William George Armstrong (1810 – 1900)

Introduction

Last year Christine and I visited the National Trust property – Cragside at Rothbury near Morpeth in Northumberland. The property was built by Sir William George Armstrong. We marvelled at his amazing inventions, his taming of the landscape, and the quirky originality of the house he had built amid the bleak Northumberland moors. As we are not Geordies we had not heard much about this man. The name Armstrong we were aware of from various organisations that bear the name. Even connections with Coventry – Armstrong-Whitworth that Alan Buckland mentioned in his presentation about the UK Aircraft Industry at our June virtual meeting. Also Armstrong Siddley car manufacturers.

After our visit to Cragside I decided to find more about the man. I discovered that William Armstrong was one of the most brilliant and charismatic figures of the Victorian Age – a self made man whose astonishing achievements have long been underestimated. Inventor, scientist, prophet and engineer. He created an industrial powerhouse on the Tyne employing 25,000 people manufacturing cranes, ships, warships, bridges and guns. He was romantic and visionary by nature, as well as intensely practical dreaming always of a better world. But he was loved, hated and feared in almost equal measure. While he brought great fame and fortune to his native Newcastle upon Tyne, and to his country as a whole, he was condemned as "a merchant of death".

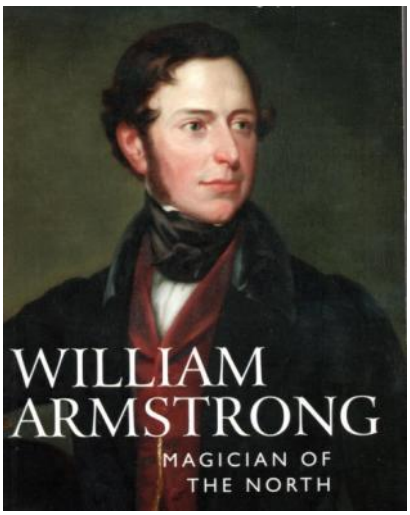

Figure 1 Armstrong Age 20

This is the story of his progression from an inventor, businessman benefactor known only around Newcastle to being an international engineer. It is a time when the United Kingdom was the most advanced country in the world leading the industrial revolution. During William Armstrong life he met with many, famous people including: Isambard Brunel; Robert Stephenson; Michael Faraday; Thomas Edison; Henry Swan, Joseph Swan, Charles Wheatstone as well as senior Government figures and members of the Royal Family.

The Beginning

William George Armstrong was born 26th November 1810 at Shieldfield on the edge of Pandon Dene in a three storey terrace house in Pleasant Row. The garden ran down to the dene this was only one mile from Jesmond Dene that was to become important later. William had a sister, Anne who was 8 years older. His father was a wealthy corn merchant, well connected with the important people in Newcastle. With the corn trade flourishing Armstrong Senior moves to the upper Ouseburn. Bought 12 acres of land and built a house. Close to wealthy bachelor friend Armorer Donkin. Armstrong Snr later became Mayor of Newcastle and an Alderman.

During his early years William Armstrong spent a lot of time fishing on the River Croquet 30 miles north of Newcastle. Anthony Donkin had a house at Rothbury close to the river.

William earnt the nickname “Kingfisher” he was fascinated with water and wanted to know how everything worked. William also admitted to poaching, fishing on the nearby Brinkburn estate.

At this time he would also spend a lot of time at the workshop of old John Fordy who did joinery work for Williams’s maternal grandfather, the owner of Walbottle Colliery. With Fordys help William would make miniature engines. Armstrong later told his friend Thomas Sopwith, (who was the father of Sopwith the aviator and plane builder again mentioned in Alan Bucklands Presentation in June) that his childhood had been a continual study of electricity, chemistry and mechanics non of which would have been taught in school.

Armstrong’s Education

William was later sent to grammar school at Bishop Auckland subjects restricted to: Reading English, writing and accounts. Average of 55 boys of whom 10 would read classics. Classists paid 10s 6d a quarter more. Armstrong lodged with Rev. Robert Thompson master of school since 1814.

One notorious incident at school William broke a neighbouring house window with a home made crossbow fashioned with the stems of old pipes. William was not attracted to the scholastic life. Nearby was small Engineering Works of William Ramshaw. He spent a lot of his spare time there. Ramshaw was impressed by his interest in machines. William was invited to Ramshaw's home and met his 18 year old daughter Margaret, 3 years his senior. Margaret was later to become William’s wife.

One major block to any of William Armstrong’s plans to follow an engineering career was his father’s solid determination that William would pursue a career in Law. His fathers own experiences had shown that a combination of education, hard work and shrewd use of connections was the key to advancement. He could not see mechanics as a worthwhile occupation.

In 1826 William’s sister Anne married former soldier William Henry Watson. Who had had a distinguished military career. Member of the 1st Royal Dragoons served under Wellington in the peninsular war at age of 16. Watson now a solicitor left his native Bamborough for London and occupied chambers in the Inner Temple in London. Watson later became a Liberal MP for the Irish seat of Kinsale and later for Hull. He was knighted in1856 and made a Baron of the Exchequer. 1st June 1828 Anne (Williams’s sister) died suddenly at the age of 25. A year earlier she had given birth to a son John William Watson.

Training as a Lawyer

Reluctantly following his father’s wishes to become a Lawyer. Armorer Donkin, a wealthy friend of his father promised William a job of Articled Clerk in Newcastle when he was trained. Donkin financed his studies in London. He was to be trained by his grieving brother

in law William Watson at the Inns of Court. In the autumn of 1828 as a 17 year old he embarked on a 37 hour stage coach journey to London.

William threw himself into his studies. Under the watchful eye of his brother in law. The work did not inspire him. He did enter into the social life around the Temple. William attended Friday evening lectures at the Royal Institution in Albermarle St where he first encountered Michael Farady, who invented many things to do with electricity. William was under the spell of Faraday.

During his time in London William returned many times to Newcastle to see his parents and would also visit the engineering works of his friend Henry Watson. He indulged in all sorts of mechanical investigations with the help of the skilled mechanics.

Cholera hits Britain

In October 1831 cholera arrived in Sunderland from India, the first time the disease had been seen in the UK. It spread to Tyneside then all over Britain. Claiming 50,000 lives 540 in Newcastle and Gateshead alone.

Realisation that the public water supply was in need of drastic improvements. Those living in the proximity of the much polluted River Tyne. Ouseburn and other burns were open sewers for industrial waste feeding the Tyne. Although there was a reservoir at Town Moor it fed water via lead pipes to stand pipes and fountains in the city. Most people drew their water from the Tyne.

Armstrong Returns to Newcastle

In 1833 William finished his studies and left London. He moved in with his parents and worked in Newcastle as a solicitor, partner in Donkin, Stable and Armstrong specialising in Land and Mining.

12th April 1835 William marries Margaret Ramshaw in Bishop Auckland. The Ramshaw parents bought William and Margaret 16 acres of land in Jesmond Dene for a wedding present. They built a house on this land surrounded it with a fabulous garden and began a programme of extensive tree planting. They did a lot of entertaining. They never had any children but were close to cousins and their children.

Hydraulics

William was absorbed with water power and hydraulics he made daily visits to Henry Watson’s works. He became friends with the Hutchinson family of engineers and made many experiments with hydraulic machinery. He attempted throughout this period to apply himself diligently to his legal duties. He was now swinging between the office and the lathe. He stayed in the legal business for a further 10 years.

