Useful Links

Timelines
http://www.victorianweb.org/technology/ir/irchron.html

http://inventors.about.com/library/inventors/blindustrialrevolutiontextiles.htm

History Learning site account of Britain in the period 1700-1900
http://www.historylearningsite.co.uk/indrevo.htm

How the industrial revolution changed the landscape
http://www.open.edu/openlearn/history-the-arts/history/heritage/industrial-revolution-changing-landscapes

Pioneers of the Industrial Revolution
http://www.revolutionaryplayers.org.uk/

History of the Workhouse, and its social consequences
http://www.workhouses.org.uk/

Primary source material preserved on the Internet Sourcebook
http://www.fordham.edu/halsall/mod/modsbook14.asp

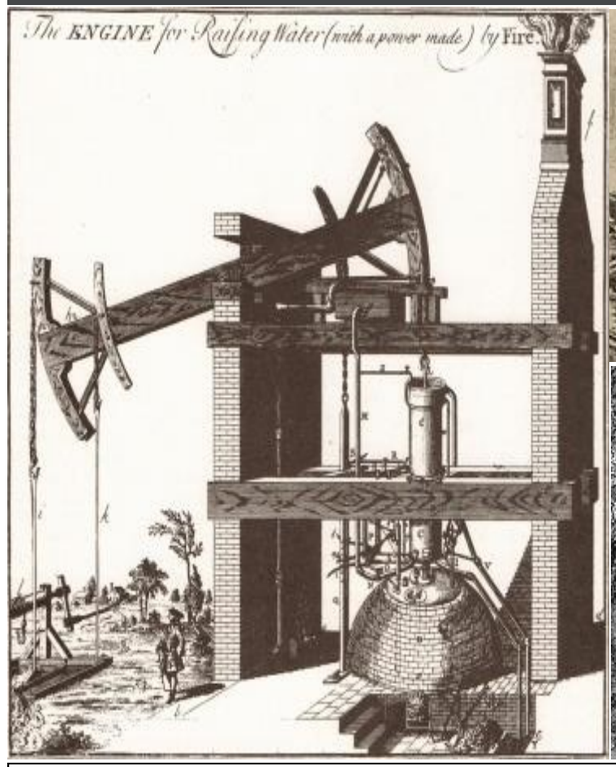
BBC Resources, including key inventions and animations
http://www.bbc.co.uk/history/british/victorians/

http://www.bbc.co.uk/history/british/victorians/seven_wonders_01.shtml

http://www.bbc.co.uk/history/interactive/animations/

http://www.open.edu/openlearn/whats-on/ou-on-the-bbc-what-the-industrial-revolution-did-us-series-summary

The Black Country:1750-1900
Coal, Iron and Steam



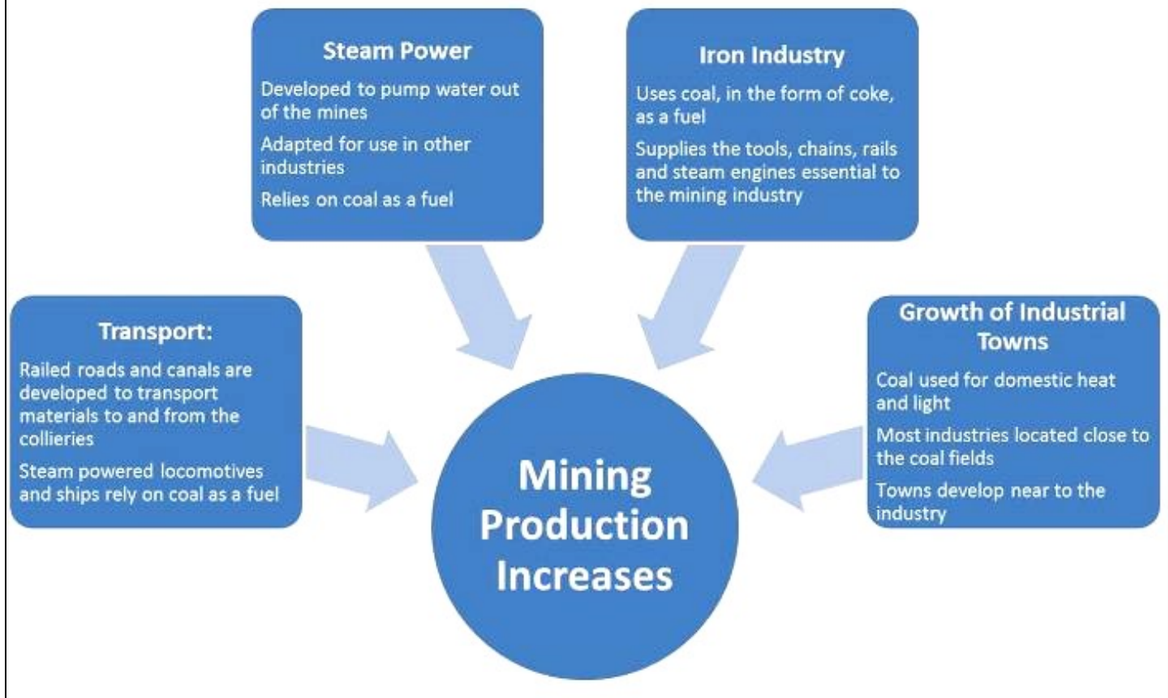
If you had visited this area 150 years ago you would have been amazed by the smoke, smell and noise of the Black Country industries. In 1868, it was described by Elihu Burritt, an American visitor, as “black by day and red by night”. This was a result of the many local industries using the natural resources of coal, iron ore, clay and limestone to produce a huge variety of products.

The period 1750-1900 was a time of significant change and development. It saw huge increases in population, the growth of towns, and revolutions in agriculture and industry. It saw improvements in science and technology, the development of new materials and manufacturing processes, the introduction of factory, public health and education reforms, and a shift towards a more democratic society. It also saw great poverty and suffering and huge inequality between classes and sexes.

Introduction

Use this trail and booklet to explore the Museum. You are here to find out about the key developments in mineral extraction and steam power that took place in the Black Country during 1750-1900.

You will discover that the coal industry and the developments in steam power were closely connected in what we call a "symbiotic relationship" - a relationship of mutual benefit and dependence.

