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Victoria's Engineering Heritage First Hundred Years 1842 — 1942

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1. INTRODUCTION

It is the aim of this paper to set out the achievements of the pioneer engineers of Victoria and to show how their work displayed their resourcefulness, powers of innovation and invention. Without their work, the resources of the State would not have been developed to the degree they have today. It is timely to recall the words of L. Sprague de Camp ('The Ancient Engineers'),'Civilisation, as we know it today, owes its existence to the engineers.'

It will be appreciated that Victorian engineers faced many handicaps; the remoteness from sources of raw materials, such as wrought iron, pig iron, coke and other materials, as well as machine tool and hand tool supplies, would have been frustrating in extreme and would have forced them to improvise in many ways. They began their activities at a time when engineering development in England and Europe was beginning to gather pace. In England, the work of the Darby's, father and son, in the late eighteenth century, in developing the use of coke as fuel in blast furnaces, had borne fruit by making larger quantities of cast iron available to engine builders. Larger steam engines resulted; in addition, machine tool builders were quick to take advantage of this development and were able to build larger and more massive machine tools. By 1825, the horizontal steam engine began to replace the beam engine, and by the middle 1830's, machine tool development began to gather momentum.

It was in this scene, then, that Victoria's first engineering firm, Langlands & Fulton, had its genesis in 1842 (1). Their first machine tool was a treadle operated lathe; this, together with blacksmithing equipment, enabled them to cope with their early work in the form of bullock drays, wool presses, agricultural machinery and iron work for buildings. In addition, they had an iron foundry and a brass foundry. The partnership was dissolved in 1846.

2. THE MINING INDUSTRY.

In 1851 gold was discovered near Ballarat and it galvanised the engineering industry into feverish activity. Langlands, Fulton, and others became closely involved with supplying machinery to the mining fields. Some engineers were tempted into trying their luck on the goldfields, but many were unsuccessful and returned to engineering. Others, however, saw a more profitable future in supplying machinery to the miners, and in many instances, started operations in proximity to the mining fields. Thus it was that Ballarat, Bendigo and Castlemaine became centres of engineering activity.

In Ballarat the firm of Richard Carter & Company became one of the outstanding firms in the district (2). Established in 1855, they became well known for their mining machinery. The Victoria Foundry, Soho Foundry, and Cornish & Bruce were also early in the field. At a later period, Lonie Dingle, Cowleys Eureka Iron Works , and the Union Foundry became well known. Some of these firms not only supplied local and interstate orders, but overseas customers as well. Indicative of the size of the machines supplied were horizontal steam engines up to 26 inch (660mm) bore and 60 inch (1524mm) stroke.

In Bendigo Joel Horwood started in 1856, Victoria Foundry in 1858 and A. Roberts & Sons in 1861. Some of Roberts machinery has been preserved at the Central Deborah mine. Another company was that of T. Horsfield who developed a rock drill that was used locally and interstate, and was exported overseas in large numbers.

In Castlemaine, several engineering firms were established, the major one being Thompson & Company. (3). The two brothers David and James Thompson, started the engineering works in 1875. As well as building steam engines, boilers, stamp batteries etc, they became well known for their sand and gravel pumps for hydraulic sluicing. In 1935 they supplied a large dredge to Cock's Eldorado Gold Dredging N.L. in Wangaratta, Victoria. This was followed a few years later by a larger dredge for Harrietville (Tronoh) Limited, Ovens Valley, Victoria. About 5000 tons (5080 tonne) in weight, it was one of the two largest mining dredges in the world.

Charles Ruwolt, who started at Wangaratta, Victoria, in 1903, began building dredges in 1908 (4). He moved his works to Melbourne in 1911 and continued dredge construction; many of these were shipped to Malaya and some were still operating in 1970. The last dredge was built in 1921. The firm remained active in the mining machinery field and built ball and tube mills, rock crushers Wilfley pumps as well as other equipment. They opened their steel foundry in 1914 and in 1929 they designed, built and erected an electric steel melting furnace.

Another Melbourne firm that was prominent in the mining machinery field was Hughes, Pye & Rigby starting in 1880. (The name was changed later to Austral Otis Elevator & Engineering Co.)(5). Engines, boilers, stamp batteries, ball mills, Wilfley ore concentrators and tables were some of their output.