William Armstrong’s investigations into hydraulics came to public attention in December 1838. Following the appearance of his article in the Mechanics Magazine about an improved waterwheel.

Waterwheels used water very inefficiently. Only a small portion of the power of a waterfall would turn the wheel. He suggested focussing the power of the water in a pipe from the top to the bottom. He demonstrated his new type of waterwheel.

William turned his attention to creating a hydraulic machine. By the autumn of 1839 a model of Armstrong's hydraulic engine had been built at Watsons works and demonstrated at Barra's Brewery. Water bought by pipes from between 130 to 50 feet. The entire pressure is applied to a piston and the wheel revolves. The first major item he designed was a hydraulically operated crane.

Few people were interested in hydraulic power at that time as steam engines were the norm for producing rotary power. It wasn't for another 5 years until he could exploit his inventions. In the meantime he turned to electricity.

Electricity

Armstrong made his first important electrical discovery in 1840. An electrical phenomenon involving a steam engine that caused a static electric charge from egress of steam from a safety valve. He contacted Professor Michael Faraday about his discovery. This could cause an explosion in the boiler. After further experiments this was called the Armstrong effect. During Second World War explosions in German tanks in the desert were caused by frictional electricity.

Armstrong came into contact with Isambard Kingdom Brunel Great Western Engineer and also George Stephenson of Railway engine fame.

Armstrong began an intensive investigation of the Cramlington Colliery Engine and its `Steam Electricity`. To try and locate the source of the electric charge and relate it to the quantity of steam he made a series of brass steam cocks fitted into glass tubes. He found 4 inch long sparks were produced as steam issued from the locomotive boiler. In the dark corona was seen around the brass steam fittings. Small sparks could be drawn from a rod held into the steam cloud collecting under the roof of the engine shed. Armstrong tried to discover if precipitation occurred comparable to that of an atmospheric thunderstorm and found some did while the rod held into the steam remained insulated. When damp affected the insulation the precipitation stopped. Convinced the electricity was not produced by the expansion of steam he had probes inserted into the boiler and proved that electrification did not occur inside. Only when steam issued from the jet

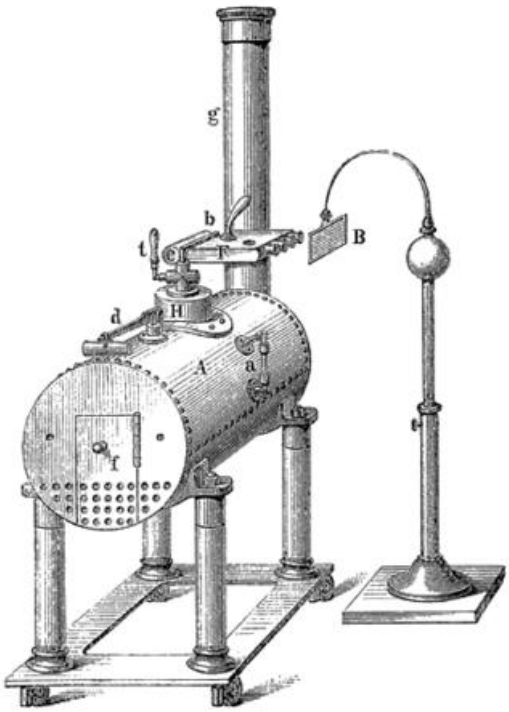

Figure 2 Hydro-Electric Generator

was electricity produced. He was mystified by the fact that steam was electrically positive but the negative could not be located anywhere on the apparatus.

Whether it was the business man or scientific curiosity or both Armstrong as it were reproduced the Cramlington Colliery boiler in a version he called The Hydro-Electric Generator. One of these still exists in the Newcastle Museum. The one in the Royal Polytechnic Institution is described in Noads Electricity and quoted by Pepper as being a cylinder boiler of 5/8 inch boiler plate, 7 feet 6inches long (2 metres approximately) by 3 feet 6 inches diameter (about 1 m). Its glass legs were 3.5 inches diameter and 3 feet long. Steam pressure 60 lbs per square inch - Spark length 22 inches.

In October 1843 William spent some time in London to supervise building of two evaporating apparatus machines at the Royal Polytechnic Institute. He wrote to Donkin to apologise for his absence from his job in the legal firm. In 1844 Armstrong delivered two speeches about Hydroelectricity at the Literary and Philosophical Society of Newcastle[1].

Some years later Williams's achievements in Electrical research were recognised by his election as a Fellow of the Royal Society. His sponsors included Michael Faraday the inventor of the Electric Motor and Charles Wheatstone one of the inventors of the Electric Telegraph.

Whittle Dene Water Company

The establishment of Armstrong's first commercial venture in 1844 was the creation of The Whittle Dene Water Company a project that would provide clean water for the working class in Newcastle it would also provide the pressure for his ideas of Hydraulic engines on the Quayside. Armstrong aged 34 became company secretary with an annual salary of £150.00 (£20,000 at today's value). The bill to create Whittle Dene Water Company was passed in 1845. Reservoirs to be built filled with the clean water of the Whittle Burn. Reservoirs were high enough not to need pumps to bring water to Newcastle.

By 1848 three reservoirs had been completed and a cast iron pipe 12.5 miles long 24" diameter, then the longest in the world. Two more reservoirs were built later. The 5 reservoirs held 515 million gallons of water. Armstrong was acknowledged to be the mastermind behind the whole project.

Hydraulic Cranes

Armstrong wrote to the Newcastle town's finance committee on 24th November 1845 suggesting the increased pressure would now allow the working of hydraulic cranes on the Quay. Speeding up the loading and unloading of ships in the port. He offered to convert one of the existing cranes at his expense. If the experiment was a success then the Corporation would lease all the cranes on the Quay for 10 years to Armstrong & Co Ltd. He suggested the cost of craneage could be cut by 20%. The council would have increased revenue at no risk cost.

[1] The Literary and Philosophical Society of Newcastle upon Tyne (or the Lit & Phil as it is popularly known) is a historical library in Newcastle upon Tyne,, and the largest independent library outside London. The library on Westgate Road is still available for both lending (to members) and as a free reference library.

Armstrong demonstrated a model of his crane to a packed house at the Lit & Phil
He proposed heavily the use of water for motive power. A pipe from a reservoir could run down over several water wheels and at the lowest point used on a piston to operate hydraulic machinery such as his crane. Hydraulic power could have a lot of uses especially where enough activity could not justify the use of a steam engine, operating lathes, printing presses etc.

Figure 3 Hydraulic Jigger

1st January 1846 Armstrong's proposals for Hydraulic cranes were endorsed by the Town Council. Under the control of Newcastle Craneage Company. Operations at the Watson's work started to convert the first crane to Hydraulic power. In July 1846 Armstrong registered a patent for an apparatus called a jigger for lifting, lowering and hauling. It consisted of a ram and multi pulley device that converted linear motion to rotary motion. By the end of the year 4 more hydraulic cranes each weighing 5 tons had been ordered and were under construction at Watsons.

W G Armstrong and Co

Armstrong formally resigns from his solicitor partnership. 1st January 1847 a deed of partnership was drawn up for WG Armstrong & Co. The same men who set up the water company. The firm's capital was £22,500 (£3M) Armstrong contributed £2000 (£200K). Later that year he gave up his position in the Whittle and Dene Water Company while still retaining his financial interest.
In 1847 the partners of WG Armstrong & Co paid £5552.00 (£500K) for just over 7 acres of land on the North Bank of the Tyne a short distance upriver from Newcastle. They started to build workshops there the start of the Elswick Works.