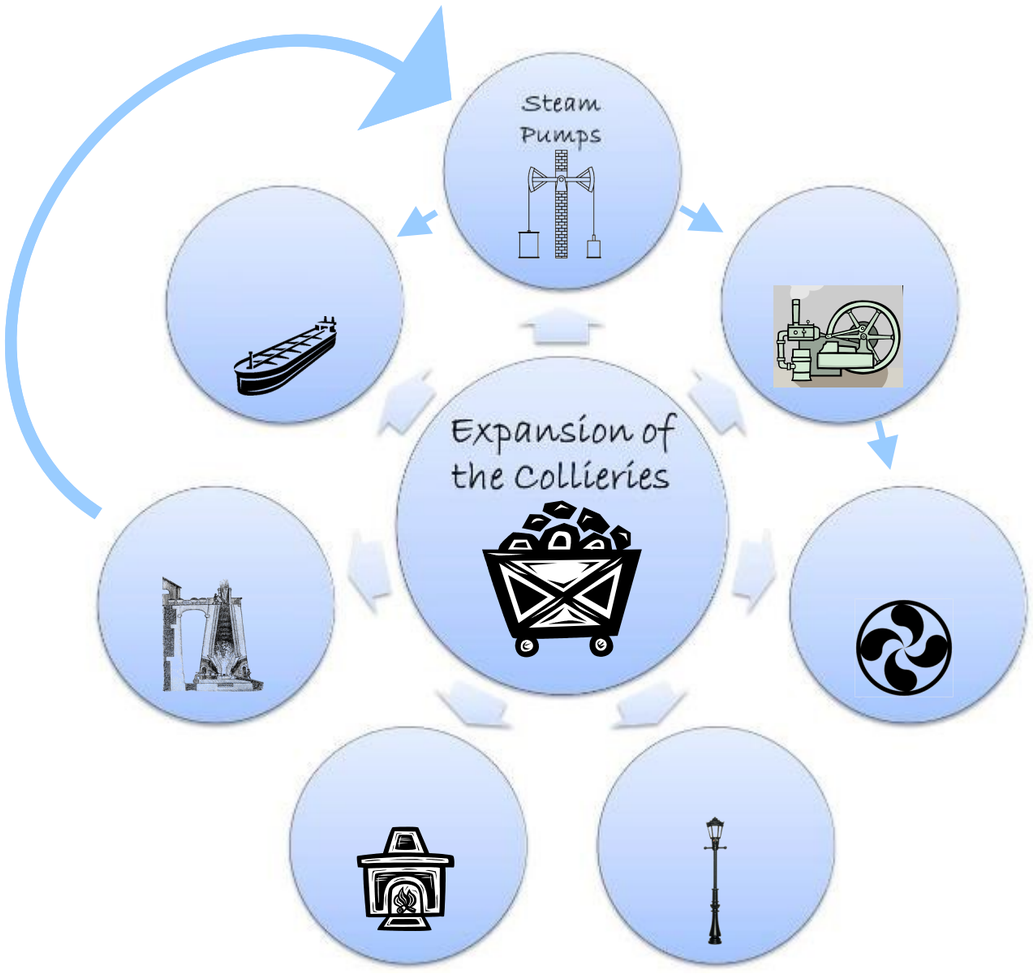


Glossary

Back-to-back	A form of terraced house, common in Victorian industrial city areas, in which two houses share a rear wall
Blast Furnace	A furnace that produces molten iron. The iron needs to be freed from iron ore by using a combination of high temperatures, air, limestone and a fuel rich in carbon
Butty	During the early part of the nineteenth century, the coal miners were not directly employed by the owners but by a contractor, called a "Butty". He engaged with the mine owner to deliver coal or ironstone at so much per ton. He employed the labourers required using his own horses and tools. After the 1872 Coal Mines Act the 'Butty' system disappeared
Cast Iron	A hard, brittle, non-malleable iron-carbon alloy. When heated it becomes molten and can be cast in moulds. It is used for mass producing complicated shapes and is strong in compression (when being squashed) but weak in tension (when being stretched
Caulking	A process to make the seams in wooden boats watertight, by driving fibrous materials into the wedge-shaped seams between planks
Chalico	A mixture of hot tar and dried horse muck, used as a sealant between timbers and iron plating
Charcoal	A black, porous material that is 85 to 98 percent carbon. It is created by heating wood or bone in little or no air to remove impurities, and was the main form of fuel for domestic heating and industry until the 18th century
Coal	A black or dark brown combustible mineral consisting of carbonized vegetable matter found mainly in underground deposits. Used as a fuel.
Coke	A solid fuel made by heating coal in the absence of air to remove most of the impurities
Forge	Make or shape (a metal object) by heating it in a fire or furnace and beating or hammering it
Infrastructure	The basic physical and organizational structures and facilities (e.g., buildings, roads, and power supplies) needed for the operation of a society or enterprise
Innovation	The creation of something new
Piece Rate	Payment based on the number of items produced, rather than the number of hours used
Puddling	A process for making a canal watertight by lining it with a mixture of clay and water
Revolution	A drastic and far-reaching change in ways of thinking and behaving
Rivet	A method of joining plates of metal with a heated metal pin
Smelting	Extract iron from its ore by a process involving heating and melting
Symbiotic	A relationship of mutual benefit and dependence
Wrought Iron	A form of iron having a low carbon content that is tough and malleable and so can be forged and welded

The Relationship Between Coal and the Expansion of Industry

Complete this spider diagram to show the main industrial and social changes brought about by the expansion of the mining industry during the period 1750-1900:



Put in additional arrows to show the symbiotic relationship between the different industries.

The Industrial Revolution

It is your task to analyse the impact of these developments. How did they affect the growth of other industries? How did they affect the lives of the working classes in the Black Country?

See if you can find the information required to complete the questions in this booklet. To do this you will need to question the Demonstrators as well as investigating the buildings and settings.

When you return to school you will be required to complete a set of "Top Trump Cards" relating to the significant people and the key innovations in the development of steam and coal that you can experience here at the museum. You will need to use your historical enquiry skills, to decide which of the cards has the greatest innovation and significance value.

CONTENTS

Black Gold

BLACK COUNTRY (The), *a tract of mines and ironworks in the S of Stafford, and on the N verge of Warwick. It extends chiefly from Wolverhampton to Birmingham, south-eastward, 13 miles; and from Dudley to Walsall, north-eastward, 7 miles. "The name is eminently descriptive, for blackness everywhere prevails. The ground is black, the atmosphere is black, and the underground is honey-combed by mining galleries stretching in utter blackness for many a league. The scene is marvellous, and to one who beholds it for the first time by night, terrific.,"*

John Marius Wilson's Imperial Gazetteer of England and Wales 1870-72

It was the abundance of the raw materials essential to industry - coal, iron ore, limestone, fire clay and sand - that made the Black Country one of the most intensely industrialised regions of the UK.

The term "Black Country" first appeared in 1868. Why do you think the region earned this name?

The 30-foot seam of 'thick coal' in the Black Country was the only resource of its kind anywhere in the country. In places the coal reached the surface and had been mined for centuries. The main centres were Sedgley, Coseley, Bilston, Wednesbury, Netherton and Halesowen.

During the 16th and 17th centuries the pits were small and tended to focus on areas where the coal seams outcropped near the surface. They developed in a random fashion against a backdrop of rural countryside and served small scale iron industries such as nail making. As they spread and multiplied they led to an increase in local population and the birth of new towns.

From the 18th Century the speed of change increased. Coal became more accessible and was in greater demand for industry. By 1860 mineral exploitation was at its peak and what was left of the countryside had disappeared into the smoke and grime of one the World's first industrial landscapes.

50 BC	Steam Engine invented by Heron of Alexandria	1707 AD	Abraham Darby develops patent for casting using reusable patterns	1709 AD	Abraham Darby introduces the use of coke for iron smelting at Coalbrookdale	1712 AD	Newcomen patents his atmospheric engine for pumping water out of mines	1730s AD	The first Turnpike Roads are built

"In places not supplied with waterworks water, the inhabitants derive their supply in some instances from tanks into which is collected the rain which falls upon the roofs of the houses...There are no public wells, but an abundance of private wells, some of which are very shallow, and all of which derive their water by soakage from the upper layers of the soil, or out of the 'spoil banks' on which the houses are built. Some are manifestly seriously polluted by sewage or excremental matters soaking into them, but are used to furnish drinking water nevertheless…"

William Lee Esq, 1852

The 1911 Census shows that the Webb family had not escaped personal tragedy and suffering. Henry and Mary Ann had been married for 37 years in 1911, but only 7 of their original 12 children were still living.

What do you think may have contributed to this high infant mortality rate?