At a later date-in 1899-the firm of Geo. W. Kelly & Lewis (6) was formed and early in the 1900's they built many steam winding engines for gold mines. Pumps for de-watering mines and air compressors were supplied, as well as other equipment. The firm held the manufacturing rights for the Corliss Steam engine and built many of them. This type of equipment - and that mentioned previously - required high standards

of craftmanship. A project that illustrated the enterprising spirit of the firm was its association with Mr. A. de Bavay, a noted research chemist, who developed the flotation process for the recovery of zinc. The firm was given the order for the plant which was installed at Broken Hill, N.S.W. and operated successfully.

3. RAILWAYS & TRAMWAYS. The great influx of migrants and merchandise into Victoria after the discovery of gold necessitated the construction of a railway line from Port Melbourne (Sandridge) to the city area in 1854. This was followed afterwards by the Brighton and St. Kilda lines; in the years that followed, railways began to spread across the State. Initially rolling stock was imported but local engineering firms soon began to take an interest in building locomotives and rolling stock. In 1870, the Ballarat firm of Richard Carter & Company was formed into a public company and the name was changed to Phoenix Foundry Company. They became almost totally involved in locomotive building and at times turned out one a week. As the bulk of their raw materials came from overseas, the forward ordering and organisation of supplies implies an organisation of outstanding ability. In addition, interchangeability of components necessitated high standards of workmanship. In all, they built 351 locomotives for the Victorian Railways; it was an epoch making episode in Victorian engineering history.

The South Melbourne firm of Robison Brothers & Co. Pty. Ltd. built 25 locomotives for the Victorian Railways in the 1890's (7) and David Munro & Company built 25 tank locomotives in 1891. In 1913, the Victorian Railways placed an order with Thompson & Company, Castlemaine for 40 'Dd' class locomotives and 20 more some time later. In 1924, the Commonwealth Government placed an order with Thompsons for 14 locomotives. Thompsons first supplied the Victorian Railways with points and crossings in 1879 and continued to do so over the years. In 1957 they built a new machine shop to deal with this phase of their work.

During World War I, the supply of steel tyres for railway and tramway wheels was cut off and it posed a serious threat to communications and transport. At the request of the Commonwealth Government, Thompson's designed and built a 500 ton (508 tonne) forging press to manufacture these items. At a later date, a 1000 ton (1016 tonne) press was built.

A number of steel bridges were required by the railways and local engineering firms demonstrated their ability to fabricate and erect them. Enoch Chambers, David Munro & Company, Campbell, Sloss & McCann, Mephan Ferguson, Johnson & Son Tyne Foundry, Robison Brothers, Campbell & Sloss and Humble & Nicholson of Geelong were among those who participated in this field.

The safe working of railways depends largely on signalling and interlocking of points. In 1880, the firm of McKenzie & Holland of Worcester, England, opened a branch in Melbourne and a short time later began the manufacture of signalling and interlocking equipment. They became well known throughout Australia and New Zealand. Early in the present century, it was realised that steam traction would be unable to cope with the growing volume of traffic on the Melbourne suburban railway system. Electrification of the system was started in 1913. Automatic signalling with all it implies was a new field for McKenzie & Holland, but with the experience of the parent company in England and other railways, they successfully mastered the problems involved.

Melbourne's cable tram system, one of the largest in the world, called on the expertise of several local engineering firms during its construction. Contracts were let in 1885 for the supply of equipment and construction of the system. Rails, and steel cables had to be imported; some of the steam engines and rolling stock were imported in the early stages, but much of the equipment was built in Victoria. The steam engines for driving the cables were twin cylinder horizontal engines 20 inches (508mm) bore by 40 inches (1016mm) stroke and were 500 horsepower (373kW). Hughes, Pye & Rigby built thirteen of them and the firm of Wright & Edwards built two. Boilers were supplied by Forman & Company, Campbell, Sloss & McCann, Langlands Foundry Company and Johnson & Sons Tyne Foundry. Thousands of steel yokes or frames to form the cable tunnels were required; they were made from light steel rails bent to shape. Wright & Edwards supplied some 80,000; Johnson & Sons Tyne Foundry supplied several thousand.

