Electrolytic copper was both the conduit for and also the product of the electrical age. Copper was indispensable for the generation and transmission of electricity on an industrial scale. Yet in order for copper to possess the necessary conductive qualities, it had to be refined to a purity made possible only by electrolysis.¹ Although the theoretical science of electro-chemistry was complex and difficult to master, it was not a matter of secret knowledge.² Whereas copper smelting had been a ‘craft’ industry, in which each works tried to prevent the others knowing about their techniques, an international community of physicists, chemists and engineers discussed electrolysis in their learned journals.³ A lecture series on non-ferrous metals given at the Royal Society of Arts in London in 1896 argued that, ‘there is but little to be said about copper refining’ because so much had been published in specialist journals.⁴ The widespread appreciation of the importance and method of electrolytic copper did not lead to an even spread of refining technology. The first patent for electrolytic refining had been registered by the Briton James Elkington in 1865. The world’s first electrolytic refinery had opened in Wales in 1869.⁵ By the

¹ Electrolytic copper emerged from four processes: (1) the mechanical process of crushing the ore; (2) the hydrometallurgical process of concentrating the ore; (3) the pyrometallurgical process of smelting the ore; and (4) the electrolytic process of refining the metal. Adapted from A. Dow, «Metal Mining & Canadian Economic Development to 1939», Business History 32 (1990), 147–161, 148; H. C. H. Carpenter, «Progress in the Metallurgy of Copper», Cantor Lecture III, 1917, Journal of the Royal Society of Arts 66 (1918), 141–153, 144.


beginning of the twentieth century, however, the American copper industry was well ahead of its competitors. Much of the public discussion of electrolytic refining referred to American plants and American techniques. The world copper industry was transformed in a very short period in the 1890s. Before 1893, most American export ore had been smelted into crude matte then sent to Europe for refining. By 1900, American exports were dominated by electrolytically-refined copper. The single most important change in the copper industry was not the fact of refining, but the emergence of huge refineries. The bench-mark American refinery, Raritan in New Jersey, had twelve hundred copper tanks at the beginning of the twentieth century and grew rapidly thereafter.

The copper refining industry thus fits into a broader picture of American exceptionalism that has found favour in recent literature. The presence of extensive mineral deposits on US soil drove the search for technological means to exploit them. The argument for American exceptionalism does, however, raise a problem in explaining the process of technology transfer. It does not account for the pattern of the transfer of large-scale electrolytic refining across the Atlantic. In the first decade of the twentieth century, refineries on the American scale were built in Germany and Belgium. The technology of big copper was not, however, adopted in Britain.

1. Technology & the Network

A solution to the pattern of technology transfer was offered by Alfred Chandler in Scale and Scope. Chandler observed that, British firms did adopt the revolutionary electrolytic techniques but failed to utilise them effectively. According to Chandler the transfer of refining technology could be explained with reference to his basic unit of analysis, the firm. The organisational capabilities of industrial firms dominated the national economies. Learned organisational skills were company and industry-specific. They were not, of course, Chandler remarked, patentable. The key to British backwardness, in Chandler’s view, was the

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dominance of «personal capitalism», which failed to foster the development of a bureaucracy. As a result, there was no institutional memory and therefore no predictive, strategic capabilities. On the other hand, the bureaucratic firm flourished in Germany. Germany was thus able to absorb the American method of refining and establish a major position in the world copper industry.¹²

For all its elegance, there is nevertheless a flaw in the classic Chandlerian view.¹³ Chandler’s characterisation of «American», «German» and «British» firms is problematic with regard to the pre-war copper industry. Chandler noted that the transfer of technology was accomplished by Metallgesellschaft, a German firm that fitted his general model.¹⁴ Metallgesellschaft was a multi-divisional company, in possession of the defining characteristic of the German firm – a central research and development laboratory.¹⁵ Its technology division was created in 1889 and, «almost all of Metallgesellschaft’s industrial undertakings – whether portfolio or direct investments – received technological assistance of one kind or another.»¹⁶

Yet it is possible to reconceptualise Metallgesellschaft not as a firm, but merely as one element of a much wider network. It was the network – not the firm – that transferred capital and knowledge, with little regard to state borders. This network was centred on the Merton family and bound together by a web of family connections in Germany and Britain, and on both sides of the Atlantic.¹⁷

Ralph Merton was a Londoner who married the daughter of a Frankfurt metal dealer. Merton settled in Frankfurt and took over the running of his father-in-law’s business.¹⁸ Ralph Merton had four sons. The eldest, Henry, returned to London to create a metal trading company in 1860: Henry R. Merton & Co. Ralph Merton’s fourth son William, or Wilhelm, Merton, took charge of the family’s Frankfurt business, having spent three years living in London running the British trading

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¹⁴ William Merton transformed the metal traders Merton & Cohen into Metallgesellschaft in 1881. In 1897 Metallurgische Gesellschaft A.G. was formed to administer processing activities. Metallgesellschaft continued to handle metal trading. In 1906 a third company, Metallbank, was added to the group. Metallbank was a finance company to which many of the holdings in American Metal and Henry R. Merton were transferred. In 1910 Metallbank and Metallurgische Gesellschaft were merged into one company. Metallgesellschaft itself became a public company. Chandler, Scale and Scope, 487–488; J. Borkin, The Crime and Punishment of I. G. Farben (New York, 1978), 167.
¹⁷ B. W. de Vries, Of Mettle & Metal: From Court Jews to World-wide Industrialists (Amsterdam, 2000).
company after the death of his older brother. William Merton himself had four sons, two of whom, Richard and Alfred, succeeded to his control of the family empire. For many decades, the Mertons maintained a fluid identity. William Merton and his sons only became German subjects in 1900. Up until his death in 1916, observers ascribed Merton’s manners and social attitudes to his ‘Englishness’.