An article in 'The Blackcountryman', based on reminiscences of old miners in the 1920s, gives an insight into the life of miners:

"yow could allis tell anybody what was pitmon cos they'd be cut an' scarred all over, fer they'd work wi'injuries as 'ud put a factery worker in 'is bed f'a month an' their flesh 'u'd be full a blue marks where they'd 'ad a clout an the coal dust 'ad got in it afore the cut sealed up. Theer was very few straight men, ar mean bodily, unless they was very little chaps, 'cops the roads they 'ad t'walk along t' the coal face or other workin's…… was so low…"

The Blackcountryman: Old-time Black Country Colliers and Collieries', Vol 13, no 2, Spring 1980, D.H. Richards

In the 1890s Henry Webb would have been earning a daily wage of 4/6d, and working eight hours a day. It was the custom in the Black Country to pay wages at a nearby public house, usually run by the mine's 'butty'. A Tipton miner described how the system worked in the 1860s:

"Ye see ivvery butty keeps a public-house, and we must go there o' Saturdays to be paid, and there he keeps us waitin'; and some gets tired o' waitin', an' begins to drink, an' mebbie they drinks three or four shillin' afore we gets our money. Then sixpence is stopped from ivvery man all round ivvery week, 'cause, ye see, ivvery man is expected to drink a quart at pay-time whether he wants to or no. Then if a new man have bin took on at the pit, a shillin' is stopped from he for fut-ale (paying the footing), an' sixpence a-piece is stopped from all the rest on us for that. An' so, ye see, wi' them sixpences, and what we drinks while we be kept waitin', there's some on us ain't got much to take out o' sixteen shillings a week."

The Folklore of the Black Country", Roy Palmer

1910 AD	Thomas Edison demonstrates the first talking motion picture	1910 AD	Women Chain Makers in the Black Country go on strike and win the right to a fair wage	1910 AD	George V becomes King

"The district is now disfigured by offensive accumulations of liquid and solid filth"

Report to the General Board of Health on a preliminary inquiry into the sewerage, drainage and supply of water, and the sanitary condition of the inhabitants of the Parish of Dudley, 1852: William Lee Esq

Find out the typical living conditions of a miner working at the end of the 19th century.

11 Brook Street—the rear Back to Back

Originally this terrace of back to back properties stood in Brook Bank, Woodsetton. They are typical of homes built in the Black Country and throughout the Midlands and North of England during the 19th century. They catered for a growing population, which was increasingly concentrated in towns and cities. The houses were built by John Jevon on land gifted to him by his uncle, Thomas King, a farmer. John Jevon was a 'charter-master', or 'butty', contracted by the tenant of a mine to supply the labour force, materials and equipment necessary to draw the coal from the pit. By the time John Jevon built his houses, the coal and iron industries were by far the biggest employers in the area. Woodsetton was situated on the western edge of the South Staffordshire coalfield, famous for its 30 feet thick coal. To the west of Brook Road, the land retained its rural pattern of fields and farms. To the east of Brook Road, however, there stretched an industrial landscape typical of the rest of the Black Country:

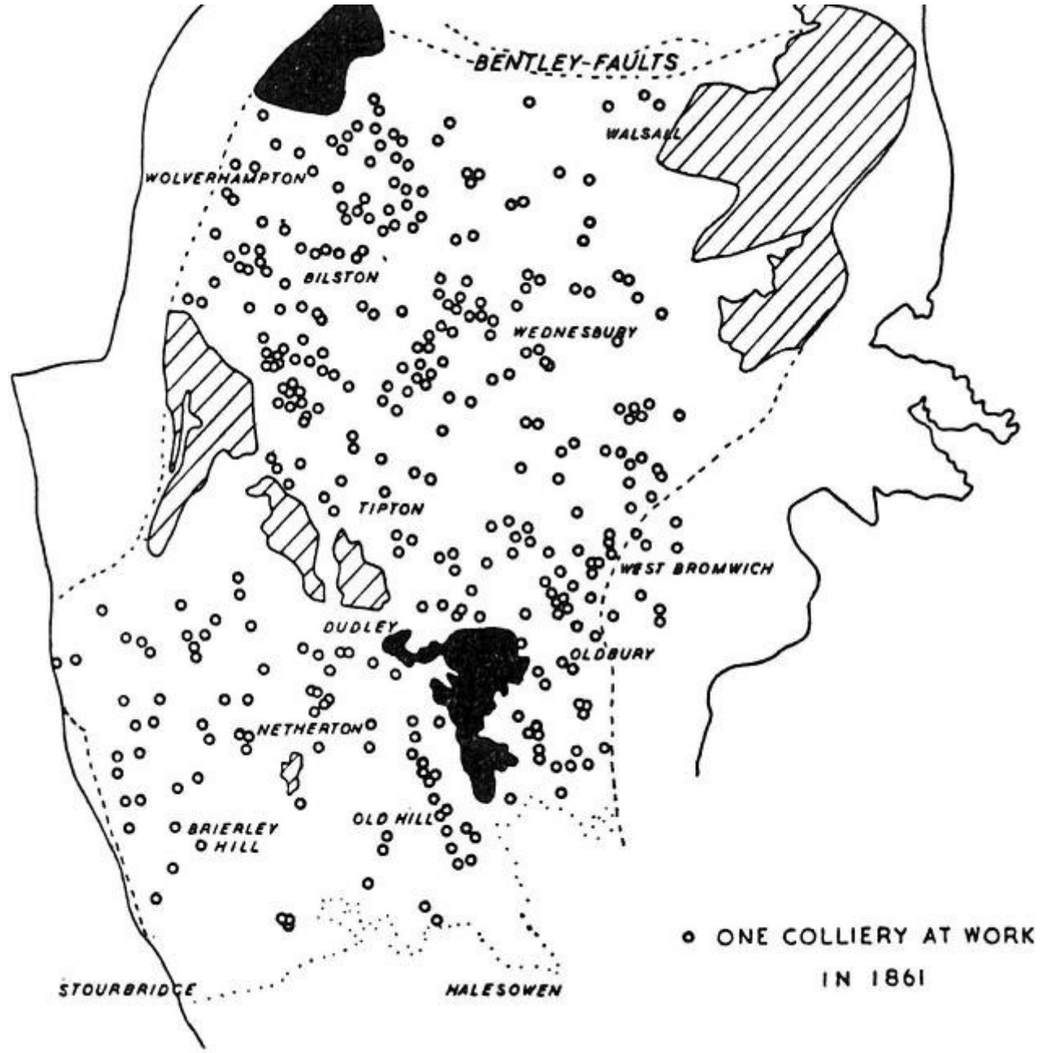
> "blast furnaces were as common as thistles and chimney-stacks like stubble, and when the sun shone only on Sundays – the day the smoke pall rolled aside…" ('Black Country', Phil Drabble)

The house is set in 1891 when a collier, Henry Webb lived in number 11. The 1891 census records that he was 42 years old, and living with his wife and six children. Number 11 was a one-up, one-down dwelling. As the windows and door were positioned only in the front wall of the house, there was no through ventilation. The rooms were barely 10 feet by 11 feet.

There is only one bedroom. Where would everyone in the family have slept?

The ground floor room, with its adjacent tiny store or pantry, served as kitchen, dining room, living room and bathroom. It is likely that Henry spent his working life in the mines. He survived until 1918, dying at the age of 69.

1905 AD Einstein publishes papers on the special theory of relativity	1907 AD The first helicopter free flight is made by Paul Cornu at Lisieux in France	1908 AD Henry Ford mass-produces the Model T	1909 AD Louis Bieriot crosses the English Channel



SOURCE: BIRMINGHAM AND ITS REGIONAL SETTING - A SCIENTIFIC SURVEY

1860 Map showing the extent of collieries in the Black Country

1738 AD Daniel Bernoulli produces a theory explaining the relationship between the pressure of a fluid and its velocity	1763 AD Treaty of Paris with France: Britain gains Canada and the West Indies	1769 AD Watt patents his first improvement to the Newcomen engine	1769 AD Richard Arkwright makes his water frame

Steam: the Power of 1000 Horses

Steam Power: the 18th century equivalent or the advanced computer today

The first steam engines were static and developed for the mining industry to pump water out of mine shafts. The technology soon developed and spread into other industries and applications until steam engines were the essential source of power and motivation for most industries.