Armstrong opened administrative offices in the centre of Newcastle, 10 Hood St. Orders came in a steady flow. Equipment had to be bought but cash flow was mainly out. Increased company's capital to £43,000 (£4.5M)

Figure 4 Portable Winch - Albert Docks Liverpool

Summer of 1847 several men joined from Watson's works. Watson's works just received contract to build Robert Stevenson's High Level Bridge across the Tyne. Although Armstrong did not have a very good business acumen he could spot people who had and he persuaded them to

join his venture.

One of first of orders was from Albert Docks in Liverpool. A sceptical Liverpool dock chief engineer visited the Newcastle Quay unannounced and saw the hydraulic cranes in action. One very clever crane operator nicknamed *hydraulic jack* so skilled at working the crane he could swing it around and lift and drop items with great precision. Based on this Liverpool docks ordered two cranes and two hydraulic warehouse lifts. Payment for the lifts was made on 15th May 1848 the first money received by the Company.

Armstrong adapted his hydraulic machines to control dock gates, open and close sluice gates, hydraulic locomotive turntables. Many orders received from rail companies on the recommendation of Isambard Brunel.

James Rendel, a waterways engineer and Armstrong won a contract worth £13,500 (£1.6m) to design and equip Grimsby Docks. There was not a sufficient water head so they built they built a 300 ft water tower and kept it filled by a steam engine. Building of Great Grimsby docks opened by Queen Victoria, her Consort and Children on 14th October was one of his big achievements

Figure 5 Millwall Dock Entrance

Orders were received from Birkenhead Docks for a swing bridge operated hydraulically this was the first of a series of swing bridges that Armstrong and Co would manufacture at the Elswick works. They also provided equipment for coal mines and lead mines.

Manchester, Sheffield and Lincolnshire Railway Co. Ordered 9 off 2 ton cranes to speed up the loading and unloading of passenger's luggage to be erected at New Holland on the River Humber. No water pressure was available, the ground too soft to build a tower. William Armstrong came up with the idea of an accumulator. A large vertical cylinder in which a heavy weight was raised by a column of water driven by a pumping engine. When the weight fell forcing the water in the cylinder down to produce the required pressure. Pressure raised from 90 psi to 600 psi. In later years pressures reaching 1500psi were possible.

In 1894 London's Tower Bridge opened with six Armstrong accumulators that opened the giant bascules in little more than a minute. Hydraulic engines could be used in almost every situation.

Honours followed, Armstrong received the Telford Medal from institution of Civil Engineers in recognition of his Water Pressure Engines.

By 1852 Elswick was producing 75 cranes a year. Increasing to an average of 100 cranes per year by 1900. Company sought orders from the Commonwealth. By 1900 export was 60% of total output.

One failure of William Armstrong was his attempt to produce a railway locomotive; he spent £2000 (£200K) trying.

The excitement of the launch of Armstrong's business career was tempered with the serious illness of his mother, Anne she died on 9th June 1848.

Still smarting from the repeal of the Corn Laws Armstrong senior was elected as Newcastle Alderman in the same year as his wife's demise. In 1850 Armstrong senior became Mayor of Newcastle. He asked his daughter in law, Armstrong's wife Meggie to be his Lady Mayoress.

Armstrong and Co Ordnance

Background information.

In the Great Exhibition of 1851 Armstrong saw a cannon made by Alfred Krupps of Essen, Germany it was capable of firing a 6 pound shot, this intrigued him.

At the beginning of September 1854 Britain, France and the Otterman Turks needed to check the Russian expansionism in the Balkans. Following a dispute about control of the holy places in Jerusalem. The Allies set sail for the Crimea peninsular with the object of besieging Sebastopol HQ of the Russian's Black Sea fleet. For the first time in 40 years Britain was at war.

The disaster occurring to British forces in the Crimea was terrifying. Britain's armaments were hopelessly out dated. Although Britain won the first battle 5000 men were lost, hundreds more were injured with no facilities to treat the injured. The whole supply system was inept and useless. This prompted Florence Nightingale and 38 nurses to set sail in the third week of October 1854. They arrived on 5th November to receive the casualties of the Battle of Inkerman. The country was horrified. Details took along time to reach the UK. Nearest telegraph was at Constantinople and Vienna.

Soldiers of the British army were ordered to bring two large cannons to the front line. With no horses 150 soldiers dragged the two ton guns through mud. Russians forced to withdraw after hand to hand fighting. 2500 British casualties at Inkerman came hard on the heels of Balaclava (Charge of the Light Brigade).

Artillery pre 1854

British Cannons were made of cast iron they had a smooth barrel loaded through the muzzle with gunpowder and fired a round ball of lead. The cannon had little accuracy and shot travelled only a short distance. The range and accuracy of these cannons was extremely poor.

A lot of work had been done on designing rifles to replace muskets. Rifles were breech loading, had a rifled barrel and bullet shaped projectile and could be fired a greater distance and with more accuracy than cannons.
Military engineering lagged 30 years behind Civil Engineering technology. Cannons were still being made of cast iron.. No advance had been made in the science of gunnery since the end of the Napoleonic wars.

IK Brunel made a model of a floating siege gun 12" Bore capable of firing 3 rounds per minute. Brunel failed to get support from the Admiralty. Sporting guns were far more modern than military guns. Between June 1854 and Autumn1855 War office received 1000s of submissions for new artillery.

Armstrong's Ordnance Designs

After seeing Krupp's Cannon at the Great Exhibition William began working on the development of a new gun.

Armstrong's first cannon weighed 5 cwt and its shot was a cylinder of solid lead weighing 3 pounds. The design Armstrong came up with had 4 distinguishing features.
Unlike previous cannons the bore was rifled giving a longer range and much greater accuracy. Allowing elongated projectiles rather than round balls. It was loaded in the breech allowing faster loading. The barrel made by the coil method of construction using wrought Iron.

William gave evidence to a royal commission on ordnance explaining the use of rifling of the barrel. Breech loading, strong enough to withstand the extra force when fired. Light enough to be moved easily. For lighter weight cannons must therefore be made of steel or wrought iron, rather that cast iron or bronze.

Armstrong tested his gun at Whitley Sands firing a solid lead cylindrical shot. He carried out many test himself at personal danger to himself. There was no science then of what pressure metals could withstand.

July 1855 Armstrong's first prototype type was presented to War Offices ordnance committee which consisted of civilians as well as military personnel. They were struck by the range and accuracy of the gun but said it was too small for the battlefield. They asked Armstrong to enlarge it.

The weapon was re-bored to take 5 pound shells. The projectile was replaced by cast iron shell thinly coated with lead also produced a concussion fuse which would cause the shell to explode on impact.

Middle of 1856 Armstrong was experimenting with different guns on the moors above Allenheads firing across the valley. He developed a nyctoscope to allow him to shoot at night. For days on end he would occupy a solitary hut high on the moors. His guns were successful in firing a 5 pound leaden bullet over 1500 yards passing through 30 inch thickness of elm.

Back to the Crimean war Russians scuttled 6 of their battleships at the mouth of Sebastopol to stop the enemy. Armstrong was asked to design underwater mines to clear the battleships. Mines used unsuccessfully to blow up the docks a job they had not been designed for.