4. WATER SUPPLY, IRRIGATION & SEWERAGE. As the population of Melbourne and the provincial centres of Victoria increased, it became evident that an assured supply of pure water was imperative. In 1853, the Victorian State Parliament passed an Act constituting a Board of Commissioners of Water Supply & Sewerage. This resulted in the construction of the Yan Yean reservoir for Melbourne's water supply and the reticulation of water to the city and suburbs. Geelong, Ballarat, Bendigo and other towns followed suit at a later date. These projects involved civil engineers in the design of catchments and reservoirs, together with the reticulation of water. Large quantities of cast iron and wrought iron pipes, together with the attendant fittings, valves, stop cocks and meters were required. Some of the companies involved were Langlands Foundry Company, Fulton Foundry Company, Mephan Ferguson, Davies Shephard, John Danks & Sons and others.

The firm of Mephan Ferguson became well known for their spiral rivetted pipes for water supply. Ferguson developed and built the machinery for forming and rivetting the pipes. The firm also became well known for the lock bar pipes which they developed. They were used on the Kalgoorlie gold fields water supply in the early part of the present century. The pipes were 30 inches (762mm) in diameter and in 28 foot (8.53m) lengths; Mephan Ferguson supplied 30,000 lengths, G. & C. Hoskins supplying an equal number.

As well as domestic water supplies, large scale catchments and distribution systems for irrigation purposes were built in the 19th century. The Goulburn Scheme was started in 1887, followed by the Coliban scheme, the Laanecoorie Basin and the Werribee scheme. The Chaffey brothers achieved fame in their initiation of the irrigation system in the Mallee area. Thompson & Co. of Castlemaine supplied many boilers and quick revolution steam engines coupled to centrifugal pumps for irrigation purposes.

Melbourne's sewerage scheme began in the late 1890's and as well as being a major civil engineering project, it provided a considerable amount of work for local engineers and foundries. Austral Otis Engineering Company, South Melbourne, supplied large quantities of cast iron pipes, as well as a large steam pumping engine; in 1909 they supplied two more. Thompson & Co. Castlemaine built four pumping engines for the project towards the end of the 19th century. Mephan Ferguson supplied several large steel pipes as well as the Clark tunnelling shields used in excavating the underground tunnels.

5. GAS AND ELECTRICITY. In England, coal gas was used for street lighting in 1814 and Victorian engineers were not slow in taking advantage of these developments. In the early 1850's, a gas plant was erected at the western end of Melbourne, somewhere near Collins Street. A new gas plant was built on the Yarra Bank in West Melbourne in 1856 and in 1857 the main city area streets were lit by gas. By 1858 a gas main was laid along Chapel Street, Prahran,as far as the Prahran Town Hall, followed two years later by a main along St. Kilda Road, Commercial Rd. and High St. By 1861 gas street lighting was in use in Chapel Street and Greville Street, Prahran. Ballarat and Bendigo soon followed Melbourne's example with a gas works in Ballarat in 1857 and one in Bendigo in 1859.

It is noteworthy that the Metropolitan Gas Company availed itself of electric arc welding early in its use in Australia. In 1922 arc welding was used to strengthen a 200 foot (60.96m) diameter gas holder at the West Melbourne Gas Works. Shortly afterwards a 163 foot (49.68m) diameter gas holder at the Fitzroy Gas Works was completely fabricated by electric arc welding. It contained 760 tons (772 tonnes) of steel and was believed to be, at that time, the largest all-welded structure in the world. (8)

In 1880, the Victoria Electric Lighting Company had its inception and supplied electricity to a part of the city. This was taken over in 1881 by the Australian Electric Company. The Melbourne Centennial Exhibition of 1888 saw electric lighting used on a large scale; Austral Otis Engineering supplied three steam engines, similar to those used for the cable tram system, for driving the dynamos. In 1894 the Melbourne City Council power station was built, and a few years later the Melbourne Electric Supply Company built its power station in Richmond.