The Newcomen Engine

This is a working replica of the World's first successfully operating steam engine. It is closely based on the original 'Fire Engine', as it was known, which pumped water from coal mines on Lord Dudley's estates. It was built in 1712 by Thomas Newcomen, an ironmonger and inventor from Dartmouth.

The Newcomen engine is arguably the most important invention of the Industrial Revolution. At the beginning of the 18th Century, miners worked long hours in terrible conditions for low wages. Accidents were frequent—not just from explosions and roof collapses, but also from flooding. About 40 tons of water were pumped out for every ton of coal mined. The problem of flooding prevented mines from going too deep, and limited the amount of coal and other raw materials that could be extracted.

From 1750-1830 coal production tripled. This was partly because the invention of the steam pump meant that more coal could be extracted, and partly because steam power became widely

PIONEER OF THE INDUSTRIAL REVOLUTION

Thomas Newcomen (1663 - 1729)

Newcomen was born in Dartmouth, Devon in 1663 where he worked as an ironmonger. He became aware of the difficulty and expense of removing water from the mines in Devon and Cornwall and set out to solve the problem by inventing the first practicable atmospheric steam pumping engine

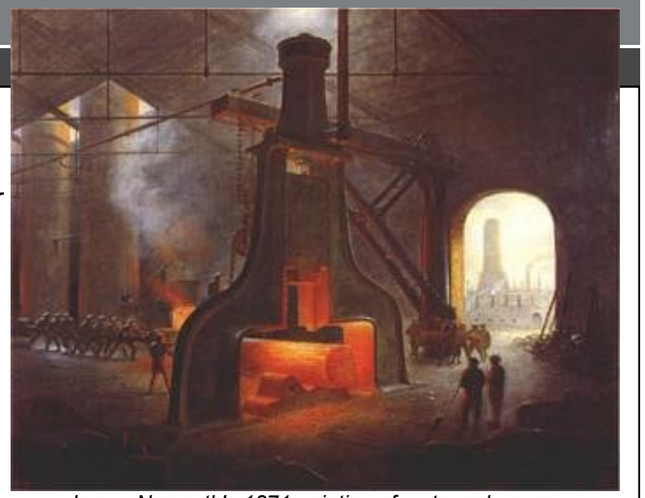
Key Developments

1769 AD Cugnot's develops the first large steam tractor	1770 AD Captain James Cook discovers the east coast of Australia	1774 AD James Watt moves to Birmingham and enters a partnership with Matthew Boulton designing and manufacturing steam engines	1779 AD The world's first cast iron bridge erected in Ironbridge

Anchor Forge

The open-sided shed standing in the middle of the ironworks is the anchor forge, originally from Isiah Preston's in Cradley Heath.

The steam-hammer was installed to forge parts for ships' anchors. Iron billets were heated in the furnace and suspended from a crane to be manipulated beneath the steam powered hammer.



James Nasmyth's 1871 painting of a steam hammer

The heat from the furnace also raised steam in the boiler between the furnace and the chimney to power the hammer which reduced the size of the iron, forging it into the shape required.

Noah Hingley's Anchor Making Shop

1901 AD Marconi transmits first trans-Atlantic radio message (from Cape Cod)	1901 AD Edward VII becomes King	1903 AD Wright brothers make first powered flight	1903 AD Emmeline Pankhurst founds the Women's Social and Political Union to gain publicity for women's rights

Side Slipways

Can you spot the rollers on the side of the canal? These were used with winches to haul boats, sideways, out of the water.

The Lifting Bridge

See the lifting bridge between the Ironworks and the Boat dock. Can you work out how it would operate? Huge weights hanging on chains over the four pulleys balance the weight of the roadway and the deck can be raised and lowered by operating a small hand winch.

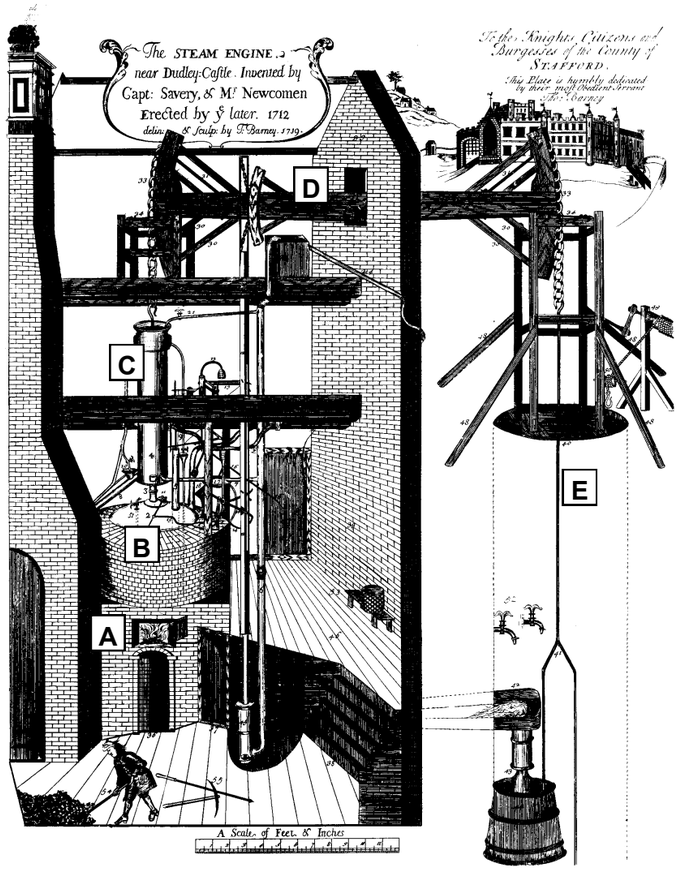
Hand Operated Crane

This would be used to load and unload the boats. Loading was a skilled job, as it was essential that the boats were evenly balanced.

1895 AD Michelin Brothers use air-filled tyres on cars	1895 AD X-rays discovered by Wilhelm Rontgen	1896 AD Marconi patents wireless telegraph	1897 AD Joseph Thomson discovers particles smaller than atoms	1900 AD First Zeppelin built

"The water in one place was nearly knee deep, and through this part we went on a carriage with a skip drawn by a horse. The water everywhere fell from the roof in great drops like the shower of a thunderstorm, out of the roof of the gateways. The horses had wax cloths spread over them to protect them a little from the rain. The water sometimes fell in spouts. It was stated that all this was merely the drainage of the water which had accumulated for ages in the coal and in the measures above it and that in four or five months...the mine would be thoroughly drained, and would be easily kept dry and comfortable with very little pumping."

CHILDREN'S EMPLOYMENT COMMISSION 1842 VISIT TO THE WALLBUT PIT



The engraving by Thomas Barney of the 1712 Dudley Castle Engine, dated 1719.

The earliest steam engines, like this one, operated on the atmospheric principle, using steam to create a vacuum below a piston in an open topped cylinder. The weight of the atmosphere then depressed the piston and raised the pumps via a centrally pivoted beam overhead.

Take a look at the diagram above. See if you can label the following parts:

A ..... B .....

C ..... D .....

E .....