End of Crimean War.

With encouragement of the government Armstrong set about building bigger guns producing 12 and 18 pounders (weight of projectile). He was helped in the initial design by Isambard Brunell and James Nasmyth. Brunell wanted to use wire on the internal tube.
April 1857 Armstrong reported the successful tests of his new 18 pounder. Brunel was now preoccupied with building his steam ship Great Eastern

William Armstrong Senior died in June 1857. On his death William jnr donated 1,284 of his fathers written works to the Lit and Phil.

Armstrong and Co were still primarily involved with producing hydraulic machinery. Gun Trials scheduled for the end of the 1857 were cancelled when Armstrong was called to Northern Italy to advise the Italians on the modernisation of Genoa docks. This was William's first trip abroad.

Competitive Gun Trials and Manufacture

Trials at government's artillery range at Shoeburyness confirmed the virtue of the 18 pounder

The trial was against a standard 32 pounder weighing 56 hundred weight. Armstrong's gun an 18 pounder weighing 12 hundred weight. Each fired several rounds at targets 2000 and 3000 yards away. Armstrong's gun fired his own projectile the standard cannon fired solid shot.
The standard cannon did not hit the target at all. Armstrong's hit every time. When fired at the same elevation the Armstrong gun went 900 yards further. 32 pounder needed 10 pounds of charge, Armstrong's needed only 2.5 pounds

Armstrong and Co were given orders for 2 more 18 pounders one 12 pounder and 400 shells.

No decision had been made in the UK about new artillery.

Fears were growing of a French invasion. Up until now ships were built mainly of wood. But with the increased power of the guns available iron clad ships were being built in French dockyards. The French also had rifled cannons.

With the return to power of Viscount Palmerston's Liberal government a large scale programme of rearmament was started. A committee was appointed to look at rifled cannons.
Armstrong & Co biggest rival was Joseph Whitworth of Manchester. Whitworth had received £17,000 as a research grant. In trials one of Whitworth's guns burst its barrel.

Another competitor was Henry Bessemer who had invented the process for making mild steel. He had set up a steel works in Sheffield. He planned to make guns from his steel.

16th November 1858 the committee recommended to Parliament acceptance of Armstrong's guns. Government ordered 100 guns and guaranteed £12,000 (£1.6M) investment for Elswick works. Manufacture of Guns got underway at Elswick works and also Royal Arsenal in Woolwich. William Armstrong made Engineer of Rifled Ordnance to War Department with a substantial salary of £2000 (£200K) back dated to 1856. The Military Chiefs wanted all guns to be manufactured at Woolwich and did not like a civilian in charge of manufacture.

Armstrong was worried that the Government would transfer all ordnance manufacture to Woolwich that would seriously compromise the Elswick works. To guard against this Armstrong offered to hand over all gun patents free of charge to the government also agreed not to sell to foreign powers in return for government underwriting his investments at Elswick works for 10 years mid January 1859 a 10 year contract signed.

General Peel recommends Armstrong for knighthood. He was knighted by Queen Victoria and Albert and made Commander of the Bath 23rd March 1859

Elswick Ordnance Company was a place of great secrecy. At the plant operators only new of their own role. George Rendell MD of company was only 26. To avoid conflict Sir William did not have legal status in Elswick although he reserved the right to join the Company when he left Government employment.

Armstrong continued development of new guns. He personally supervised trials at Shoeburyness January 1859. Trials carried out methodically 5 guns in a battery. Targets at 625, 1500, 2000 and 3000 yards From 18 pounder some shots fired into an oak butt 625 yards distance. Shot passed through entire thickness and continued for a further 600 yards. The butt was 6ft thick 9ft wide and 9ft high. Size of gun defined by weight of projectile. This power unknown in any gun. The range at an angle of 35 degrees was 9175 yards just over 5 miles. Military witness was astonished at this gun.

Britain had been engaged in hostilities with China for last 20 years. Since the outbreak of the Opium Wars in 1839. Britain was seeking to increase its commercial penetration of China. In 1858 China had failed to ratify the Treaty of Tientsin (Which opened several Chinese ports to foreign trade and establish a Chinese Maritime customs service under British Supervision). Allied raids by gunboats on Taku Forts guarding the Peiho River came to grief due to poor armaments.

Failure of Gunboat raid in 1858 saw an Anglo French force leave for China in 1860 carrying Armstrong breech loaders. The guns were used to great effect.

110 pounders weighed 4 tons and were the largest breech loaders possible.
The breech was the thicker end of the gun where most force occurred. Vent piece could blow out. Breech loaders were good against wooden ships but not iron clad. Future

development of breech loaders was not started until 1870. Armstrong turned his attention to rifled muzzle loader cannons.

Wooden ships were being replaced by iron and later by steel. RN *Warrior* was first iron built British battleship she was built to outclass the French equivalent *La Goire* built of wood with a 4.5" iron attached to a wooden hull. Warrior's hull built entirely of iron longer that the French and narrower she could travel at 14 knots 2 knots faster than the French. Warrior was armed with Armstrong guns 4 off 70 pounders and 10 off 110 pounders. 110 pounders had a range of 2.5 miles.

In 1862 in American Civil war two iron clad ships the *Monitor* for the union and *Merrimack* for the Confederacy, could not get the better of each other both with Armstrong breech loading guns.

Armstrong started to develop larger guns rifled muzzle loaders new class of monster guns: 6, 12, and 22 tons. Based on the size of shell they could fire were called 150, 300 and 600 pounders. Two larger guns called Little Will and Big Will after Armstrong. Big Will was able to fire a 344lb round steel shell which smashed through iron plate 11 inches thick shell struck the plate at a velocity of 1,560 feet/second, the solid oak beams behind were splintered it was a personal triumph for Armstrong against his rival Whitworth.

The **Bombardment of Kagoshima**, also known as the **Anglo-Satsuma War**, was a battle fought between Britain and the Satsuma Domain in Kagoshima from 15 to 17 August 1863.

Figure 6 Armstrong gun used at the Battle of Ueno against the Shogitai 1868 China

The British were trying to extract compensation and legal justice from the daimyō of the Satsuma Domain for the Namamugi Incident in 1862, when vessels of the Royal Navy were fired on from coastal batteries near Kagoshima. The British bombarded the city in retaliation and pushed back the Satsuma, but were unable to defeat them and eventually retreated two days later. The Satsuma declared victory and after negotiation fulfilled some British demands for the Namamugi Incident. Armstrong breech loading 110 pounders were used in the bombardment Kagoshima some of the vent pieces blew out. Following this the 110 pounder breech loaders were declared not suitable for military use.

Armstrong Ordnance Co look to Export Market

The Government suspended the contract with Armstrong Ordnance & Co., all gun manufacture was to be done at Woolwich. Armstrong resigned from his government post and moved back to Newcastle. Workers and Directors at Elswick refused to be defeated. Although Armstrong's patriotic feelings stopped him from exporting his ordnance to foreign powers he was persuaded by Stuart Rendel that there was an interest overseas. Whitworth had already sold his guns to Brazil.

In 1862 the International Exhibition opened in London Armstrong's guns were the central exhibit. There were 6 million visitors over the 6 months of the exhibition. Also exhibiting was Alfred Krupps of Essen, Germany.