In 1921 the State Electricity Commission of Victoria started with the turning of the first sod at Yallourn. It was created to exploit the brown coal deposits of South Gippsland and to bring electric power to all parts of the State, as well as making Victoria independent of outside sources of coal. Local engineering firms played a major part in the design and construction of massive power station buildings, transmission line towers (Johns & Waygood Limited supplied over 400 towers for the first transmission line from Yallourn to Melbourne) and other aspects of the project. In the field of power production, Thompson & Company, Castlemaine, in 1920 commenced the manufacture of steam turbines, condensing and feed heating plants for power stations all over Australia. In 1927, they had under construction six 25,000kW turbines with condensers for Bunnerong power station in New South Wales. They were built to the design of the Metropolitan-Vickers Electrical Company Ltd., England, who supplied the rotating portions of the turbines. Thompsons also supplied the circulating water pumps for the condensers. The firm also supplied condensers and water circulating pumps for 125,000kW generating sets at Yallourn. In addition, water turbine casings for the Sugarloaf-Rubicon Hydro-electric scheme were built.

6. SHIPPING. The growth of trade with Victoria from overseas and interstate made ship repair facilities necessary early in the history of the State. Ship building was also undertaken. One of the first firms to tackle this work was Forman & Company in South Melbourne, who started in 1854; the dredge 'John Nimmo' was built by them. Campbell, Sloss & McCann built the 'SS Lady Loch' in 1886; originally built for the Victorian Department of Trade & Customs, it was used later for servicing lighthouses. Johnson & Sons Tyne Foundry built barges, small craft, gold dredges for New Zealand and did ship repair work. Buchanan & Brock (originally Buchanan & Nodrum) built steamers for the Gippsland Lakes, tugs, launches and other craft, as well as ship repairs. Australian Forge & Engineering Company, Williamstown built the pilot steamer'Victoria' Local engineers supplied machinery for the River Murray paddle steamers; Wright & Edwards, Fulton Foundry Company and David Munro & Company were among those so engaged.

Mention must also be made of one of the most outstanding mechanical engineering inventions of the twentieth century. This was the Michell thrust block; devised initially for marine propeller shafts. It was the invention of Mr. A. G. M. Michell, a Melbourne engineer; it was patented in 1905 and was adopted by the British Admiralty and by ship builders generally. It solved a problem that was holding up development of large ships.

7. BUILDING & HOUSING. In the early years of Victoria's history, basalt deposits at shallow depths in various areas provided suitable building material. Other rock deposits were also exploited. Similarly, various clay deposits, particularly in the Northcote and Brunswick areas, were used for bricks and tiles. The demand for brick and tile making machinery was met, amongst others, by firms such as W. Anderson & Sons, Machar & Teale, Langlands Foundry Company and John Welch.

The increasing height of multi-storey buildings required steel framing and Peter Johns' Melbourne Iron Works was one of the first to provide rivetted steel girders and columns in the 1880's for this purpose. At a later period, Austral Otis Engineering, Edward Campbell & Son, and A. Challingsworth shared in supplying the demand.

The increasing height of office and other buildings necessitated the use of lifts, and once again Peter Johns took a leading part in this field. From supplying hydraulic goods lifts to warehouses, he began constructing passenger lifts for offices, hotels and public buildings. Shortly afterwards, Austral Otis Elevator & Engineering Company entered the field, together with the Australian Waygood Elevator Company. Johns & Waygood installed their first electric lift in Greens Buildings, Swanston Street, Melbourne in 1907.

8. PASTORAL INDUSTRIES. The production of wheat and other cereals began early in the history of Victoria; by 1851 there were 52000 acres (21044 hectares) of land under cultivation. Despite this, considerable quantities of wheat and flour had to be imported. The demand for agricultural implements was met by many local engineering firms; in Melbourne Langlands Foundry Company, Fulton Foundry Company, David Munro, Hugh Lennon, Mitchell & Co., T. Robinson, were amongst those who met the demand. Some engineers saw advantages in being in close proximity to the wheat growing areas, hence Ballarat became a centre for many firms in this field. George Munro, D. B. Macaw, Dingle Laverick, Kelly & Preston, and John Tynan were some of those who produced implements of all types. Many firms made a feature of interchangeability of parts on their machines, thus helping to solve the repair problem.