Key Developments

1776 AD America declares its independence	1779 AD Samuel Crompton develops the spinning mule	1781 AD Watt develops the compound steam engine	1785 AD Cartwright makes the first powered loom	1786 AD Boulton uses steam to power his coin factory

By the time Newcomen died in 1729 there were at least one hundred of his engines in Britain and across Europe. At first they tended to be used to pump water out of mines, or to raise water from rivers to serve waterwheels. It was the first source of power that wasn't dependent on a water supply and could in theory be located anywhere. However, as early versions were highly inefficient, burning huge quantities of coal, and as transport systems were still very basic, they tended to be located close to collieries.

Improvements were made by James Watt and other engineers but it took over 70 years before the steam engine was adapted to create a rotary motion. Once this was achieved it could be used to power the winding gear on collieries, and to replace water wheels to power machinery in factories.

How did this change the location of industry?

INNOVATION OF THE INDUSTRIAL REVOLUTION

The Steam Pump

Key Engineers/Inventors:
Thomas Savery
Thomas Newcomen
James Watt

The steam pump was the first successfully working steam engine. Not only did it enable more raw materials to be extracted, allowing industry to expand but it also provided the first source of mechanical power. It was to become the main source of power to drive the industrial revolution.

Key Developments

1787 AD John Wilkinson makes the first iron boat	1788 AD Boulton uses a rotary steam engine in his factory	1790 AD Arkwright's steam-powered factory opens	1792 AD William Murdoch demonstrates coal gas lighting	1792 AD Napoleon proclaims himself First Consul of France

Boat Dock
The thousands of boats that used to work the Black Country canals all needed constant maintenance.
Castlefields boat dock is typical of the many on the Black Country canal system. It is equipped to build new working craft and to repair those of iron or composite construction. The dock can accommodate three boats, drawn sideways out of the water by winches onto the slip. It includes an 1880s brick blacksmith's forge containing a large general-purpose hearth with hand-operated bellows, a nail and rivet store, a woodshed, paint store and stable.

Look at the buildings closely. Can you see that they are all made from old wooden boats?

Why was a stable important?

Metal boats were constructed by joining sheets of wrought iron together with heated iron pins, called rivets. Riveting is still used where light weight and high strength are important, such as in aircraft.

Wooden boats were constructed with butted planks. The tiny seams at the joints were made watertight by a process called "caulking". This involved using a typed of stranded hemp—called oakum—rolled into lengths and driven into the seams with a caulking mallet and chisel. The exterior of the boat was then coated in thick hot tar.

Chalico: A mixture called "chalico" was made using hot tar mixed with dried 'oss muck. This was used as a sealant between timbers and iron plating - sometimes referred to as 'ossmuckanta'.

1888 AD Hertz produces radio waves	1889 AD Eiffel Tower built	1889 AD Hollerith invents the first calculating machine using punch cards	1890 AD Rubber tyres first used on bicycles	1892 AD Rudolf Diesel invents the diesel engine

BCN District No.1 Dredger

Built in 1873 by the Birmingham Canal Navigations Company, this riveted iron spoon dredger was used to clear silt and rubbish off the canal bed. It was hand-operated with a team of three men. They used the "spoon" and crane on board to collect the silt, and then shovelled it away by hand.

Carter's Yard

If you have time take a look at Carter's yard and find out more about the use of horses.

1879 AD	Edison invents the incandescent lamp	1881 AD	First colour photograph taken by Frederic Ives	1884 AD	Charles Parsons' first steam turbine	1885 AD	Benz develops first automobile to run on internal - combustion engine.	1885 AD	Eastman invents the box camera

Racecourse Colliery

Although the pit head frame marks the position of one of the original coal pits on the site, Racecourse Colliery is a reconstruction of a typical small colliery of c1910 - with a Manager's Office, a weighbridge, miners' hovel and blacksmith's shop. It has been named after the Earl of Dudley's private racecourse which once ran across this part of the Museum before the construction of the railway.

The coal and other minerals on the Museum site were owned by the Earls of Dudley and their exploitation was arranged through the Earls' Mineral Agent.

The South Staffordshire Coalfield contained measures of coal, ironstone and fireclay. They appeared in "seams", each with their own particular properties and uses. The top seam was the Brooch coal (a hot, swift burning coal ideal for domestic use); the next layer was the Thick Coal, a 30ft seam of coal used for iron smelting as well as domestic fires. Below this lay the Heathen Coal, considered the best for gas manufacture and coking; next were layers of Rubble Coal and Stinking or Sulphur Coal - poor quality and not usually worked. The lowest measures included the New Mine Coal, Fireclay Coal and Bottom Coal. Ironstone was found some distance below the coal and was also split into separate seams.

The Thick Coal was mined here from 1814-88 whilst the extraction of the lower beds, including the Heathen Coal, the New Mine Top and Fireclay Coal continued until 1926. Ironstone was worked on the site in the mid-nineteenth century and fireclay from 1890 to 1912. Limestone was also extracted from the 1940s. In 1902 the Mine was worked by J & S Baggott and had five underground and two surface workers.

Key Developments

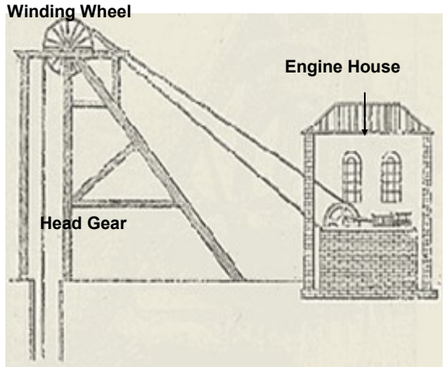
1796 AD	Edward Jenner pioneers vaccinations for smallpox	1800 AD	Act of Union means Ireland is no longer a separate country	1801 AD	John Dalton publishes his law of partial pressures for gases	1801 AD	Richard Trevithick constructs the first steam road vehicle	1801 AD	First Ordnance Survey Maps published

At the back of the Engine House is the large drum which held the wire rope that ran over the wheel at the top of the head frame

Winding Engine

The wooden pit frame stands over a brick-lined shaft 30 metres deep. Go up the steps into the Engine House to see the winding engine. This was made by J.C. Stark and Co. in Devon and probably dates to about 1860.

The winding engine performed 3 separate tasks. What were they?



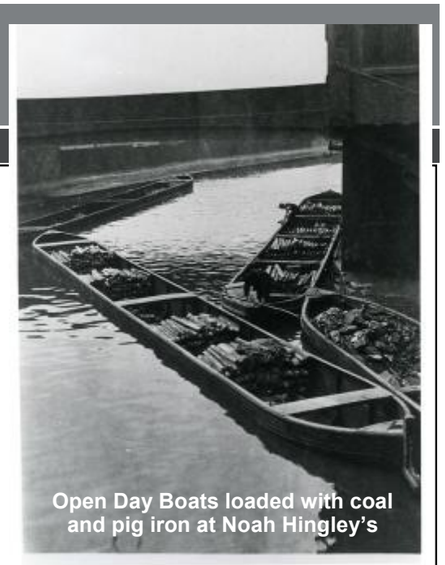
How did the Winding Engine work?

Key Developments

1803 AD	Richard Trevithick constructs the first steam locomotive	1804 AD	German inventor Freidrich Winzer patents coal gas lighting	1805 AD	Battle of Trafalgar	1807 AD	Fulton invents the steam boat	1810 AD	Macadam develops a new type of road construction

Bessie

A single ended riveted iron day boat built locally in 1895 for the Hartshill Iron Company. These open 'joey' boats worked short distances carrying bulk cargoes such as coal and iron ore. Although most working boats at the time were wooden, larger firms used riveted iron boats like this one. They were more expensive to build but they lasted longer. Bessie could transport up to 30 tons of cargo such as coal or iron at a time.



