

Textile Industries - PART TWO - The Cotton Mill of Cromford

North St, Cromford

The late eighteenth century saw a period of rapid technological advance and expansion in Britain that later spread worldwide and represented the beginnings of modern industrial society. Cromford, then a tiny hamlet in an isolated valley, was to play a crucial role in that development and has helped earn the Derwent Valley its reputation of 'the cradle of the industrial revolution' and World Heritage site status. It was here that Richard Arkwright established the first mechanised cotton spinning factories.

An age-old skill, spinning wool had remained essentially unchanged for centuries. The fibres in the raw material would be teased out from a hunk by the spinner, and a twist added by the twirling action of a weighted distaff or drop spindle, which often also served as a bobbin onto which to wind the thread. Spinning was done in virtually all rural houses across the land. It was a job for any idle moment, requiring little equipment or light, and often providing useful supplementary income for poorer families. Once the hand- and great-wheels were invented to augment the simple spindle, the spinner could not only work faster but also sit down.

Cotton spinning on the other hand was a relatively new process in eighteenth century Britain. Cotton fibres are generally shorter than wool, which required some adaptation and development of the basic technique.

Raw cotton was mainly imported from British colonies in America, where at this period the tragic fact is that its production relied on the exploited slave labour of the plantations. If imported as raw cotton bolls, the cotton had to be first beaten and then picked clean of seeds and other fragments. Then it would be carded to straighten the fibres, by spreading the cotton onto toothed cards, which were brushed together until the fibres were all lying in the same direction. The carded cotton was then lifted off in soft, fleecy rolls, and converted to **rovings** by twisting one end to the spindle of a hand wheel while at the same time drawing out the carding horizontally with the other hand. Unlike wool, it took two

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operations to get from carded to spun fibres because the cotton cardings were too weak to be drawn out into an even thread in a single operation.

At this period, cotton was good only for the **weft** of a piece of cloth - the threads that were woven side to side from the shuttle. The strength of a length of cloth came from the long **warp threads**, that were fixed to the loom. The warp threads were provided by linen thread, mostly imported by the hank from Ireland or Germany at this time.

The weaver prepared his loom by warping, or winding the linen thread onto pegs. A coarse twilled cotton fabric could be over a yard wide, and it could take two men to throw the shuttle with the weft thread back and forth across the loom.

In 1733, John Kay invented the flying shuttle, which slowly transformed the slow and clumsy process of weaving. Kay's shuttle was spring-loaded, which enabled the weaver to use it one-handed and to weave much wider cloths. The fly shuttle had the potential to double the speed of weaving.

But as weaving technology advanced, insufficient cotton weft thread was becoming a problem. The first significant breakthrough in the mechanisation of spinning came with James Hargreaves' invention of the 'Spinning Jenny' in 1764. The story goes that he called his invention after his daughter, Jane, who knocked over the spinning wheel at home. The spindle kept turning and Hargreaves realised that a single horizontal wheel could drive many spindles. His Spinning Jennys eventually ran as many as eighty spindles each. However, a skilled operator was still required and the process was better suited to longer fibred wool than cotton. It was a significant advance, but not the definitive breakthrough.

The stocking knitting industry was also developing, and in a more innovative and fashion conscious manner. The stocking frame had been invented to knit stockings as long ago as 1589 by William Lee, and the industry had long flourished. Like weaving, it was the ideal

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cottage industry, and, as we heard in part one of this podcast, frameworkers' cottages sprang up, distinguished by their long attic windows to maximise the light.

Then, in 1759, Jedediah Strutt invented the rib-knitting frame, which enabled stockings and their tops to be knitted together on the same frame. This was another significant innovation but, as with the fly shuttle, its potential was increasingly restricted by one vital bottleneck in the production process – insufficient and poor quality thread.

The need for a breakthrough in spinning technology was becoming increasingly urgent. In 1761, the Society for the Encouragement of Arts, Commerce and Manufactures offered a fifty-pound prize for a successful spinning machine...

And this, is the point at which Richard Arkwright steps in to history and became a mighty player who was to change forever the way we make things.

Only the bare bones are known about Arkwright's early life. We know that he began his career as a barber and then a wig maker with his own company. He travelled the country collecting hair and became aware of the issues the textile industry was facing. His activities are seen chiefly through the eyes of others almost all who remember him as a man who aspired to better himself, but was not entirely likable. William Nicholson, a potential biographer in the years after Arkwright's death, faced this dilemma – was he 'a superior genius' and remarkable inventor, or was he 'a cunning schemer and collector of other men's inventions, supporting them with borrowed capital and never afterwards feeling or showing any emotion or gratitude to the one or the other?' Nicholson could not decide and never wrote the biography.

As a young man, Richard Arkwright teamed up with a clockmaker called John Kaye and his partner Thomas Hayes to perfect a model of a spinning machine, based on pairs of rollers rotating at different speeds. Even before Arkwright came along, it seems Kay and Hayes had been trying to make a spinning machine for some time, but had run out of money and

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destroyed their own work in their frustration. Hayes' critical advance was in devising fluted rollers to card the raw cotton, which rotated at different speeds to draw out the rovings. Arkwright recognised the breakthrough and found the initial financial backing for the venture. They set up a workroom in the parlour of the Grammer School in Preston and set to work.