Armstrong offered Stuart Rendel a 5% commission on any overseas order he bought to Elswick. Orders came from both sides of the American civil war, orders followed from Egypt, Turkey and Italy. With military conflicts breaking out in many parts of the world in the 1860's and 1870's good market for Guns and also continuing orders for munitions.

Armstrong's guns were used in the American Civil War (1861-65); Schleswig-Holstein War of 1864; Austro-Prussian War (seven Weeks) war of 1864 which included naval battles between Italy and Austria; the continual Civil War in Spain between 1868 and 1870 and her wars against Peru (1864-5) and Chile (1865-66); the war of Paraguay against Argentina, Uruguay and Brazil between 1864 and 1870; the War of the Pacific 1879-84, which pitted Chile against Peru and Bolivia; and the continual wars between Turkey and the Balkan peoples which culminated in the Russo-Turkey War of 1877-78. China also needed to build up its defences following the Japanese invasion of Formosa (Taiwan) in 1874. World demand for weapons especially warships increased during the 1880's and 1890's as the major powers launched armament races and naval power entered a period of growth and technological development.

Following new experiments with Muzzle loading guns. Ulysses Grant US President visits Elswick works to inspect monster guns in 1870

Elswick Works Expands

In 1863 Elswick works was producing ordnance and hydraulic machinery. The massive growth of the railways and docks generated requirements for Armstrong's hydraulic machines. So extensive were orders 30 hydraulic cranes would only be a single order. Armstrong merged the Ordnance and the Engineering Company under the banner of Sir W. G. Armstrong & Co. Extra land was acquired to the east of the existing site. New engineering buildings were constructed. Blast furnaces were added and a 30 ton steam hammer installed that shook the nearby houses. Ore for the iron making came from the Risdale Iron Mines owned by the firm.

Ship Building

In 1867 Armstrong signed an agreement with shipbuilder Charles Mitchell to construct gunboats at Mitchell's ship yard at Low Walker, 6 miles down stream from Elswick. Weapons were built and fitted at Elswick.

Charles Mitchell had married Anne Swan in 1854. Charles Mitchell would be later instrumental in founding Swan Hunter shipbuilders.

The first product of the collaboration was *Staunch* a 79 foot long "gun carriage" ordered by the Admiralty and completed in 1869. It carried a single 9 inch muzzle loading gun. It was lowered for reloading and raised for firing. Staunch had no protective iron skin, making it lighter and much faster. It was used for patrolling shallow coastal waters. Staunch was a resounding success. In the 1870's and early 1880's the yard completed 21 of this gunboat class. 3 for Britain; 2 for the Netherlands; 4 for Australia; and 11 for China. By 1877 Elswick was shipping dismantled *Staunch* gunboats in crates to various parts of the world to be reassembled at their destination under supervision of Elswick engineers.

The River Tyne

The biggest impediment to Armstrong's expansion was the state of the River Tyne. Shipyards expanded and size of the vessels using the river increased. The relative shallowness of the water produced challenges.. Extensive dredging started in 1860. By 1878 Elswick had a 26–foot depth of water and a wharf was built. Another crucial event was the removal of the 18th century low level river bridge and replaced with a wrought iron swing bridge manufactured and equipped by Armstrong & Co. The Swing Bridge was the latest in a series of groundbreaking bridges built by Elswick Works. This gave him a gateway to the sea. The prelude to opening a shipyard at Elswick.

Figure 7 Elswick Works

Italian Connection

The first ship to pass through the new bridge was the Italian ship *Europa* which went upriver to load a huge 100 ton gun for the Italian Government. Ever larger hydraulic cranes were built to lift ever larger guns. At La Spezia the gun was lifted off by an Elswick made crane the then world's largest weighing 180 tons.

The Italians were a large customer of Armstrong's. In 1866 Captain Augusto Albini of the Italian navy bought a large quantity of Armstrong 150-Pounders each weighing 6 tons. Italy were on the Prussian side of the Austro-Prussian War. The Italians wanted more guns, after the defeat by the Austrians at Lissa in the eastern Adriatic – Armstrong won favour by agreeing to divert to Italy a consignment of guns for Turkey but not paid for.

Italy was Armstrong's largest customer. Eventually a branch of the Armstrong Company was established at Pozzuli in the Bay of Naples. Headed by Rendel and retired Captain Albini.

Gunpowder

During the 1870's two Elswick men, Fredrick Abel and Andrew Nobel were making world changing discoveries in the field of gunpowder. After dangerous experiments they created gunpowder with slow burning properties. In one step muzzle velocity increased from 1,600 ft/sec to 2,100 ft/sec. This resulted in longer barrels to the guns which changed back to breech loaders, with advances in steelmaking the problems with breech loaders were overcome. Some years later they made two 12 inch guns of 43 tons weight to UK government specification..

The Gatling gun was invented by Richard Gatling during the American Civil War. In 1870 Armstrong became the British Licensee. One year later Armstrong Ordnance had 36 considerably modified for the British Government. Gatling Gun was good business for Armstrong, it was used as a field gun and also for naval use.

Warships

The demand for Gunboats from Low Walker increased. Originally a merger between Armstrong and Mitchell in 1881 was suggested. Armstrong's colleagues advise against it. In 1882 Armstrong bought the Low Walker Shipyard. A new company Sir W. G. Armstrong, Mitchell and Company Ltd was launched with a capital of £1,575,000 (£200m). Mitchell and Swann became directors of the new company. Public sale of shares raised £665,000 (£81M).

Following the success of the Gunboats, and hot on the heels of *Staunch*, inspired by the Gunboats but much larger and faster. *Esmeralda*, built at Elswick. She carried two 10-inch breech-loading guns and six 6-inch guns and could reach speeds of 18 knots. With an overall length of 82.2 metres (270 ft) and width of 12.8 metres (42 ft), *Esmeralda* had a normal displacement of 2,950 tons and a draught of 5.6 metres (18 ft). She was partially armoured. The boilers and engines were contained within steel decks below the waterline. His was the

first of a group of deadly, well-protected warships that were known universally as Elswick cruisers.

The reigns of Armstrong Whitworth were taken over by Andrew Noble as Vice Chairman, Armstrong still the Chairman but was now 72. With his free time Armstrong could spend more time in pursuit of his other interests including experiments with electricity.

A steel works was added to the existing Elswick works in 1884 containing two Siemens-Martin open hearth furnaces. Output rose to more than 2,500 tons per week, supplying steel and forgings for the manufacture of the large guns. Steel for shipbuilding was purchased from other sources.

October 1884 saw the opening of a new shipyard at Elswick. Elswick concentrated on the manufacture of gunboats and the Low Walker yard on other naval ships. The first vessel launched at the new yard on 13th October 1884 was Panther, a torpedo cruiser for the Austro-Hungarian navy. The keel was laid for a new battleship called *Renown* she would be heaviest and costliest vessel constructed on the Tyne to date with a displacement of almost 11,000 tons.
This marked the start of 33 years when Elswick would be at the forefront of the world's major naval yards.
Renown was renamed *Victoria* in honour of Queen Victoria Golden Jubilee. The first ship to be built and armed by one company she cost £724,855 (£95M).