Open Day Boats loaded with coal and pig iron at Noah Hingley's

President

President was built in 1909 in Fellows, Morton and Clayton's company dock at Saltley, Birmingham Steamers could carry only 18 tons compared to over 25 tons in a horse drawn boat, but were powerful enough to tow several unpowered boats (called butty boats). They usually worked "fly", that is day and night, on the canals between London, Birmingham, Coventry, Derby, Leicester and Nottingham.

Flyboats *were for transporting high value, perishable goods as quickly as possible. They were built for speed with a different hull design to cut through the water and a rounded section rather than a flat bottom. They carried under 20 tons to enable them to travel faster, and had priority over other boats when entering locks.*

How is President powered?

Key Developments

1876 AD	Bell invents the telephone.	1877 AD	Four stroke internal combustion engine invented by Nikolaus Otto	1877 AD	Edison invents the phonograph	1877 AD	Bell and Cameron patent refrigeration plant for ships

Walk along the tow path from the Lime Kilns to the Boat Dock.

The Museum's collection of historic boats represents the various types once found on the BCN (The Birmingham Canal Navigations) - the name given to the waterways of the Black Country and Birmingham. There are examples of both wooden and iron construction day boats, wharf boats, ice breakers and a spoon dredger.

See if you can find these boats.

Prosper and Edna Irene

Two large wooden boats sunk under water in the canal opposite the lime kilns. They have been submerged to protect them from further deterioration.

These two boats are examples of **Wharf or "Hampton" Boats.** Wharf boats came into being from about 1870 onwards in order to transport the maximum amount of coal possible using just one horse. They were a lot longer than traditional narrow boats, and could carry up to 50 tons of coal. As they were so large, they could not go through locks so were only used in this area, working the highest level of the canal from coal yard to coal yard.

Ross

A horse-drawn icebreaker built in 1868 and used to clear a way through the ice when the canals were frozen. If the canals were iced over it stopped the boats—and no work meant no wages. Notice that the boat is half the length of a normal narrow boat. The boat would have been dragged through the frozen canal by five or more horses to provide the power and speed. A team of eight men would rock the boat from side to side, creating a wave in the water to break the ice into pieces.

What material is this boat made from and why?

Key Developments

1867 AD Alfred Nobel produces dynamite, the first high explosive which can be safely handled.	1867 AD Reform Act gives most men the vote	1869 AD Suez Canal is completed	1870 AD Penny Farthing introduced

"Much coal was mined by simply following the seam into the hillside, often for up to 100 yards. Eventually though, proper mining methods had to be used. The sheer thickness of the seam caused problems and pillars of coal had to be left to prevent cave-ins. The main coal brought to the surface was in large lumps, these were easier to sell than the slack and rubble, which was mostly left underground."

Doctor Plot: "Natural History of Staffordshire".

Find the two large boilers outside the Winding Engine. These are made out of sheets of wrought iron that have been joined together with rivets to create a container strong enough to withstand the high pressures of steam. Heating all the water in the boiler to convert it to steam took a long time so the fire beneath the boiler was kept lit all the time. The "egg-ended boiler" would have originally been used with this winding engine. The haystack boiler is a much earlier version and is the type used in a Newcomen Engine.

Working the Mine

The actual work was very crude—the main tools being used were picks and shovels. The coal went into 4-wheeled tubs which were pulled to the pit bottom on rails by ponies. The pit ponies spent the best part of their lives underground. Miners and horses looked after each other. There were many stories of them pulling men to safety from flooded mines.

Methods of working the coal varied from mine to mine, but coal from the 30 foot seam and other thick seams was extracted principally by the pillar and stall method.

What was this?

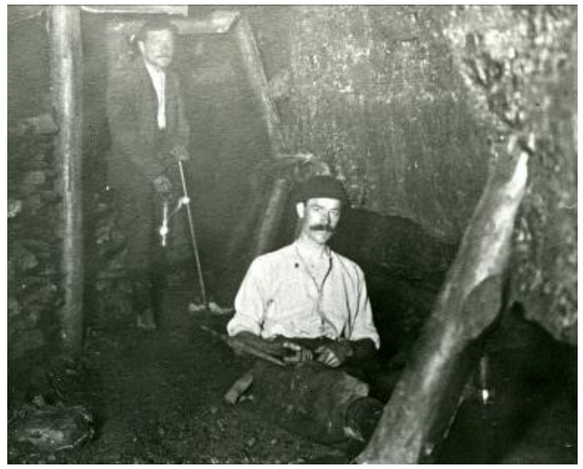
Wooden pit props were used to support the roof above— you can see some lying about the site. They had to be bought by the colliers' boss (called a "butty" or charter master) and as he had to pay for them he used as few as possible—leading to frequent roof collapses. When all the coal had been mined, the props would be pulled out to be reused elsewhere. This made the ground above unstable, causing houses to tilt or sink down into the ground. (You will see the effects of this later when you investigate the tilted cottage 'Jerushah'.)

Key Developments

1810 AD John Buddle improves mining ventilation systems by dividing the workings into several discrete "districts". This is still used today.	1811 AD Luddites begin smashing factory machines because they fear they will lose their jobs	1812 AD The first horse-drawn bus system is operated	1814 AD Stephenson's steam locomotive

"The chief miners, the undergoers, were lying on their sides, and with their picks were clearing away the coal to the height of a little more than two feet. Boys were employed in clearing out what the men had disengaged. Portions are left to support the great mass until an opening is made on each side of the mass and also part is taken away from the back. This undergoing is a dangerous part of the work, as, notwithstanding all that experience and judgement can do, occasionally too much is taken away, and a mass of coals will suddenly fall and crush the men and boys engaged"

CHILDREN'S EMPLOYMENT COMMISSION 1842 VISIT TO A COAL-PIT, NEAR DUDLEY



Here you can see a miner cutting out below a seam. He leaves some support for the mass of coal above so that it does not fall down and crush him. But when he has finished he will remove these, and let large lumps of coal fall into the cavity below.

Take a look in the miners' hovel. A fire was kept lit in the hovel and wet clothes left hanging over night were usually dry again by the morning. The men could also brew a hot drink or fry bacon or an egg on a shovel over the fire. Notice the blacksmith forge.

Why do you think this was needed?

Notice the system of rails at the top of the bank by the Head Frame. The coal would be lifted up the shaft in wheeled tubs. The Banksman—the man at the top of the shaft—would take the tub from the cage and push it along the rails to the land sale wharf. The rails are laid on a slope above the wharf to make it easier to tip the truck. Coal merchants would come with their carts to the wharf and load up with coal. These carts would be weighed on arrival at the weighbridge, and then weighed again after they were filled.

Can you see the colliery spoil tip of "tocky dirt"? This was a typical sight in the Black Country industrial landscape

Key Developments

1815 AD War with France ends and the Corn Laws are passed	1815 AD Sir Humphry Davy invents the safety lamp—the ***Miners' Friend***	1815 AD George Stephenson produces a flame safety lamp	1815 AD Telford's London to Holyhead road is constructed	1818 AD Mary Shelley writes "Frankenstein"

"All the activity and industry of this kingdom is fast concentrating where there are coal pits, the rest of it has but one object, which is the cultivation of the soil, and to open as immediate a market with coal and manufacture by means of inland navigation as possible"

Arthur Young 1791

This intensity enabled a huge increase in movement of materials and products allowing the Black Country and Birmingham to become literally "the workshop of the world". By 1800 canals, steam engines and collieries were all working in concert.

Can you think of 3 advantages of these man made waterways over using roads?