The operation of winnowing in wheat harvesting was loathed by wheat growers, and it took the ingenuity and perseverance of H. V. McKay to solve the problem. He took out patents in 1885 and began operations in

Ballarat, moving later to Melbourne. His machines were built to a standard specification and interchangeability of parts was guaranteed.

In parts of Victoria, traction engines and tractors had difficulty in working in wet soil and sandy soil. These were overcome by the invention of a special type of road wheel. Developed by Frank Botrill, an inventor and blacksmith, it came after the development of the caterpillar tread and a patent was taken out for it in 1907. A tractor and waggon with these patent wheels was built by A. H. McDonald & Company, Richmond, in collaboration with Austral Otis Engineering Company. McDonalds also supplied tractors with Bottrill wheels for use on the construction of the Trans-Continental Railway. Another unique invention was a four wheel drive steam traction engine; conceived by Thomas Quinlivan, a farmer living near Coghills Creek, Victoria, it was designed by Mr. G. F. Wightman, Works Manager of Cowleys Eureka Iron Works, Ballarat, and built by them. Nothing like it had ever been built before; it was patented in 1908.

The production of wool required the use of wool scouring and associated machines, wool presses, and other equipment. Hall Brothers, Clifton Hill, Victoria made a specialty of wool scouring machines. Wool presses were built by many firms from the earliest days; Humble & Nicholson of Geelong, built over one thousand, many being shipped to South America. Peter Johns began building hydraulic wool presses prior to 1880. The introduction of the sheep shearing machine in 1888 eliminated a good deal of labor in the sheep shearing industry. It was the invention of Wolseley who came to Australia from Ireland; Herbert Austin, who had served an apprenticeship with Langlands Foundry Company, collaborated with Wolseley in the production of the machine. Production was carried out at the works of R. P. Park, South Melbourne.

9. FOOD PRODUCTION. Flour mills were built in various parts of the State, to cope with the demands of increasing population. A number of local engineering firms supplied mill machinery, pre-eminent being Robert Bodington, and Schumachers Mill Furnishing Works. Both these firms supplied a full range of flour milling, grain and seed machinery. Meat works were established fairly early in Victoria together with tanneries. One company that became well known for its products in this field was that of J. T. Stamp; Stamp was associated with Walter Powell for some years in the manufacture of abbotoir machinery. Dairy products feature largely in the State's primary industries, but the preservation of meat and dairy products was not satisfactorily solved until the advent of refrigeration. A Geelong inventor, J. Harrison, developed an ether-compression refrigeration process that was used in a Bendigo brewery in the 1850's. Robison Brothers fitted two ships, the 'Protos' and the 'Europa' with refrigeration equipment in 1880 and 1881; they took cargoes of frozen meat to England. Humble & Nicholson, Geelong commenced building refrigeration and ice making plants early in the 1880's. Lowther & Jarvis, The Atlas Company of Engineers, and R. Werner & Company were other firms that became well known in the refrigeration field.

Preserved meat exports began about 1868; the Melbourne Meat Preserving Company was the most successful in this field, and by about 1880 were employing a large number of tinsmiths to make the thousands of containers required. This demand for containers led to the manufacture of press tools, sheet metal working machinery, power presses and the like. Such work demanded precision engineering methods and the firm of W. G. Goetz & Sons Ltd. became one of the leaders in the field.

10. INTERNAL COMBUSTION ENGINES. The first gas engine built in Victoria was produced by G. Scott & Sons in 1884. It seems apparent that Victorian engineers kept themselves well informed of developments in England and Europe; Lenoir in France developed the first internal combustion engine in 1860 and Otto developed the four cycle petrol engine in 1876. It was not long before Victorian engineering firms launched into the production of internal combustion engines, mostly small ones for farm use. John Buncle in Melbourne, Jelbart Brothers and Ronaldson Brothers & Tippett, both in Ballarat, Geo. W. Kelly & Lewis, A. H. McDonald & Co., H. V. Hampton, and E. Coulson were some of those that were busy in this field. McDonalds started production of small petrol engines in 1904; Geo. W. Kelly & Lewis began building similar engines in batches of fifty in 1910. Quantity production required interchangeability of parts, thus necessitating jigs and fixtures, as well as precision measuring methods and equipment. All this led to engineers honing and refining their skills, paving the way at a later date for automobile and aircraft manufacture.