The Mertons comprised, however, not only Ralph Merton, his sons and grandsons, but a much broader network encompassing relations by marriage, such as the Cohens, Ellingers, Hochshilds, Ladenburgs, Eulers, Baers and Vogelsteins, built up over several generations. This wider group meets all the criteria for a ‘clan network’. Self-evidently, the Mertons were a ‘blood-kinship’ clan. They also acted as a ‘social-integrative’ clan with internal social and emotional ties extended to those who, even if not relations by blood or marriage, had been socialised into the network. A notable example of this latter type of member was the head of the network’s London operation, a gentile who had joined as an office boy and worked his way up over the decades. Most importantly of all, the network acted as an ‘economic-co-operative clan’, comprised of calculating and cooperating individuals. The roots and main activity of the Merton network was metal trading, a business involving constant transactions and a high degree of uncertainty, against which the shared trust in long-term equity for ‘insiders’ acted as a hedge.

The Mertons themselves, however, were at pains to stress the identity of the firm rather than the network, thus complicating the task of later commentators such as Chandler. The structure of the network was deliberately camouflaged to look like a discrete series of free-standing firms. Such practices were standard on both sides of the Atlantic. In America, the copper industry was a byword for disguising ownership and control. The American Smelting & Refining Company (ASARCO) and Amalgamated Copper comprised two of the seven ‘great trusts’. The ‘trustbusters’ enjoyed limited success against the copper trusts. The veil

19 de Vries, Of Mettle & Metal, 97.
was lifted only in times of crisis; much of the information about the Mertons that reached the public domain was the result of wartime or post-war trials. In pre-war Germany, William Merton, when challenged about the nature of the network, followed the standard practice of dissimulation. When identified as a premier exponent of «stock-and-bond-capitalism», who controlled legally-independent foreign firms through stock manipulation, Merton retorted that he was, in fact, creating truly independent business organisations. This was untrue. The London metal trading operation, for instance, was fully integrated in the network. It had become a limited company in 1898. Although Metallgesellschaft had only a relatively small holding in the company, the Merton private finance corporation owned a quarter of the shares and a Merton front company in Switzerland owned another large stake. William Merton directly controlled well over half of the share capital – the very pattern of «stock and bond» control he was at pains to deny. In public, he deprecated the model of the multinational corporation because, he claimed, problems of communication meant that branch offices could not be properly controlled from head office in Frankfurt. His unspoken alternative was a network that did not need day-to-day instruction because its thoroughly socialised members already understood each others’ minds.

The Mertons’ business strategy was underpinned by an understanding of technology and its implications. They identified the revolution in copper refining that had begun in the USA in the late 1880s. They realised that this great leap forward in production capability was matched by a likely increase in demand. In 1891, their home city, Frankfurt, held the International Electrical Exhibition. A system for transmitting high-voltage AC between a generating station on the Neckar river and the city was built for the exhibition. In 1891, there were forty-three electricity-generating stations in Germany; in 1904 there were well over a thousand – a twenty-six fold increase. By that date, seventy per cent of global copper production was electrolytically-refined for potential use in electrical systems.

The Merton’s response to these opportunities was a policy of «backward integration» on a transatlantic basis. Merton-controlled trading companies moved into refining. In 1887, the Mertons formed the American Metal Company in the USA. In 1891 American Metal built a large refinery in New Jersey. Copper refining was attractive to backward-integrating traders because of its «low asset-specificity by site». There was no need to build copper refineries near copper

27 In the Matter of the Non-Ferrous Metal Industry Act 1918: Board of Trade and Gardner – Particulars Delivered by Henry Gardner, March 1919, AMC Archives.
29 Chandler, Scale and Scope, 487–488.
32 Wilkins, Foreign Investment, 269–70.
33 Chandler, Scale and Scope, 487–488.
mines. New Jersey had no geographical proximity to the main American copper reserves in the western United States. Yet the forward-integrating Anaconda mine from Montana also built its main refinery in New Jersey. A number of factors led the refiners to the mid-Atlantic seaboard: lax corporate governance, good communications and a secure supply of high-voltage electricity. For a backward-integrating concern such as the Mertons, the arguments were all on the side of locating near the consumer.34 By 1911 American Metal, and another German firm of traders-turned-producers, Aron Hirsch & Sohn, controlled thirteen per cent of world refinery output.35

The Mertons transferred the technological advances in copper refining in America even closer to the European market. Electrolytic refining was far from undeveloped in Germany.36 Norddeutsche Affinerie in Hamburg had commissioned the world’s first continuously-operating copper tankhouse as early as 1876. Yet when the Mertons took over the company at the beginning of the twentieth century, they began afresh with a new facility in the Peute industrial area on the outskirts of the city. The transfer of all processing activity to the new Peute site was complete by 1913. From the time Norddeutsche Affinerie was completed until the outbreak of the First World War, something of the order of sixty per cent of American copper exports were shipped to Germany.37 At the same time, the Mertons began to diversify their sources of supply. In 1906, the Union Minière du Haut Katanga was created to exploit the Copperbelt of the Belgian Congo. The Mertons responded by opening another major electrolytic refinery on the same model as Norddeutsche Affinerie. As in the case of Hamburg, they already owned a refining plant in Antwerp.38 Their new Belgian copper refinery was opened at Hoboken in 1912.39

Technology transfer through the Merton network had created a strong position for the family by the time the First World War broke out. The claim that ‘for a generation German interests had dominated the metal output of the world’, was, however, overstated.40 The Mertons had an important but far from dominant position in the USA. In the last full year before American entry into the First World War, the Mertons, in conjunction with their allies the Vogelsteins, handled sixteen per cent of American copper by weight. The American Smelting & Refining

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38 S. M. Auerbach, «Jews in the German Metal Trade», *Leo Baeck Institute Yearbook* 10 (1965), 188–203.
40 Morse, «The Price-Fixing of Copper», 71–106.
Company (ASARCO), however, handled over fifty per cent.\textsuperscript{41} Nevertheless, the Mertons combined a strong position in the USA with a truly dominant position in Europe. By importing large-scale electrolytic refining, on the American model, to Hamburg and Antwerp, the Mertons had overtaken all their potential rivals. The entry barriers for any European concern that wished to challenge their hegemony – stretching from processing in continental Europe to trading on the main spot market, London, were exceptionally high.

