Collecting the First Exhibits for the
Museum of Science & Technology

Presented By President Rev. Dr. Richard Hills

On Tuesday 19th September, 2006

On 20 October 1969, Lord Rhodes of Saddleworth formally declared the Manchester Museum of Science and Technology open at a ceremony held in its temporary home, 97 Grosvenor Street. This was the climax of years of discussion and months of planning, for the need for such a museum in the Manchester area had long been recognised. This can be traced back to at least March 1839, when Richard Roberts was involved with founding an institution with the grandiloquent title of the Royal Victoria Gallery for the Encouragement and Illustration of Practical Science. Its aim was to illustrate the progress made in industry and science and to have a collection of apparatus 'combining philosophical instruction and general entertainment' and to present experimental demonstrations which, in particular, would arouse the interest of young people. Alas its life was short and its apparatus disappeared. Yet its founding concepts were similar to those embodied later in various reports.

Through the difficult period of the nineteen-fifties, the idea was kept alive by the late Alderman Sir Maurice Pariser and a few members of the staff at Manchester University. When the late Professor Donald S.L. Cardwell was appointed Reader in the History of Science and Technology at the University of Manchester Institute of Science and Technology in 1963, the Principal, the late Lord Bowden, suggested that he should investigate the possibilities of starting a Science Museum. A Joint Committee consisting of representatives of Manchester City Council, Manchester University and the University of Manchester Institute of Science and Technology was established. The Education Department of the City of Manchester was a strong supporter of the scheme in spite of one Councillor asking at a meeting why a science museum was necessary when people could look at machines in UMIST - which didn't go down very well in some quarters. But more important, this Committee approved a Report prepared in 1966 recommending the establishment of a museum. This report became the founding document of the present Museum.

Also stretching beyond what might be called these official circles was a growing range of people interested in Industrial Archaeology. This was stimulated by, for example, Professor Owen Ashmore at the University Extra Mural Department arranging lectures on the subject there, at the Central Library as well as at many classes scattered throughout the region. These led, in part, to the formation of the Manchester Region Industrial Archaeology Society, to whom I express my thanks for their support and help in establishing the Museum. Its members put me in contact with potential exhibits, helped with their removal and display, catalogued the archives we acquired and then, more importantly as the Museum developed, helped to demonstrate our working exhibits. In return, the Museum became the base for the Society where it could hold its meetings and house its archives. Likewise the Manchester Association of Engineers also deserves my thanks for the support given by its members. Here were people such as Jack Diamond, Professor of Mechanical Engineering at Manchester University, and Koenigsberger, Professor of Machine Tools at UMIST, to whom I could turn for advice about the suitability of objects that were offered as well as their historical importance.

But this is running ahead of the presentation of that 1966 Report. The financial difficulties at that time prevented any start being made on a new building or even the adaptation of an old one. So that important material should not be lost, Dr. Cardwell (as he was then) and his newly appointed Research Assistant, Richard Hills, began in 1965 to collect exhibits in a store situated in a railway arch on Sackville Street. They also persuaded manufacturers to hang on to potential items until a Museum could be launched. Through such contacts, it became apparent that there existed a wealth of material which would be lost if a place could not be found to display it. For myself, it was a very steep learning curve for, having been born and bred a Kentish man, I thought Manchester produced only textiles but I was quickly made aware of its extraordinary range of scientific and technological discoveries and inventions, so much so that I entitled Manchester as 'The Centre of the Industrial Revolution'.

I have always said that the salvation of the Museum came through the University Methodist Chaplaincy. In the course of developing the University Campus, UMIST had purchased for redevelopment the headquarters of the Manchester Unity of Oddfellows. The first two new buildings projected in this area did not involve the site of this one so 97 Grosvenor Street was left standing. Agreement was reached in 1965 that it should form a temporary home for the Methodists in one half until their new chapel was built and for the new Manchester Museum of Science and Technology in the other half. The finance for this new venture was provided equally by the three bodies mentioned above. The budget in 1968 of £12,000 provided for a staff of Director, two Technicians, Secretary and one porter/cleaner. Two more porter/cleaners joined to help with the opening in the autumn of 1969.