INNOVATION OF THE INDUSTRIAL REVOLUTION

The Canal System

Key Engineer/Inventor:
James Brindley

From 1766-1900 the canal system was the main means of transporting goods in the Black Country and Birmingham. Over 160 miles of canals enabled raw materials and finished products to be shipped out all over the country and the world. The transport network linked the collieries and ironworking industries with the ports of Bristol and Manchester and were instrumental in making the Black Country the workshop of the world.

Boats were powered initially by horses. They could carry more than thirty tons at a time with only one horse pulling - more than ten times the amount of cargo per horse that was possible on the road. The tow path found on one side of all canals was for the horses—see how the path is ridged to prevent the horses from slipping. In tunnels however their was no tow path— the horse would be walked over the hill to the other side. To get through a tunnel the men working the boat would have to lie on top and use their feet on the side of the tunnel to 'walk' the boat—called legging.

1855 AD Coal Mines Act includes the specific safety rule requiring that an 'adequate' amount of ventilation is produced	1856 AD Henry Bessemer develops his converter to mass produce steel	1861 AD Veloe's pede bicycle is introduced	1865 AD First transatlantic telephone cable laid linking Britain and America

Transport: The Canal System

Transport changed very quickly in the period 1750-1900 as a result of new technologies, large-scale investment in the country's infra-structure, and the increasing need for better methods of moving goods. The developments had an impact upon life in the country, shortening travel times over longer distances, and enabling industrialists to seek new markets in previously out of reach areas of the country. More raw materials and goods could be shipped to and from factories, providing further impetus to the industrial age.

The Canal Arm

The canal arm is original to this site, and was built from the main Wolverhampton-Birmingham line to serve the lime kilns in c1839.

The story of coal and the development of the canals are very much bound up together. The transport of coal was the primary concern for the building of canals in the Black Country, although the canal system was to make the rapid industrialisation of the region possible.

PIONEER OF THE INDUSTRIAL REVOLUTION

James Brindley (1716-1772)

Brindley was born near Buxton in Derbyshire. He was the pioneer of the British canal system.

By the age of twenty six he had founded his own business constructing mills and steam engines. This led him to work as a canal engineer surveying and laying a network of canals totalling 375 miles. His projects included the Bridgewater Canal (between Manchester and Liverpool) and the Grand Trunk Canal (between Trent and Mersey).

There were nearly 160 miles of canals constructed in the Black Country and Birmingham. This started with the construction of the Staffordshire and Worcestershire Canal (1766 - 72) and the Birmingham Canal with its arm to Wednesbury (1768 - 72), built under the supervision of James Brindley, "the father" of the English canal system.

Subsequent canal development rapidly took off as canal links, arms and wharves intensively covered the Black Country in a frenzy of 'Canal Mania'. At their height, they were so busy that gas lighting was installed beside the locks to permit round-the-clock operation. Boats were open and horse drawn, often built without cabins for maximum carrying capacity. Journeys were generally short haul, with the cargoes such as limestone, coal and iron being moved relatively short distances within the Black Country and environs.

Key Developments

1848 AD	Chartist march in London—their petition with 2 million signatures is handed to Parliament
1850 AD	The first Coal Mines Act - creates a Mines Inspectorate with power to enter any workings. All fatal accidents to be reported within 24 hours
1851 AD	Joseph Paxton's Crystal Palace built

"Two kinds of gas are produced in the mines which are destructive of human life. One is the carbonic acid gas, or, as it is called, damp, by which a miner may be damped to death, that is choked and the other is the carburetted hydrogen gas, which is commonly called the sulphur, by which a miner may be scorched or burned to death, or he may be dashed before it by its explosive force, or burnt under the ruin which it occasions, or may be suffocated by the foul air after the explosion."

CHILDREN'S EMPLOYMENT COMMISSION 1842, VISIT TO A COAL-PIT, NEAR DUDLEY

Mining was a dangerous business and accidents were common.

Can you list four main causes of accidents?

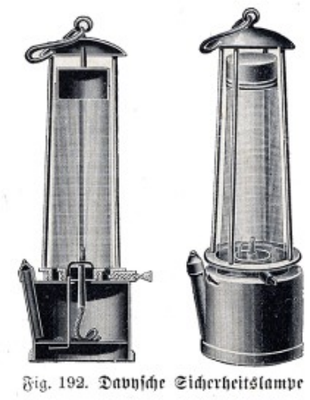


Fig. 192. Davysche Sicherheitslampe

Take a look at the manager's office and the weighbridge office. Notice that there are no safety lamps in the office. From 1815 the Davy and Stephenson oil safety lamps were available. They helped to reduce the risk explosions by using a gauze to protect the flame from coming into contact with an explosive gas like methane.

Many Black Country pits did not use safety lamps because the shallow workings enabled some of the volatile gases to escape to the surface. Lighting consisted of tallow candles stuck in clay — and the miners preferred candles as they gave a brighter light. Mines like this were known as "naked lamp" mines. The deputy or fireman would go down the mine before the start of the shift with a candle on the end of a stick to burn off any gas!

Jerushah: Tilting Cottage

This cottage used to be situated at 12 Cooper's Bank, Gornal Wood. It was probably built in 1847 and was affected by subsidence as the coal from the Earl of Dudley's mines was dug from underneath the area. In 1987 the house was carefully dismantled and reconstructed at the Museum to ensure that all the crookedness and tilts within the structure were retained.

Key Developments

1823 AD	Charles Babbage invents a calculating machine
1825 AD	Stockton and Darlington is the World's first public transport system
1830 AD	Liverpool and Manchester railroad opens
1830 AD	Swing Riots take place. The workers protest for more jobs and better wages
1831 AD	Michael Faraday generates electricity

Uses of Coal

Domestic Use

By 1840 one third of coal mined was for domestic fires, providing both a means of heating and cooking, and lighting for homes. Early hearths had relied on charcoal as a fuel as it burns with less smoke and odours. However, coal gradually replaced charcoal with the widespread use of the coking process of coal to remove many of the impurities and new technology improved the design and efficiency of chimneys.

Enter Jerushah, to see a black lead range in use. Coal not only provided the fuel for cooking, but also heated the water. If you go next door, into the attached 'brewus' you will see a working "copper" (cast iron bowl) with a fire below. The boiler was the only means of getting large amounts of hot water for washing clothes, cleaning the house and filling the bath.

Coal Gas Lighting

During the 17th and 18th centuries a number of men experimented with using coal and other substances to create gas for illumination. However, it is William Murdoch, a Scot who worked in Cornwall and later Birmingham, who is recognised for implementing the first commercial use of gas lighting in Britain. In 1792 he successfully lit his house and office in Redruth, Cornwall where he was employed as the senior engine builder for the Birmingham firm of Boulton and Watt. He also lit a street lamp outside his home. In the 1790s he moved to Birmingham as the manager of the Birmingham Boulton and Watt factory, and built a gas manufacturing plant that was used to light their Soho Works in 1803.

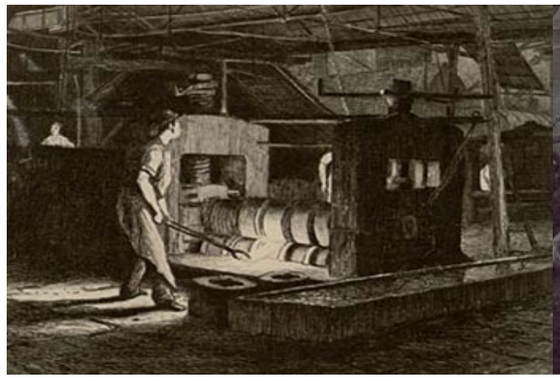
Coal gas was the primary source of gaseous fuel in Britain until the widespread adoption of natural gas during the late 1960s and 1970s. It was used for lighting, cooking and heating and was often supplied to households via a municipally-owned piped distribution system. By products from the production process included coal tars and ammonia - important chemicals for the dye and chemical industry.