\textbf{2. The Impact of War}

Networks relying on the free movement of people, ideas and commodities across national borders were particularly ill-suited to conditions of ‘world’ war. War privileged patriotism over commerce, and demand over supply. Nevertheless, the Merton network proved remarkably resilient even in face of strengthening wartime economic nationalism. The British state, a negligible factor in the non-ferrous metal sector before 1914, became an important player. Even in the face of state power, however, the network did not accept changes to its position passively. Indeed, the fact that negotiations did not run their course until the end of the war suggests the strength of the Mertons’ opening position.

In the case of non-ferrous metals, the ‘backlash’ against globalisation was definitely a post-1914 phenomenon.\textsuperscript{42} Although one can detect grumbling about the Mertons, there was no purposeful nationalistic attempt to curtail their network during peacetime. The ‘imperial nationalist’ opportunists could only challenge the network under the peculiar conditions of war.

Within the British Empire, two groups, Swansea copper smelters and Australian non-ferrous metal mine owners had a pressing interest in renegotiating their relations with the Mertons. The Swansea copper smelters had followed a very different course from that of the Mertons. Although the first electrolytic refineries were built in Wales, refining did not become the key element of the trade in Britain. In the early twentieth century, most of the Welsh producers dropped out of electrolytic refining to concentrate instead on fire refining, or advanced smelting of copper. There was a technological and business rationale behind this decision. Electrolytic refining was excessively costly if the copper was not intended for electricity-conduction. In addition, electrolytically-refined copper was not sufficiently malleable for industrial use. The Welsh strategy was to fire-refine cheap, flexible copper, mainly for use in the domestic shipbuilding industry. Although this decision was not in itself irrational, it was misguided. By 1914, it was clear that the Welsh smelters had manoeuvred themselves into a cul-de-sac.\textsuperscript{43} Those

\textsuperscript{41} F. E. Richter, «The Organization of the Copper Market», \textit{Harvard Business Review} 1 (1923), 196–211.


\textsuperscript{43} Newell, «'Copperopolis'», 75–97.
Welsh producers who had forward-integrated into dealing during the nineteenth century were increasingly forced into a subsidiary relationship with the Mertons, who not only held the trading agencies for their own electrolytic European facilities but had an influential role in shaping the market via their US interests. Traders buying and selling copper under these conditions were at a permanent disadvantage. The lessening of Merton power and resources could only be to their benefit. In 1914, the ‘Welsh’ were led by Cecil Budd. Budd’s family owned a copper smelter near Swansea. He himself headed one of the Mertons’ trading rivals, Vivian, Younger and Bond. Since 1902, Budd had chaired the London Metal Exchange.

The second group who had an interest in, literally, renegotiating their contracts with the Mertons were a number of Australian mining companies, known collectively as the Collins House Group. Members of the group had extensive interests in the Broken Hill silver-lead-zinc mines in western New South Wales. The most outspoken representative of the ‘Australians’ was W. S. ‘Bill’ Robinson of the Zinc Corporation. At the turn of the twentieth century, many observers had believed that Broken Hill would prove a finite asset as, ‘the complexity of the sulphide ores so completely outmoded the early methods of treatment … that the mines would be abandoned after the oxidised ores were extracted.’ Lead mining created spoil heaps which were rich in tantalisingly inaccessible zinc. From 1905 onwards, a two-fold solution emerged. First, hydrometallurgic techniques were applied to create zinc concentrates on site. This process was far from straightforward, however. The near identical specific gravity of the zinc and the gangue defied the first attempts at concentration. It took fifteen years of continuous effort at Broken Hill to produce a workable flotation technique that could be applied to this difficult ore.

The Mertons were in an excellent position to exploit this breakthrough. They had arrived in Australia in 1896, and their Australian Metal Company had invested in many of the businesses working to perfect the zinc concentrates. The zinc concentrates were shipped to Merton-owned processors in Europe. The concentrates were treated by roasting followed by distillation in retorts, a method long established in the European zinc industry. The costs and profits of this operation

were rationalised through a complex system of transporting concentrates between Germany and Belgium. Roasting plants were built where their chief by-product, sulphuric acid, could be used in other industries. The labour and fuel intensive distillation facilities were located near to population centres with coal and clay available.\(^50\) Although the basic technique for zinc smelting had been internationally-established for a century, the German and Belgian plants were more advanced than those of their competitors. The «essence of zinc smelting was the temperature of distillation.» The Germans and Belgians made the best retorts and built the strongest furnaces, resulting in «harder driving» at much higher temperatures than elsewhere.\(^51\) In the first decade of the twentieth century, the export of Broken Hill zinc concentrates for distillation underwent a nine-fold increase.\(^52\) As a result, the Mertons were able to impose long-term contracts.\(^53\)

Depending on where one stood in the wartime debate, the zinc arrangement was the result either of German technological superiority or financial chicanery.\(^54\) Although the Broken Hill producers wished to charge more for their concentrates, the contracts prevented them from doing so. Yet without the German and Belgian facilities, the zinc concentrates were essentially worthless. The war offered the Collins House Group a two-fold solution to their problem: they could abrogate the contracts and then get the state to pay for the exceptionally risky and technically challenging development of new refining methods for zinc. There was a stark contrast between the electrolytic refining of copper and that of other non-ferrous metals. Whereas copper refining had been mastered, attempts to apply large-scale electrolytic methods to other metals had met with almost universal failure.\(^55\) The first electrolytic zinc patent had been registered in Paris as long ago as 1883. Although the principles of electrolytic zinc were well understood, the practical results achieved before the War had been limited.\(^56\) Without zinc refining, the Mertons would be able to reimpose the contracts as soon as the war ended.