Hidden away in the Grammar School, behind some gooseberry bushes, Arkwright and his collaborators were so secretive that that neighbours grew suspicious, accusing them of sorcery. Two old women complained that the humming noises they heard at night must be the devil tuning his bagpipes. Nevertheless, after thirteen weeks, they perfected their model.

The solution to mechanised spinning that Arkwright had devised was twofold. First, building upon the principle of using rollers to feed the rovings onto the spindles, he realised that four pairs of rollers were necessary. The bottom rollers were fluted, the top covered in leather. The distance between the pairs of rollers was governed by the length of the fibres, and therefore critical. Too close, and adjacent pairs of rollers grip the fibres, which break. Too widely spaced, and the fibres drift apart between them. The relative speed with which the rollers rotated was also very important. By running the second set at twice the speed of the first and so on, the length of the roving was drawn out, and before it could break, it was passed forward to be twisted.

The second innovation was to use weighted rollers to ensure that the fibres were gripped tightly as they were driven forward. Arkwright then used flyers above the bobbins to put the twist into the thread. Power drove the rollers, and the thread was pulled down by the weight of the spindles at the bottom of the machine. The bobbins onto which the thread was wound were not driven, but rather retarded by light spring brakes. All the operator had to do was supply the frame with rovings at the back, replace the bobbins as they filled and join the yarn if it broke. Compared to the jenny, this was unskilled labour; the sophistication was, all in the finely adjusted machinery, whose potential to run many spindles at once was clear. The prototype had four bobbins, and this was to rise to thirty-two and eventually a hundred and twenty eight. In the words of Ralph Mather, 'Arkwright's machines require so few hands, and those only of children, with the assistance of an onlooker [that] a child can produce as much as would, and did on average, employ ten grown up persons.

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Arkwright may have taken advantage of some of the discoveries of others, but he certainly contributed much himself to this breakthrough.

In 1769, Arkwright patented the design of his spinning frame and took the crucial decision that the new spinning frame was to be licensed for use only in units of a thousand. This made it a factory-based innovation from the start. Such large machines also required external power to drive them; after a brief experiment with horsepower in Nottingham, Arkwright moved to Cromford in 1770, and signed a lease on land to erect a cotton spinning mill.

Cromford was at that time a scattered community that depended chiefly on lead mining. Cromford's small size and relative isolation seem to have attracted Arkwright, who was very sensitive to the possibility of others copying his invention.

Arkwright built his first mill in 1771, using waterpower from Bonsall Brook and the Cromford Sough (suff). He found his labour force partly from the miners' families, and partly through advertising in the local papers. Those who moved to Cromford had to be housed, and it was for this purpose that North Street was built. Arkwright specifically advertised for large families, and the thirty houses on North Street would have housed much of his initial workforce. They are probably the earliest examples of the terraced industrial housing that was to become so characteristic of industrial towns over the next century. Unlike later versions, North Street was built to a high standard, with attention to details like sash windows and almost classical door frames which would have impressed those used to the poorer quality housing of the day. The upper floors still have their original, long windows, a sign that the occupants were expected to supplement their income by working at home. Typically, it was the women and children who were employed at the mill, tending the machines and joining broken threads. The men would be employed for building, for machine-making or mending, as mill supervisors or at home on their loom or knitting frame.

Cromford, through its association with Sir Richard Arkwright, was home to the first experiments in the factory system, and became a model settlement acknowledged and copied by contemporaries. Never before had people been set to work at fixed hours in such an organized, specialised way, on a mechanised process housed from start to finish in a single building. Sometimes called the 'Father of British Factories', Arkwright transformed Cromford from a scattered community of lead-mining families into a tightly knit village, providing work and basic social services for all ages.



The exact date of construction of North Street is not known, but by 1776 seems most likely, when Arkwright's second mill became operational. The houses are solidly built of the local gritstone and were originally built as one room deep dwellings on three floors. Compared with later such terraces, the rooms are relatively generously sized, at some fifteen feet square, and are spared neighbours to the rear as became more typical for later housing of this kind. They also offered more than just accommodation.

Internally, each house was the same. The front door opened from the street into a living room with a cooking range, where the family would have spent what few waking hours were left after the long day at the mill. The ground floor had stone flags on timber joists over a cellar. A narrow, slightly winding staircase led to a first floor bedroom, and then up to the workroom on the second floor (perhaps also used as a second bedroom). At No 10 North Street, filled-in blocks in the floor of the attic room suggest that frame knitting was carried out here, the vigour of the operation of the knitting head requiring such a machine to be stabilised by fixing it to the floor (unlike a hand loom). There would have been an earth closet outside; water was drawn from the village pump. At a later date, a lean-to was added onto the back of each house, providing a separate kitchen. The street would almost certainly have backed onto fields, much as Number 10 does onto its paddock. Arkwright once rewarded his best workers with 'a milch cow' each, and even in the twentieth century some of the houses had pig cotes at the bottom of their small back gardens.

Urban patterns of work were being established, but the inhabitants of North Street otherwise lived a fairly rural existence.

In part three of our podcast, we look at developments in other parts of northern England and discover what remains of our once great mills and the cloth trade.