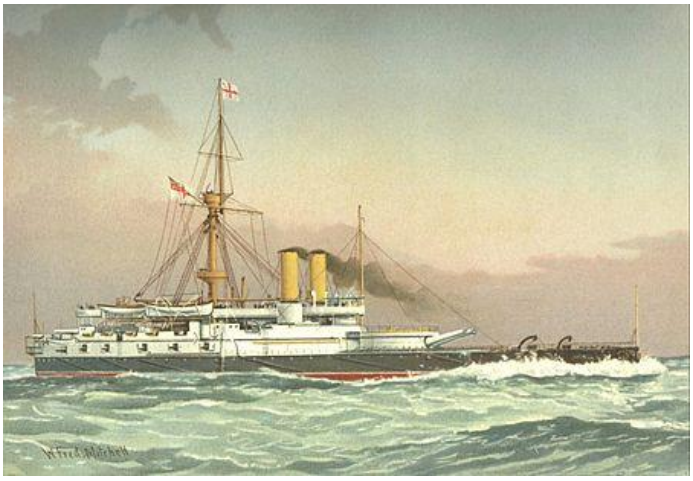

Figure 8 HMS Victoria

Following the opening of the Elswick shipyard the demand for the Esmeralda class of cruiser was overwhelming. Orders arrived from Austria-Hungary, Italy, China, Spain, Rumania, Argentina, Norway, Portugal, Turkey, Brazil and the USA. New technological improvements the ships speed was increased dramatically – and they cost less than half of battleships.

Armstrong campaigned for a change in Britain's Naval Defence policy. He spoke about the pursuit of peace. He argued that for the cost of one ironclad, the British Navy could have 3 unarmoured ships of far higher speed; steel plates for the hulls and guns and engines should be as light as consistent with their efficiency. He pointed out that at present there was not a single ship in the British Navy carrying a complement of arms sufficiently powerful to engage the faster vessels built at Elswick.

Britain had more than half of the ocean-carrying trade of the whole world in its hands and its ships in every sea conveying merchandise of huge value. In the event of war the merchant ships would attract the interest of hostile cruisers

The Naval Defence act of 1889 stimulated innovations in the design of warships and weapons.
During the early 1880's Henry Swan, manager of the Low Walker shipyard came up with idea of using a ships hull as a container for oil. In 1886 the first Oil Tanker crossed the Atlantic with a cargo of oil. During the next 20 years the Armstrong Mitchell firm was at the forefront of oil tanker developments. In that time shipyards in the North East were responsible for 200 tankers: 21 built on the Wear and 32 on the Tees but 147 on the Tyne with Armstrong' company taking the lion's share of 96.

Another creation at the Low Walker yard was a train ferry to carry freight and passenger trains across Lake Baikal in Siberia for the Trans Siberian Railway. This ship also needed to break through ice. *Baikal* was able to break through 36 inches of ice.

Soon after the ground breaking *Staunch* gunboat was perfected at the end of the 1860's orders began to arrive in every post. During the 1870's Elswick built 11 gunboats for China. Small unarmoured cruisers were built for Japan. Larger cruisers built for Japan carried 2 off 28 ton 10-inch guns worked and loaded with hydraulic machinery; 10 off 5½ inch guns each weighing 5 tons; 10 off 1-inch machine guns; 2 rapid fire guns; 4 improved Gatling guns made at Elswick and a set of torpedoes ejected form 4 tubes.

By the early 1880's after Japan's Navy expansion bill had provided for a massive increase in defence spending – Elswick was starting to receive serious enquiries from Japan about warships and guns. In 1894 during a war with China over the control of Korea Elswick built warships were used to great effect. Armstrong kept Japan supplied with guns throughout the Sino-Japanese wars. Armstrong's hardware was credited with the Japanese victory. William Armstrong was presented with the Order of the Sacred Treasure of the Rising Sun.

Japan, following the success against China, embarked on a further 10 year military expansion. This included the construction of 4 battleships, 12 cruisers, 63 torpedo boats and 23 torpedo-boat destroyers. Most of the orders went to British Shipyards, the majority to Armstrong-Mitchell yards.

Despite the sudden death of Charles Mitchell in August 1895, 1896 was one of the most successful years for the firm with 20 warships at various stages of completion, 15 at Elswick and 5 at Low Walker total displacement of 90,000 tons. Between 1897 and 1900 six ships were built for Japan. Launched on 27th June 1899 *Hatuse* was 400 feet long more then 76ft wide with a displacement of 15,000 tons. Up to that date the largest ship seen on the Tyne. The ships armaments included four 12-inch guns; twelve 6-inch guns; twenty 12-pounders and five torpedo tubes. The launch was witnessed by senior Japanese officials but also representatives of the United States, Chile, Portugal and Norway. It was a symbolic moment, a reminder of Japan's emergence on the world stage.

Even though a lot of warships and armaments were being built for foreign nations there was always a British warship being built at Elswick. All foreign orders had to be sanctioned by the British government.

Chile ordered an Esmeralda class of Cruiser. This would be the standard cruiser for the next 20 years. Two cruisers were built for Spain in 1886, but both sunk in the Philippines during the Spanish- American war of 1898. The American's raised the two ships and they were incorporated into the American Navy and survived for another 40 years.

Education at Elswick works

William Armstrong the benefactor built educational establishments for the Elswick workers and their families. He believed that a worker, with education would be a big benefit to the business. With the expansion of the Elswick works the landscape changes with more housing being built to the west of the town centre along the Scotswood road. As well as housing a large number of Public houses sprung up, more than 40 along 1½ miles of Scotswood Road.

Stormy Undercurrents

By the beginning of the 1870's the Elswick Works stretch for ¾ miles along the north bank of the Tyne. The population of the Elswick district was 28,000 an eightfold increase on 20 years earlier.

William Armstrong had a very good relationship with his employees. Until the spring of 1871 when workers throughout the North East demanded a reduction in the working week to 54 hours from 59. Wearside workers demanded a of 9 hours working day. 6 days X 9 hours = 54 hours The workers went on strike . The strike did not last long, the employers capitulated and agreed to the strikers demands.

A Nine hour league was formed in Newcastle. The Manufacturing Engineers met on 6th May 1871 and with Sir William Armstrong in the chair rejected workers demands. 20th May the workers went on strike in Newcastle. Armstrong advertised overseas for workers to come to Elswick and replace the strikers. Armstrong caused further unrest by closing the schools attached to the Elswick works. 1000 workers were imported from Belgium, Germany, Norway and Sweden.

In the end in September both sides compromised the manufacturers offered a reduction to 57 hour working week. The workers still demanded a 54 hour week, they then agreed to a reduction in pay of 3 hours – the difference in the number of hours in dispute. The strike ended on 7th October after 20 weeks. It was a victory for the men, the masters had been taught a lesson in industrial relations.

There was a second dispute in 1897 a demand for a shorter working week that affected the whole country. William Allen had implemented an eight hour day at his Scotia Works in Sunderland. In July 1897 the increasingly powerful Amalgamated Society of Engineers called their members out on strike.

Armstrong made his last visit to Elswick that year during the visit of the King of Siam, he was too old to take any part in the dispute. The President of the Federated Engineering Employers was Colonel Dyer manager of the Elswick Steel works. The Employers were

much better organised. The bitter fight dragged on for 6 month, the men withdrew their demand for an eight hour day and reconciled themselves to a peacetime working pattern that would prevail until the 1920's.

Cragside

Back in 1863 Armstrong took sometime off, he had not had a holiday for 15 years. He returned to his childhood favourite the River Crocket. The morning after his arrival he took a walk along the bank to what is now called Cragside Hill and decided, sitting on a boulder that this would be a pretty site for a house. He spoke to a man leaning on a fence to enquire if any land was for sale. The man pointed to a gorge that included an old mill that was for sale. When Armstrong returned to Newcastle he made further enquiries and bought the land. The original intention was to build a house of about 8 to 10 rooms with a stable for a pair of horses. He spent sometime planning the transformation of the Northumbrian moor into an earthly paradise.