The war transformed copper and zinc from international commodities into «strategic minerals». Their use was central to the munitions industry. The use of non-ferrous alloys for ammunition had been a product of the «breech-loading revolution» of the 1860s and 1870s. It had created a demand for self-contained metallic cartridges, standardised on a global scale by the beginning of the twentieth century. Cartridges were made of an alloy of seventy per cent copper and


\(^{52}\) Zierer, «Broken Hill», 83–108.

\(^{53}\) Wilkins, \textit{Foreign Investment}, 273–274.


thirty per cent zinc – known in Britain as ‘Admiralty brass’. Noted a wartime commentator, ‘are essential for the production of cartridge cases, alike for rifle, machine-gun and the lighter types of artillery.’ Looking forward, the metals industry expected the importance of non-ferrous metals for armament production to increase further, albeit unpredictably.

The specific opportunity for the Welsh and the Australians, led by Budd and Robinson, to unseat the Mertons was the change in the legal regime – and the underlying climate of political opinion – created by the war. The course of these changes was far from inevitable, however, and had to be managed by ‘self interest with guile’. Within days of the outbreak of war, the Asquith government had issued a ‘trading with the enemy’ proclamation. Although the proclamation forbade transactions with anyone resident in the German empire, it specifically stated that there was ‘no objection to British firms trading with German and Austrian firms established in neutral or British territory.’ Although the controls on German firms within the British Empire were tightened by further trading with the enemy legislation passed in 1914 and 1915, the permissive attitude to dealing in neutral countries continued.

The British arm of the Merton network, Henry R. Merton, avoided expropriation as an enemy concern because the shares owned by the Mertons’ Swiss company meant that German companies did not have a controlling interest in the firm. The war, nevertheless, placed the Mertons’ London operation in a vulnerable position. Henry R. Merton was Metallgesellschaft’s agent for the transport of the Australian zinc concentrates to its European refineries. A number of ships were caught in transit by the outbreak of war. Merton’s paid for the concentrates from their own funds and diverted the shipments to warehouses in Britain. As a result, they were found guilty in a British Prize Court of aiding and abetting the enemy. The Attorney-General coined the phrase ‘the German octopus’ to suggest a world-wide conspiracy of German-Jewish business interests out to destroy the British Empire. According to some members of the right-wing press, Merton’s was the world HQ for this conspiracy.

57 Ministry of Munitions, Official History, Volumes VII (The Control of Materials) and X (The Supply of Munitions) (London, 1922).
60 P. Panayi, ‘German Business Interests in Britain during the First World War’, Business History 32 (1990), 244–258, 247.
62 H. Gardner, A Statement (For Private Circulation Only), 1917, AMC Archives.
63 The Globe, 21 October 1915.
Yet at the same time as the Attorney-General was trying to whip up fears of a German conspiracy, other parts of the British government were still dealing, amicably, with Merton’s. The Admiralty praised Henry R. Merton’s managing director, Henry Gardner, as an adviser whose, ‘expert knowledge had been found to be of considerable value’.  

 Britain imported the bulk of its wartime copper and zinc from the United States. Given the plenitude of American resources, there was no shortage of supply per se, the problem lay rather in the escalating cost of the metals. Between September 1915 and January 1916, the cost of copper to the state rose by over eighty per cent. Given the relationship between American Metal and Merton’s, Gardner was a key figure in securing supply at acceptable prices.

The combination of the ‘war of attrition’ without, and the attentions of ‘opportunists’ within, meant that this position was inherently unstable. In January 1916, a new Trading with the Enemy Act prohibited trade with persons of ‘enemy nationality or enemy association’ resident in Britain or allied countries. The 1916 Act ‘signalled the real end of business as usual … emotion coupled with economic opportunism produced an all-out assault on German businesses in the UK which law and custom had hitherto protected’. In response Henry Gardner worked hard behind the scenes to escape from the taint of ‘enemy association’. He proposed that Henry R. Merton and Metallgesellschaft should swap their holdings in each other. Thus a British company and a German company would be created. Each would go its separate way. Their commitment to either side’s war effort would be unambiguous. On 7 and 8 February 1916, Gardner met a Metallgesellschaft delegation in the Hague, capital of the neutral Netherlands. At the end of the two days, the delegations agreed an exchange of shares.

