in Sydney and from then on naval boilers were produced in large numbers on Cockatoo Island into the 1950s.13

Although it had been engineers from Sydney University advising the Australian Commonwealth’s Navy during the rebuilding project, it was the Technical College in Sydney that benefited most from the reconstruction exercise. By the time all torpedo-boat destroyers had been completed the College had successfully established marine engineering in its syllabus. Subjects covered included the construction of light and heavy duty engines, gears and propellers, screws, their installation and much more, all required for building naval ships.14 Ten years after the Australian Navy ambitious project had been launched the syllabus already covered more than 30 subject areas. Training was not confined to the campus and included practical training in the yards.

In the second part of this article (co-authored with Alexander Hayward) we will examine in detail what skills and technologies were transferred from Glasgow to Sydney and what machinery and tools were needed and acquired by the naval yard in Australia, and we plan to make available an inventory of Scottish-made machine tools used at Cockatoo Island at the time *Warrego* and her sister ships were built.15 We also will further examine the role and relationship of apprenticeships and engineering training on Cockatoo Island and how newly acquired shipbuilding skills became institutionalised in Sydney and elsewhere. Looking more closely at the actual skills, training, machinery and yard practices will enable us to address broader questions about replication of action and knowledge. This in return will enable us to contribute to on-going discussions on what humans – and machines – can do.16
NOTES


2 This early area of the Australian Navy has been canvassed by several authors; however, little or no attention has been paid to the transfer of shipbuilding knowledge. For one of the more comprehensive studies see J. Jeremy, *Cockatoo Island* (Sydney, 2005).


4 NAA: MP1049/14, 1911/3652.

5 NAA: MP1049/14, 1911/3652. No records have been identified yet who these men were and what trades they represented. This will form a crucial part of our planned fieldwork in Australia.

6 Biles, *The modern battleship* (n. 3 above).

7 The Denny Tank in Dumbarton is maintained as a museum today and its machinery is part of National Museums Scotland.

8 UGD: 3/5/0460, the contract was largely negotiated by Fairfield and much of the contractual material is still in existence.

9 For an introduction to Cockatoo Island see Jeremy, *Cockatoo Island* (n. 2 above).

10 Lake steamers are one good example, such as the still active SS *Walter Scott* (1899) on Loch Katrine.

11 NAA: MP1049/14, 1911/3652.


15 Tentatively scheduled for publication in *ICON* at the end of 2015.