1832 AD	The Reform Bill makes changes to the voting system and gives more people the vote	1833 AD	Slavery abolished in the British Empire	1834 AD	Charles Babbage draws up the first plans for a digital computer	1834 AD	Poor Law Act is passed which says able-bodied poor can only get help in workhouses and the conditions in workhouses should be harsh

The increase in the production of lime as a fertiliser not only shows how science was being applied to farming techniques, but also led to an increase in crop yield - leading to lower food prices.

What type of stone do you think has been used to construct these lime kilns?

Explore the village at the bottom of the Museum site to find other industrial processes that relied on coal as a fuel. The Museum tells the story of the life-styles, cultures, traditions and industry of the people living in the Black Country. It highlights the entrepreneurial and manufacturing skills of the inhabitants and the impact they were to have on modern industry. It is the story of things being made as well as lives being led.

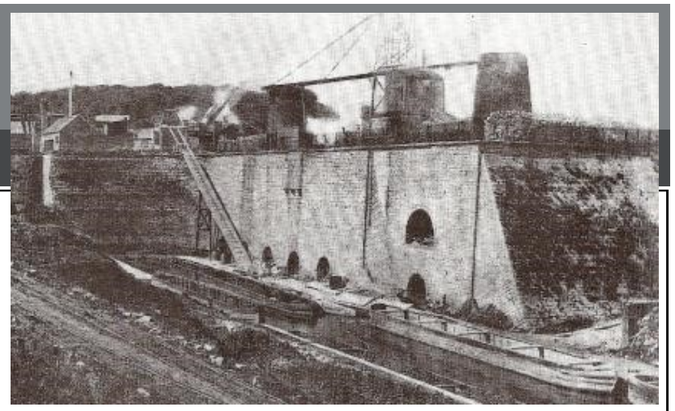


Name five traditional Black Country Industries seen at the Museum that were reliant on coal as a fuel.

Key Developments

1843 AD	Brunel's steamship *Great Britain* launched—the first screw propelled iron merchant ship	1843 AD	South Shields Committee. Report on the causes of Accidents in Coal Mines	1845 AD	Robert Thompson patents the pneumatic tyre	1845 AD	Great Irish Potato Famine. Millions of Irish people die or emigrate

The Lime Industry



This was another industry that relied on coal as a fuel.

Limestone was quarried extensively in Sedgley, Dudley and Walsall. It was one of the many raw materials in the region that contributed to the successful industrial development of the Black Country. It was used in iron making as a flux in the furnaces but could also be converted to lime by burning.

These lime kilns were built in 1842 and were in use until about 1926, burning limestone quarried from underneath Dudley from nearby Castle Hill and Wren's Nest. The shafts of the kilns were topped with 28ft chimneys that belched out smoke and fumes continuously. The kilns were filled with alternate layers of limestone and coal. Small waggons on rails were used to transport the raw materials around the top of the kilns and the shafts were loaded through doors in the base of the chimneys. Also on top of the kilns was a winding gin, similar to those used in mines of the period, for raising the raw materials delivered by canal boats to the basin below. The three brackets that supported the 'arm' of the gin can still be seen projecting from the front of the kilns above the third tunnel. In the 1870's it was replaced by a steam crane. The quicklime was raked out at the bottom of the kilns and placed into tubs in the tunnels on the towpath, before being put onto the canal boats.

Quicklime and lime dust was a dangerous substance and could burn eyes and the skin. Lime burners wore gaiters for protection, with cloth wrapped around their hands and faces. A hospital (later the Guest Hospital over the road from the Museum) was constructed in 1849 by the Earl of Dudley for the care of lime workers blinded whilst employed at his works.

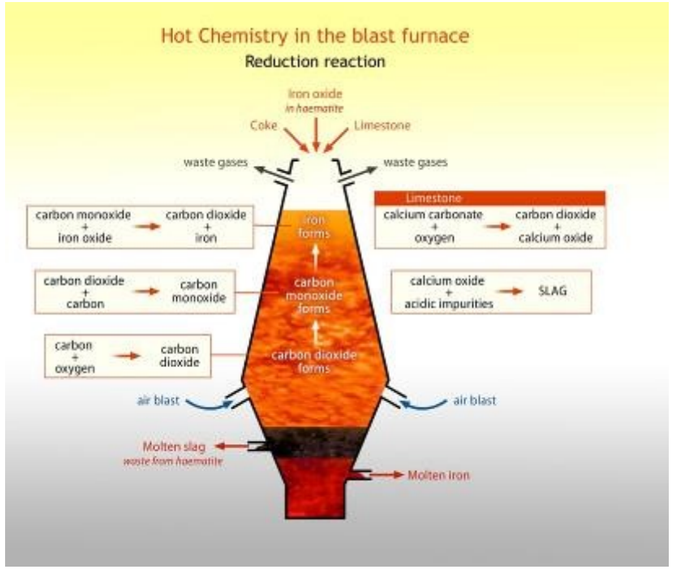
Key Developments

1839 AD	Goodyear invents vulcanized rubber
1839 AD	James Nasmyth invents the steam hammer
1842 AD	The Royal Commission Reports on Children in Mines
1842 AD	The 1842 Mines Act: • No females employed underground • No boys under 10 years employed underground

Industrial Use

There was a strong link between the development of mining and the development of the iron industry. Not only did the mine provide the raw materials for forming and shaping iron, but it also made use of the many iron products created in the Black Country. However, before the coal and the iron industry could really expand in the Black Country, two problems had to be solved.

What were these?



INNOVATION OF THE INDUSTRIAL REVOLUTION

Smelting of Iron using coke

Key Engineer/Inventor:
Abraham Darby I

In 1709 in Coalbrookdale, Shropshire, Abraham Darby first began to smelt iron using coke as a fuel instead of charcoal. This was the creative leap that would help iron making break away from dependence on woodlands and water power and become an industry that has changed how people live, work and communicate across the world.

1835 AD	House of Commons Report from the Select Committee on accidents in mines
1837 AD	Victoria becomes Queen of England
1837 AD	Brunel's steamship *Great Western* launched
1838 AD	John Ericsson develops the screw propeller
1838 AD	The Sirius is the first ship to cross the Atlantic under continuous steam

Racecourse Colliery
Black Gold: mineral extraction

(See pages 3-5)

Lime Kilns
Impact of coal and development of canal system

(See pages 18-19)

Dudley Canal Trust
(Booked Groups only)
Transport and extraction of lime

(See pages 18-21)

Trap Shop
Black Country Metal Industry

Jerushah: Tilted Cottage
Black Gold: mineral extraction

(See pages 3-5)

Carters Yard
Transport

(See page 24)

"Into the Thick": Underground Mine Experience
(For booked groups only)

See how miners worked the Thick Coal and other seams in the Black Country in about 1850. It is a drift mine with a sloping tunnel down which you can walk into a maze of roadways and working areas so that you can experience the underground conditions in a safe yet realistic way.

Back to Backs
Living conditions of a miner's family

Nailmaker
Black Country Metal Industry Demonstration

Brass Foundry
Black Country Metal Industry Demonstration

Boat Dock & Lifting Bridge
Transport

(See pages 22-26)

The Chainmaker
Black Country Metal Industry Demonstration

Anchor Forge
Steam Power

(See page 29)

Newcomen Steam Engine
Steam Power

(See pages 6-7)

School
For Booked Groups only)

The impact of the free, compulsory education system.

Canal and Boats
Development of Transport System (See pages 18-23)

Rolling Mill
Black Country Metal Industry