Henry Merton was reconstituted, purged of German interests, in July 1916. It was even given a clean bill of health by the leader of the Conservative party and Colonial Secretary, Bonar Law. The deal that Gardner had struck created as many difficulties as it solved, however. Bonar Law’s support was more than outweighed by the hostility of the Australian government, influenced by Broken Hill interests, which publicly branded Merton’s as an ‘enemy concern’. In March 1916, the Australian prime minister, William Hughes, advised by W. S. Robinson, declared

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64 H. Gardner, *A Statement* (For Private Circulation Only), 1917.
67 Exchange of Merton Shares held by Germans against German Shares and other Securities held by British Subjects: Conference held at the Hague, 7 and 8 February 1916, AMC Archives.
that his government was determined to escape, «the octopus that controlled the metal market».70

The Mertons’ attempts to bring themselves into technical compliance with the law did little to appease their critics.71 The final element to the anti-Merton campaign was to move from negative propaganda to positive proposals for an alternative. By 1916 Cecil Budd, established as the Ministry of Munitions’ chief adviser on non-ferrous metals, was in an excellent position to do this. Budd developed a grand scheme for an imperial metals policy.72 Budd’s plan had two main features. First, the state should finance an attempt to solve the problems of zinc refining. «Admiralty brass» required a particularly pure grade of zinc known as «fine zinc», unobtainable through standard horizontal retort distillation. It had long been acknowledged that electrolytic refining was a good potential method for the production of «fine zinc». In peace-time, however, there had been limited demand for the product, overwhelmingly from military consumers. Before the war, the Brunner Mond firm ran a small electrolytic refinery in England using by-products of their other chemical processes.73

Large-scale electrolytic zinc refining – using ore concentrated by the Broken Hill froth flotation method and then desulphurised by German-Belgian type roasting – was initiated by Anaconda in the USA during 1915. The demand for military brass in Europe suddenly made it an economical proposition. Once more, the question was not one of technology per se but of technology applied on an industrial scale. The leading British metallurgist, Harold Carpenter of Imperial College, London, warned that Anaconda’s facilities «were very large works, treating enormous quantities of copper ore on a big scale, and the production of zinc there would work in with that of other metals in the plant. It was questionable whether, even if it paid the Anaconda works to treat zinc ores in that way, it would necessarily be a solution to the problem for other districts where zinc ores existed.»74 Nevertheless, the Australian government was willing to back the creation of an electrolytic refinery at Risdon in Tasmania.75 Zinc required much more electricity than copper to refine.76 An ambitious Tasmanian scheme for hydro-electricity had collapsed as a private venture in 1914 and had been nationalised – Tasmania thus had the potential for the production of hydro-electricity but no local need for it.

70 The Morning Post, 10 March 1916 quoted in Panayi, «German Business Interests in Britain», 252.
71 Hardware Trades Journal, 24 November 1916.
72 «Development and Control of the Empire’s Mineral Resources and Protection of the Metal Supplies required by the Empire’s Industries», 16 April 1917, SUPP3/56, PRO.
74 Discussion following the reading of J. C. Moul- den’s lectures on, «Zinc, its Production and Industrial Applications», Journal of the Royal Society of Arts 64 (1916), 580.
75 A. H. Ashbolt (Agent-General for Tasmania), «Industrial Developments in Australia During and After the War», Journal of the Royal Society of Arts 69 (1920), 68–81, 73.
Broken Hill was keen to use the facilities paid for by the state. At the same time, the British government agreed to back the creation of a National Smelting Company, to build a zinc smelter at Avonmouth, near Bristol. National Smelting’s proposed plant was very large by international standards, comprising twenty roasters and nearly ten thousand retorts. Zinc concentrates would be shipped from Australia to Avonmouth for distillation, they would then return to Australia for electrolytic refining.

The second element of the Anglo-Australian plan was that imperial resources should be marketed by an organisation free of ‹alien control›. Budd proposed that the British government should form a public-private corporation to purchase and sell minerals and to invest in mining and processing operations in the Empire. Behind a commercial façade, the corporation would work to prepare Britain for the next war. That war would be fought on the basis of British mastery of the technology needed to process the non-ferrous resources of the British Empire. Budd christened his new organisation the British Metal Corporation.

The corollary of founding the British Metal Corporation, however, was the need to destroy the Merton organisation. Otherwise, Henry R. Merton’s contacts and expertise made it the most obvious vehicle for overseeing the mineral resources of the empire. It would be impossible to persuade investors to support the new corporation if it was in direct competition with Merton’s. The means by which the government planned to remove Merton’s from the picture was the Non-Ferrous Metals Bill. The Bill would, in the opinion of the Morning Post, ‹reinstate the British born in a small part of his ancient birth-right.› The proposed law decreed that anyone involved in the trade would need an annually renewable licence issued by the Board of Trade. As a High Court judge later commented, the law was so obviously targeted at one company that it ‹might very well be described as the Statute of Merton›.

There was, however, far from universal support for the Bill. It had no bearing on the conduct of the war. By 1917–18 Britain’s supply of non-ferrous metals was entirely adequate. Problems of distribution and cost had been solved by strict state regulation under the control of the Ministry of Munitions. Many people in the metals trade were appalled by political attempts to stoke up anti-Merton senti-
ments. A cross-section of opinion amongst government supporters in the House of Commons reacted badly to attempts to use the «German octopus» argument. Many in the trade knew that Budd and Robinson were behind the measure and suspected that their patriotism was motivated by commercial interest. «May we not question the wisdom of giving zinc this «privileged» position,» remarked one critic, «We got the supply we wanted by paying for it – better to do that than enhance for all time the price of zinc to English manufacturers, which say what they will, is what the «capturers» mean.»

The government had to make some significant concessions to ensure the Bill’s passage. The onus of proof that a company was under enemy control was transferred from the trader to the Board of Trade. A provision was introduced that any appeal should be heard in the courts. These concessions proved significant. When the measure became law in 1918, Merton’s applied for a licence and was duly turned down. Robbed of its raison d’être, the company went into voluntary liquidation. But Henry Gardner was not willing to give up the fight. He formed a company under his own name to carry on where Merton’s had left off. When he too was refused a licence, he took the government to court and won. Convinced by the parade of the good and the great in the metals trade who appeared to provide «very remarkable testimony», the High Court ruled that Gardner was a patriot and not «subject to mesmeric influence».