Designed by Richard Norman Shaw an architect from Edinburgh, building began at once Armstrong and his wife took lodgings in a old mill cottage at Debdon Burnfoot so they could supervise the building. The 20 acres of rocky, heath-covered, treeless moorland that Armstrong had bought was described as a lunatic place to build a house. They had to dynamite the rock to create a platform on the side of the hill to make a platform for the house in the first place. Later when thy extended the house with a billiard room they had to dynamite holes to fit it in.

Figure 9 Cragside today

The house was built roads constructed and planting began. A staff of 80 men were employed to build the roads alone. The Armstrong's gradually acquired more and more land eventually laying out 36 miles of roadway and 9 miles of footpaths. Attention was devoted to clothing the bare hillside with vegetation.

William Armstrong was still obliged to spend much of his time in London or Newcastle leaving his wife Meggie to supervise the construction work. The Armstrong's moved into Cragside in the summer of 1865. They were still sharing space with decorators by March of 1866. They had many visitors to the new house.

Figure 10 Cragside from the Gorge

In 1869 Shaw was asked to draw up plans for adding a library and dining room on the north side with a plunge bath and hot air heating system in the basement to heat the bedrooms above. Shaw stayed with Armstrong for 25 years.

They continued to buy land as it became available until they owned most of the land from Rothbury to Warton along the River Croquet and north west to Netherton extending to almost 15,000 acres. Armstrong was eager to get all modern conveniences installed as soon as possible. In 1867 he wanted a telegraph to his house linked via Alnwick. He connected the local hotel the hotel keeper took charge of the instrument and sent and delivered message.

Figure 11 Fire Place weighing 10 tons

Armstrong was attracted to the site of Cragside not only for its natural beauty but also for the potential it offered for the use of water power. Soon after taking up residence at Cragside he began with help of hundreds of workmen to create a series of lakes – reservoirs that could be used to drive hydraulic machinery. The first two Tumbleton and Debdon were made by damming the Debdon Burn. Tumbleton provided a 35 ft head to a pumping house from where a hydraulic engine distributed water to the house for drinking, bathing and working labour-saving devices such as a passenger lift. A waterfall in Debdon Burn almost a mile from the house was used for Cragside's first hydroelectricity. In the early days a turbine was installed powering, the estates sawmill and other mechanical devices during the day. At night the electricity was used to light the house. The first house in the world to be lit by electricity. Two more lakes were constructed on a plateau above the house.

In 1878 the house was illuminated by electric arc lights this provided a very harsh light. In 1880 Armstrong's friend Joseph Swan[2] persuaded him to try his incandescent electric lamps. These provided a much softer light. Swans lamps were first shown to the public at the Lit and Phil in February 1879. Chaired by Armstrong. Swan later formed a company with Thomas Edison to provide lighting on a commercial scale. 45 lamps were installed at Cragside. The 6hp turbine was capable of lighting 37 lamps at any onetime.

Figure 12 First Water Wheel to Power Dynamo

In 1886 The final and most ambitious energy-generating scheme at Cragside drew on resources from Black Burn that provided a 340 ft head of water to a turbine in a powerhouse. This provided improved power to the main house and other buildings on the estate. A second dynamo was added in 1895 to charge Faure batteries to provide electricity when the turbine lacked water pressure. The idea of producing hydroelectricity at Niagara Falls in the US came after Alexander Muirhead visited to Cragside.

As years went by, the development of Cragside allowed Armstrong to devote more time to his favourite occupations, planting, building and doing electrical experiments. The massive planting eventually included 7 million trees. It is thought that in this corner of Northumberland the change of the landscape resulted in a 1°C increase in the average temperature and noticeably wetter in winter.

A hydraulic ram was used to provide water to Cragside. Armstrong installed labour saving devices for his permanent staff. Particularly the estate laundry, two hydraulic lifts that connected the two kitchen levels to the rest of the house. The spit in the kitchen was driven by a hydraulic engine. A system of electric gongs summoned guests to meals. The central heating system was driven by a hydraulic engine. A pioneering telephone system connects each room in the house and to some outbuildings.

Figure 13 Bridge built by Armstrong to cross the Gorge

[2] Joseph Swan was the founder of Swan Brand Company. There was until some 20 years ago a factory in Stratford- upon-Avon producing Swan Brand kettles

Armstrong went to auctions and galleries to buy works of art to decorate the building. Over the years he amassed a large collection. His major purpose in moulding Cragside was his determination to integrate his inventions and the need for it to grand enough and amazing enough to impress the high-powered business clients from around the world.

Royal Visit to Cragside

Tuesday 19th August 1884 at 5:25pm after a 5¼ run from London the Royal Train steamed into Newcastle Central Station. The first royal visit since 1854. The train only stopped for 5 minutes to allow some local dignitaries to board. The final destination was the village of Rothbury. The royal visitors – Prince of Wales, heir to the throne; his popular Danish wife Alexandra and their 5 children aged 14 to 20 were to spend 3 days enjoying the hospitality of Sir William and Lady Armstrong at Cragside. The size of the retinue had made it necessary for Armstrong to reserve the entire County Hotel at Rothbury. The royal family occupied the Owl suite at Cragside. The architect had just completed a 15 year transition from a hunting lodge to a residence fit for a 19th century emperor. For the visit Armstrong had installed a network of lights that illuminated the whole valley.

The Prince of Wales the next day opened the dock at Coble Dene near the mouth of the Tyne at South Shields. The royal party progressed through the City of Newcastle that had only acquired City status 2 years previously. Another task of Prince of Wales was to open Armstrong Park.

On the last day the Royal Party accompanied by Armstrong boarded a palatial paddle steamer at Fish Quay. The *Paráe Amazonas* built to carry passengers on the Amazon. 30 other steamers carried City dignitaries and hangers on. They steamed up river to see the Elswick works. They turned and travelled down stream through the Swing Bridge built by Armstrong in 1876 allowing shipbuilding at Elswick 12 miles from the sea. They also passed under Robert Stevenson's high level bridge. The Prince of Wales then opened the deep water dock at Coble Dene near the mouth of the Tyne at South Shields. The docks were the first project of the new Tyne Improvement Commission. 72 million tons of sand had been dredged to produce a docks that had a depth of 30 feet. The docks made use of Armstrong's earlier hydraulic inventions.

The extravagance of the Royal visit in 1884 started a succession of visits to Cragside by monarchs and magnates from around the world seeking to do business with Armstrong. The Crown Prince of Afghanistan , for example came to Cragside in 1895 with a retinue of more than 50, including cooks. The catering staff were provided with special charcoal fires for the preparation of food. - 'everything in the shape of flesh meet had to be bought to them alive' To be killed and cooked by themselves'

Three years later in Queen Victoria's golden jubilee honours list of 1887 Sir William Armstrong was raised to the peerage as Baron Armstrong of Cragside. He was the first engineer indeed scientist to be raised to the peerage.