11. WARTIME PRODUCTION. It has been said that no country can afford to go to war without having a well-organised and efficient secondary industry. In this regard, Australia was well served by the well established engineering firms that had grown up in less than one hundred years. During World War I, the Commonwealth Government called on selected local engineering firms to assist in the war effort, one of them being Geo. W. Kelly & Lewis. They had an order for shell cases, which required special lathes for their production; none were available so the firm designed and built their own. Three months after commencing work, twelve were delivered. The firm also built three air-craft engines for the Australian Flying Corps; they were 80 horsepower (60 kW) and modelled on a Renault prototype. Johns & Waygood also produced several thousand shell cases. It was mentioned earlier that Thompson & Company, Castlemaine, were called on to design and build a 500 ton (508 tonne) forging press for the production of steel tyres for railway and tramway rolling stock. They also built marine engines during the war.

The outbreak of World War II was not unforeseen, and some time ahead of the catastrophe, the Commonwealth Government made plans to ensure that local engineering firms were fully organised to cope with the burdens that would be laid on them. Many firms built special annexes to deal with the requirements of the Defence Department and in many cases undertook work that was completely foreign to them. Only a few examples can be quoted. Charles Ruwolt (now Vickers-Ruwolt) built a special annex for the manufacture of 3" (76.2 mm) trench mortar bombs, and at a later date, undertook the manufacture of 25 pounder gun howitzers. Nine months after the receipt of the order, the first gun was submitted to the Army Inspection for proof tests. This was an extraordinary feat in view of the fact that the firm had had no previous experience of ordnance manufacture, and that they had to design and build some machine tools for special machining operations. In addition to these contracts, the firm also supplied tank attack guns, 200 horsepower (149kW) Diesel engines, and other items. Kelly & Lewis had a wide ranging program of steam generating sets for the Navy, air pumps and fans for sloops and cor-

vettes, portable pumps, barges, sections steel telegraph poles and radio masts. Johns & Waygood made 10 pound (4.53kg) and 20 pound (9.07 kg) mortor bombs, 20 pound (9.07 kg) aerial bombs, made and assembled torpedo parts, steel structures of all kinds, as well as machine tools for defence factories. Thompson & Co., Castlemaine, built marine engines circulating pumps, supplied massive forgings to other companies, marine propellers, tank attack guns and many other items. This is to say nothing of the achievements in the automobile and air-craft manufacturing industries. In fact, it is only a small picture of all that went on during those years.

12. CONCLUSION. The economic values of our engineering heritage are many. The potentialities of the pastoral and agricultural industries were made possible by the supply of suitable equipment. Gold production laid the foundation of the State's wealth in its early years. Dairy products, meat products, and fruits were kept fresh in cool stores supplied with equipment furnished by Victorian engineers. The exploitation of the brown coal resources of southern Gippsland brought electric power to all parts of the State.

Many social values accrued from our engineering heritage. The provision of fresh water and the installation of sewage treatment plants brought about a great improvement in public health. The coming of gas and electricity brought a marked improvement in living and social conditions; streets were made safer at night, cooling and household heating were improved and pollution was reduced. The installation of machinery in factories and farms eliminated much drudgery, arduous and laborious work, as well as eliminating many hazardous tasks. It made a reduction of working hours possible, with increased leisure. The installation of telephones and telegraphs was a great boon enabling as it did, instant communication in city, rural and interstate areas. Roads, railways and tramways improved social life by quicker, easier and safer travel.

It is perhaps appropriate to conclude with the sentiments expressed by the late Mr. E. P. Lewis, former Chairman of Kelly & Lewis Limited. In a foreword to the company book 'Fifty Years of Engineering' published in 1949, he said,

> "In recent times the tides of political and economic thought seem to have set against enterprise. The appreciation of its benefits has been overshadowed by a too close preoccupation with its deficiencies. But while this world needs the virtues of courage, vision and honest workmanship, enterprise will always have its part to play."

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