At the beginning of 1919, the newly-fledged BMC under the direction of Sir Cecil Budd was faced by a reborn Henry Gardner company. Although Budd’s attempt to exclude Gardner from the business altogether had failed, he had certainly pushed him into second place within the British metals trade. He had removed him entirely from the Australian zinc trade that Merton’s and Metallgesellschaft had dominated up until 1914. In order to carry out this manoeuvre, Budd had played on a strain of anti-semitic feeling present in parts of the British press and political establishment. Henry Gardner had had to declare to the High Court that he could trace his family back for 250 years in Scotland and that it had never intermarried with «foreigners».

85 The Ironmonger, 8 December 1917; PSO (BT 15), Memorandum on Zinc, June 1928, SUPP3/69, PRO.
86 Bell, «Could We If We Would…?», 25.
87 Sir Woodburn Kirby to Merton’s Shareholders, 9th March 1920, AMC Archives.
88 Board of Trade v. Henry Gardner, Extract of Judgement of Lord Chief Justice, 30 May 1919, AMC Archives.
90 In the Matter of the Non-Ferrous Metal Industry Act 1918: Board of Trade and Gardner – Particulars delivered by Henry Gardner, March 1919, AMC Archives; The Times, Law Report, 30 May 1919.
Budd’s business strategy for BMC was to copy the Metallgesellschaft model of an integrated metals business as closely as possible. The Mertons had demonstrated the obsolescence of both Budd’s family smelting and trading businesses before 1914. He had used the unexpected opportunity offered by the war to turn the tables and to take over their business. As far as zinc was concerned, the Anglo-Australian alliance protected itself against a post-war counter-coup by arranging very long contracts between the Broken Hill mines, the Risdon electrolytic refinery and the National Smelting Company’s Avonmouth distillation facility.\(^\text{91}\)

However, the idea of a self-contained British empire in metals proved to have strict limits in business logic. The Mertons had been so successful, not just because they had integrated their businesses, but because of their clan organisation. Although forms of business organisation could be replicated, the same was not true of clan networks. The Merton businesses that BMC inherited were sound. Too many of its subsequent ‘strategic’ acquisitions were money-losers rather than money-makers, however. In Australia, the Risdon refinery was producing electrolytic zinc on the same scale as Anaconda by 1923. With the end of the war, however, the demand for its products collapsed; world refining capacity far out-stripped ore production.\(^\text{92}\) The Avonmouth plant was even less successful. It failed to process a single ounce of zinc before the end of the war. Instead of the impressive facility that its backers had promised, Avonmouth was small and non-functioning. It was described in one account as a ‘ruin’. In 1922, the government wrote off its loans and refused any further subsidy.\(^\text{93}\) National Smelting was forced into bankruptcy from whence it was bought by a BMC coordinated consortium.\(^\text{94}\) The fact that National Smelting was ‘a far-sighted conception of Imperial interests … an undertaking of great importance to the Empire’ did not necessarily mean that it was a sound business proposition.\(^\text{95}\)

Although the Mertons had been weakened by the war, the advantages they had created before 1914 were not entirely dissipated. During the war, the Hoboken refinery had been behind the front line in German-occupied Belgium. In 1919, it was confiscated by the Belgian government and turned over to a Belgian company. In Britain, the Mertons had lost control of Henry Merton’s in 1916, but Henry Gardner had survived as a potential ally. The Merton interests in American Metal

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93 PSO (BT 15), Memorandum on Zinc, June 1928, SUPP3/69, PRO; Burn, «Broken Hill Zinc Concentrates», 81–82.
95 BMC, Report of Ordinary General Meeting, 13 March 1924.
had been sequestrated by the US government when America entered the war in April 1917. The assets had, however, subsequently been purchased by William Merton's former associates, the Hochschild and Vogelstein families. The company thus maintained close personal, though not legal and administrative, ties with its former parent. The post-war Merton organisation was thus even more clearly a clan network than it had been before 1914. The network showed a significant capability to recover in the 1920s.

In the late 1920s, American Metal took the decision to expand its activities in the British Empire, becoming the leading player in the Rhodesian Copperbelt revolution of 1927 to 1932. Northern Rhodesia abutted the Katanga copper fields whose products were already refined at Hoboken. American Metal concluded that the flotation method of concentration applied to copper was the key technology for the exploitation of the Northern Rhodesian sulphide ores. During the First World War, American copper works had been rebuilt to take advantage of the flotation technique, originally developed for the creation of zinc concentrates. Copper sulphide particles were made to float on a froth created by the addition of oil and acid to milled ore, while the lighter gangue sank. BMC, on the other hand, given right of first refusal on the Copperbelt, declined to invest. The Merton network was still capable of making better business decisions, based on a grasp of the technical possibilities, than BMC.

In Europe, the Metallgesellschaft itself rapidly revived under the leadership of Richard Merton. His initial efforts were directed to recovering the American refineries. Although he failed to repossess the Mertons’ American businesses, he managed to persuade the American government to pay him nearly $7 million derived from the profits of the sale of American Metal. This injection of hard currency helped in rebuilding the European business. Norddeutsche Affinerie remained the largest and most efficient copper-smelting factory in Europe. Although Merton could no longer call on subsidiary companies in Britain and the United States, he still had close allies in, and expert knowledge of, those countries. He was thus able to raise significant loans to expand and modernise the European businesses. The importance of Merton’s ability to mobilise his father’s international network to ensure the survival of the Metallgesellschaft is starkly illustrated.