Jesmond Dene

Despite the attention lavished on Cragside, Meggie still regarded Jesmond Dene as her true home. Since inheriting Armorer Donkin's fortune in 1851 Armstrong had been extending the original 16 acres acquired by his father-in-law, by purchasing neighbouring property as it became available. In 1860 Armstrong conceived the idea of building a banqueting hall at Jesmond Dene where he could entertain large numbers of Elswick workers and their families. He built a hall 40 ft by 80 ft on the west bank of the Ouse Burn that could hold 2000 people. Heaton Park was created in 1878 when Addison Potter, Armstrong's cousin sold 23 acres to the Corporation of Newcastle. Soon afterwards Armstrong gave 29 acres of his land to form Armstrong Park. In 1883 he increased the amount of land given for the purpose of a public park it now covered nearly 100 acres. The banqueting hall was also gifted to the City of Newcastle. built years earlier as an entertainment place for his workers.

Bamburgh Castle

Bamburgh Castle, a dilapidated building, was purchased by Armstrong in 1893 for £60,000 (£7 million) promising to preserve and restore the property. The purchase included several hundred acres of land including 3 farms and a share of the Farne Islands, 25 small offshore islands that provide a haven for seabirds and seals. The restoration took nine years to complete and cost £1 million. Armstrong lived at Bamburgh as the restoration was nearly complete and wrote his last book there. entitled *Electric Movement in Air and Water* . Published in 1897 regarded a masterpiece of scientific knowledge.

Successors

Baroness Armstrong died at Jesmond Dene on 2nd September 1893 aged 86 following a stroke.
Baron Armstrong died aged 90 at Cragside shortly after 1pm on 27th December 1900 probably from pneumonia. He was buried next to his wife in Rothbury churchyard. He left £1.4 million about £170 million in today's money.

Meggie and William did not have any children so most of their wealth was inherited by their great nephew William Watson-Armstrong including Cragside and Bamburgh Castle, including the Farne Islands. The new Lord Armstrong's gullibility led him into some dubious business ventures. He lost a lot of money to the French fraudster Henri Lemoine who claimed he could make synthetic diamonds. All in all 10 years after his great-uncle's death Lord Armstrong was reckoned to have debts of £0.5 million. To raise the required money some of the Armstrong Heirlooms were sold at auction. Land was sold off at Bamburg castle. Eventually in 1977 the Armstrong family were obliged to transfer the ownership of Cragside and its possessions to the National Trust in lieu of death duties. The Farne Islands were bought by public subscription and given to the National Trust as an important breeding place for sea birds and seals.

The Armstrong companies rolled on after the founder's death under its own powerful momentum. There was some infighting and squabbling between members of the board. The business prospered during the First World War. Following mergers and sales the original business was incorporated into Vickers Shipbuilding, Armstrong Whitworth, Armstrong–

Siddley car manufacturers. Shipbuilding and ordnance manufactured prospered again during the Second World War. The astronomical output of Vickers-Armstrong during this time is illustrated as “33,000 guns and gun barrels, 860 naval mountings, 3,500 gun carriages, 1.25 million shells and bombs, 11 million cartridge cases, 16 million fuses, 39,000 high-pressure air and oxygen cylinders, 23,000 aircraft undercarriages and 3,500 tanks. Wellington Bombers and Supermarine Spitfires. In the 1960’s Vickers- Armstrong was absorbed into Swan Hunter. In 1977 the company was nationalised and became part of British Shipbuilders. Swan Hunter was returned to private ownership and survives today as part of BAE Systems.

Bibliography

William Armstrong Magician of the North by Henrietta Heald

Appendix

Punch took great delight in labelling William Armstrong a warmonger and making fun of the absurd arms race underway in Britain. The navy was claiming that it could build ships that were so strong they could resist any missile. The artillery represented on this occasion by Armstrong was out to prove that regardless of the strength of any ship a weapon could be made that was powerful enough to penetrate it. Influential religious figures were proclaiming the second coming of Christ – and ordinary people were complaining that taxation was spiralling out of control. Punch ridiculed this state of affairs in an article of 19th April 1862 called ‘Pull Armstrong, Pull Admiralty’ and subtitled ‘a probable chronology.

1860 MR ARMSTRONG of Newcastle-upon-Tyne invents Rifled Ordnance that will knock any ship to pieces. He is knighted and the Admiralty is beknighted.

1861 The Admiralty recovers, and invents iron ships that resist any known cannon-balls

1862 SIR WILLIAM ARMSTRONG invents a gun that smashes the Iron Ships into blacksmithereens. The Admiralty collapses.

1863 The Admiralty re-expands and invents Platina Ships fastened with diamond cement, and Sir William Armstrong’s balls fly to pieces like bon-bons.
MR GLADSTONE doubles the Income-Tax.

1864 SIR WILLIAM ARMSTRONG invents Brazen Thunderbolts (supposed to be the original Jupiters) and in a pleasing experiment sends the greater part of the British Fleet to the bottom of the sea.

1865 The Admiralty invents Torpedo vessels which sail underwater below the range of any guns.
SIR WILLIAM ARMSTRONG tears his hair out and swears in the Newcastle dialect.

1866 SIR WILLIAM ARMSTRONG invents a vertical gun that discharges Greek fire straight down, and for the second time he destroys the greater part of the British fleet. The Lords of the Admiralty are about to hang themselves, when a thought strikes them and

they don't.
MR GLADSTONE again doubles the Income-Tax

1867 DR. CUMMING, who has for some weeks been having his coals by the sack, proclaims the millennium (second coming of Christ). As there is to be peace everywhere, the Admiralty does not invent anything, but waits to see.

To test DR CUMMING's veracity and to find out whether lions will lie down with lambs, the Zoological Society (against the advice of their excellent Secretary, MR SCLATER) lets loose their biggest lion while a charity school is in the Gardens. As the lion, instead of lying down with the lamb, only lies down to digest him, the Admiralty thinks there is a mistake somewhere, and determines to invent a new fleet.
MR GLADSTONE once more doubles income-tax.

1868 The Admiralty invents a Stone Fleet, with cork keels, and defies SIR WILLIAM ARMSTRONG

1869 SIR WILLIAM ARMSTRONG invents the Hannibal, or Alp-Shell, which contains the strongest vinegar, and melts the Stone ships. Having for the third time destroyed the British Fleet, he is raised to the peerage as LORD BOMB.

1870 The Admiralty invents an Aerial Fleet, which sails in the clouds, out of shot range and the First Lord takes a double sight at SIR WILLIAM ARMSTRONG
MR GLADSTONE again doubles the Income-Tax.

1871 LORD BOMB invents a Balloon battering-train, and in an experimental discharge brings down all the British Fleet into the German ocean.

1872 The Admiralty, in desperation, invents a Subterranean Fleet, which is conveyed by tunnels to all the Colonies, but MR GLADSTONE blandly suggests that, as everybody now pays twice his income in taxes, the people may object to further imposts unless some proof of economy is given.

Government therefore stop the pensions of a hundred superannuated clerks, discharges some extra night-porters at the Treasury, and brings in estimates for the Subterranean Fleet.

1873 LORD BOMB invents his Typhaeons, or Earthquake Shells, and suffocates the British Fleet in the Tasmanian Tunnel.
MR GLADSTONE for a fifth time doubles Income-Tax

1874 THE EMPEROR OF THE FRENCH proclaims the Second Coming, which of course immediately occurs, no more warships are wanted, and the collectors remit the quarter's Income-Tax not yet due.
LORD BOMB invents his Volcanic Fireworks in honour of the occasion, and by some accident burns up the Public.