97 Chandler, Scale and Scope, 562–563.
99 Coleman, The Northern Rhodesia Copperbelt, 27–77.
104 Manchester Guardian Commercial, 16 October 1930.
105 Manchester Guardian Commercial, 16 October 1930.
by the fate of the Mertons’ erstwhile German competitors, Aron Hirsch und Sohn and Beer und Sondheimer, neither of whom recovered from the losses they suffered during the war.106

The power of the network was to be feared. BMC had been created to prevent Germany re-establishing a monopoly position in strategic metals. Its initial successes in copper were the product of a unique, time-limited factor. In the immediate post-war years, the Allied governments had access to vast stocks of copper scrap derived from surplus munitions. The British government gave BMC preferential access to its stocks, thus allowing it to establish a strong and profitable position.107 The last British copper refinery closed in 1921 at a time when the demand for new electrolytic copper was low due to the ready availability of recycled refined copper.108

When the copper scrap was exhausted, however, BMC became very vulnerable to opportunistic renegotiation of contracts for copper supply: renegotiation that it proved utterly unable to resist. An American cartel, Copper Exporters Incorporated, was created in 1926.109 «The policy of Copper Exporters, Inc.,» noted one market observer, «and of certain foreign producers and German handlers of copper [i.e. the Mertons] brought about a sort of rationing of copper to Great Britain in order to get rid of the floating supply.»110 Faced with this combination, BMC had little choice but to accept the dictation of the alliance and set prices at its behest.111 Instead of being a market leader, organising trade for the strategic benefit of the British Empire, BMC was forced into the position of a junior partner.112

BMC’s board feared the revived Metallgesellschaft. They worried that it could become a threat to BMC’s survival if the American copper exporters chose to ally with it, as had happened in 1926.113 Metallgesellschaft was also a direct threat to BMC in its core markets. «It became clear that this company wished to re-enter the international field, and more particularly the field of the British Empire where it had once played so great a role,» Oliver Lyttelton, one of BMC’s managing directors, wrote in 1934, «and that we must therefore either be prepared to fight for the position which we had gained there or else we should secure immunity from competition by making the Metallgesellschaft our partners and by negotiating a general geographical segregation of our businesses.» Since BMC would, in all

106 Auerbach, «Jews in the German Metal Trade», 188–203.
107 BMC, Reports of Ordinary General Meetings, 1921–1926; Rio Tinto Company Ltd. Finance Committee, Minutes, 15 December 1926 and Directors’ Minute Book, 23 December 1926, RTZ Archives.
108 PSO (BT 11), April 1928, SUPP3/69, PRO.
110 Richter, «Copper Industry in 1927», 35.
113 Financial News, 30 May 1930.
likelihood, lose in a direct fight for business, it was much wiser to cooperate.\footnote{Review of AMC Activities in 1934, AMC Archives.} For his part, Merton was much more inclined towards cooperation than competition. The experiences of the previous thirteen years had given him a healthy respect for the power of nationalism to overcome purely economic rationality. Those world-economic connections which have a political basis, such as those between a mother country and her colonies, or those binding the various elements of the British Empire he reflected, are always better able to withstand a crisis than the purely economic relations between independent states.\footnote{Richard Merton, «European Metal Market Trends», 249.} The merger of British and German interests was well in hand before the Wall Street Crash, albeit formalised only after it.

In March 1929 Sir Cecil Budd retired and handed over to a new triumvirate of managing directors.\footnote{BMC, Report of Ordinary General Meeting, 13 March 1930.} Within months, the new team took the decision to enter into a full-blown alliance with the Metallgesellschaft. This volte-face was an admission that Budd’s political coup against the Mertons had secured only a temporary advantage for BMC. BMC had tried to copy the Mertons’ business model but was less effective at operating it. Three elements were involved in the recreation of the Merton-dominated system.\footnote{AMC, Meeting of Directors, 11 March 1931, AMC Archives.} In July 1929, an Amalgamated Metal Corporation, owning the share capital of both BMC and Henry Gardner, was formed.\footnote{Agreement in Principle, 23 July 1929, AMC Archives; Henry Gardner’s evidence to Zinc Committee, n.d., SUPP3/7, PRO.} In March 1930, AMC reached an agreement for an alliance with the Belgian company which controlled Merton assets confiscated in 1919.\footnote{AMC, Meetings of Directors, 12 March 1930, 9 April 1930, 9 July 1930, AMC Archives.} In May 1930, a final capstone agreement with the Metallgesellschaft was signed.\footnote{AMC, Meetings of Directors, 12 November 1930, AMC Archives; Review of AMC Activities in 1934, AMC Archives.} The outcome of these negotiations was an agreement to create a formal alliance having for its object mutual co-operation and exclusion of competition.\footnote{AMC had a holding of approximately 14 per cent in Metallgesellschaft; Metallgesellschaft a 10 per cent stake in AMC, AMC, Meeting of Directors, 16 May 1930, AMC Archives; Berliner Tageblatt, 29 May 1930; AMC, Meeting of Directors, 6 August 1930, AMC Archives; Financial Times, 13 August 1930; AMC, Meeting of Directors, 9 December 1931, AMC Archives.} BMC bought a one-third stake in Norddeutsche Affinerie.\footnote{Manchester Guardian Commercial, 16 October 1930; PSO (BT) 377, December 1937, SUPP3/87, PRO; Foreign Office & Ministry of Economic Warfare, Economic Advisory Branch, Economic Survey of Germany: Section H – The Metal Industries (Restricted Circulation, 1944), Appendix I: Principal German Metal Producers; Protocol of Exchange of Shares Agreement between Amalgamated Metal Corporation Limited and Metallgesellschaft, 21 May 1930, Frankfurt-am-Main, AMC Archives; AMC, Meeting of Directors, 13 August 1930, AMC Archives; AMC, Meeting of Directors, 15 October 1930, AMC Archives; AMC, Meeting of Directors, 12 November 1930, AMC Archives; Review of AMC Activities in 1934, AMC Archives.}

BMC’s heavy investment in Norddeutsche Affinerie was not a case of technological transfer but of the transfer of capital.\footnote{P. Scott and T. Rooth, «Public Policy and Foreign-}
imperial technological assets to compete against the German technical superiority, BMC invested in that technical superiority. Instead of investing in British or imperial companies with doubtful claims to profitability, it had acquired a stake in one of the most successful refining operations in the world, a mature business already developed by the Mertons. Norddeutsche Affinerie used the investment to finance the building of an advanced furnace for the processing of copper concentrates from Cyprus and to construct a new sulphuric acid plant.\textsuperscript{124} In making these investments, however, BMC had abandoned its original raison d’être.\textsuperscript{125} By 1930, any claims that the company might have to an ‹imperial mission› were, at best, slight. ‹It is significant,› one English financial journalist observed, ‹in view of current political ideas, that the greatest British metal producers have completely disregarded the idea of an Empire Zollverein›.\textsuperscript{126} ‹The English-German-Belgian group,› wrote the \textit{Berliner Tageblatt}, ‹which now exists in the metal trade comprises all the undertakings, upon which was built the Merton Metallgesellschaft Group, which existed before the War.›\textsuperscript{127}

4. Conclusion
The study of electrolytic refining fits, to a degree, into the classic Anglo-American account of technology. There were good reasons why Britain, having exported the basic concepts of refining, pyritic smelting and concentration to the United States could not re-import the technological systems developed by the Americans. In copper terms, Britain was becoming a ‹minerals poor economy› at just the time America was becoming minerals rich. The development of imperial copper fields occurred on a large scale only after the American technological lead had been fully established.

This explanation fails to account for the much more successful German response to American technical innovation. Here we can suggest a measure of historical contingency, relating more to questions of identity than of technology. The Londoner, Ralph Merton, was absorbed by the Cohens of Frankfurt. He appears nevertheless to have split his trading investments equally between London and Frankfurt. His eldest son was dispatched back to England but proved much less talented than his younger brother as either a trader or a business manager. Although the youngest Merton was resident in Britain when the first electrolytic refinery opened, he had returned to Germany, swapping positions with yet another brother by the time the full implications of electrolytic refining for conductive

\textsuperscript{125} Chandos, \textit{Memoirs}, 124 – 128, 133 – 134.
\textsuperscript{126} Manchester Guardian Commercial, 16 October 1930.
\textsuperscript{127} Berliner Tageblatt, 29 May 1930.
copper had become apparent. Equally, the displacement of the family leadership in England, but its continuation in Germany, seems to have been a reflection of personal talents and inclinations rather than a product of a culture of indolence. Comparative cultural studies of business—predicated on nationality—are obviously difficult to sustain if nationality was a fluid commodity.

In the narrower sense of technology transfer, it is possible to see that the nature of the networks and firms played a larger role than any kind of mechanistic progression of scientific study or technical education. The technical knowledge required for the construction of electrolytic refineries was widely diffused. The knowledge differential related more to the ability to construct a system in which technical knowledge could profitably be employed. One would need more data than presently available to disentangle completely the relative importance of the organisation of the multi-divisional firm per se from the trading advantages generated by the clan network. William Merton himself was an avant la lettre Chandlerian. In the memoir he wrote in 1907 for the business education of his sons, he argued that Metallgesellschaft’s technical departments—the metallurgical laboratory, archive, library and information office—created in the 1880s, “enabled the company to avail itself of the statistics and costings necessary for analysing its profitability”. Metallgesellschaft’s statistical publications became a standard for the metals trade. Some insiders certainly thought the network was more important than the firm. In his 1965 memoir, the former Metallgesellschaft employee, Siegfried Auerbach, concluded that, “In spite of the industrial and technical expansion the commercial side of the business remained the chief source of profits, thanks to its international renown and its increasing turnover.” Richard Merton treated technology as a given constant. He stressed the importance of new sources of ore, but above all the primacy of politics in shaping the market. It was the management of risk that was uppermost in his mind. The evidence as it emerges from this study tends to suggest that the Mertons succeeded both as executives and clansmen. Their British impersonators fell short on both counts, requiring them to co-opt both the Merton organisation and the Mertons themselves only a decade-and-a-half after severing themselves from both.

128 de Vries, Of Mettle & Metal, 91–92.
131 de Vries, Of Mettle & Metal, 107–108.
132 Auerbach, “Jews in the German Metal Trade”, 196.
Verborgen verkabelt: Netzwerke, Firmen und der Transfer der elektrolytischen Affinierungstechnologie


The hidden wiring: Des réseaux, des compagnies et le transfert de la technologie de raffinage électrolytique

L’électroraffinage de cuivre, essentielle pour la «révolution électrolytique», fut une innovation centrale sur le champ technique à la fin du 19ème siècle. Des raffineries électrolytiques importantes furent construites en Amérique dans les années 1890. La technologie traversa l’Atlantique et arriva à Hambourg et Anvers à la veille du Première Guerre mondiale, mais, bien que le travail de pionnier soit accompli en Grande-Bretagne, la technique du raffinage électrolytique n’y était pas transférée. L’article examine le rôle d’un réseau dans le transfert de la technologie électrolytique. Il part de l’idée que les principes du raffinage électrolytique étaient, déjà en 1900, bien compris et que la construction et le contrôle des raffineries en Europe étaient plutôt le résultat des considérations transnationales que celui de différentes technologies nationales. L’article analyse ensuite la tentative opportuniste facilitée par des économistes nationalistes de l’ère du Première Guerre mondiale d’acquérir des technologies contrôlées par les Allemands. Cette tentative tournant autour d’une introduction de nouvelles méthodes de raffinage de zinc (incluant l’éléctrolyse) n’était couronnée que d’un très faible succès et indique que de bonnes relations commerciales étaient plus importantes que la possession des connaissances technologiques.

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