At that time, the only other general science museums in England outside London were those at Birmingham and Newcastle-upon-Tyne. In the North West, there was the Liverpool Maritime Museum, the Coal Mining Museum at Buile Hill, Salford, and the textile machinery collections at Tonge Moor, Bolton, and Higher Mill, Helmshore. Hence there was a need for a museum to reflect the wide range of industries in the area. Therefore the aim of this new Museum was to explain the major discoveries and inventions in the history of science and the history of technology, using wherever possible exhibits made in or linked with the North West. Even so, collecting exhibits had to be restricted to a comparatively small range of subjects which had had the greatest impact in making the North West the Centre of the Industrial Revolution.

It was recognised that 97 Grosvenor Street was only a temporary home and that Manchester justified a much larger museum. Therefore I was faced with the dilemma, whether to concentrate solely on the displays in that building, in which case there would be little more for a larger place, or whether to collect for the future. I realised both were necessary. Soon a chapel on Rosamund Street and a near-by house were pressed into service as stores. Space was lent at a mill beyond Rochdale. Then we were able to use an old bakery at Gorton but in 1973 had to move everything from there to a store in Newton Heath. Not only was this constant moving of exhibits demoralising for the staff as well as a waste of precious time and resources, but it did not assist in preserving the exhibits. The position was alleviated a little in July 1973 when the Methodists vacated their half of the building so that it was possible to lay out the exhibits there properly, install services and demonstrate the machines. The name had been changed in May 1972 to the North Western Museum of Science and Industry, reflecting the importance of the collections. Then in 1976, the constitution of the Governing Committee was changed to incorporate the Metropolitan authority, the Greater Manchester Council. In this agreement, the Greater Manchester Council provided 5/12 of the revenue, the City of Manchester 2/12 and the Universities of Manchester, Salford and UMIST provided 5/12. The budget for that year was £122,745 with a staff of seventeen. The City of Manchester also provided two Education Officers and a Secretary. Visitor figures rose from 10,133 in 1971 to 45,095 in 1976 and 62,666 in 1977.

What always surprised me, and as I look back still does surprise me, is both the range and quality of exhibits we were able to collect. The report on University museums by the Standing Commission on Museums and Galleries in 1976 stated, ‘Some of this Museum’s collections are of international significance’. (Report on University Museums, Standing Commission on Museums and Galleries, London, 1976, p. 36) These included steam engines, machine tools, papermaking, cotton spinning, weaving and scientific instruments. So let us first consider scientific instruments. Perhaps John Dalton’s eye is not one of the most exciting exhibits visually, but Dalton’s work on colour blindness, meteorology, and above all his atomic theory brought international recognition of Manchester as a scientific centre, raising its status beyond just a mercantile town. But all of his achievements, such as the atomic theory, are difficult to interpret and display for the general public.

Our collections had to be focused on the Manchester region so the work of the scientific instrument maker, John Benjamin Dancer, in the middle of the nineteenth century had to feature prominently, so much so that my designer was surprised to discover how much more important was London than Manchester for producing scientific instruments. Not only do brass microscopes, theodolites and telescopes have considerable visual appeal, but we arranged some telescopes, including a large one by Dancer, so people could look through them out of a window. Ann Durant, who was then Chair of the Museum, complained about having to lift each one of the Cub Pack she had brought to the Museum so the boy could see through the telescope. We were able to acquire early examples of Dancer's cameras dating from the middle of the nineteenth century including one for his pioneering work on stereoscopic photography. Again an example of a stereoscopic picture was arranged in a case so that it could be viewed by the public. But this could not be done with Dancer's other pioneering work on microphotography, so his microphotographic slides remained preserved out of sight. Dancer also worked with another early photographic process, that of Daguerre. In 1842, Dancer photographed Market Street on a Daguerre plate, probably the first photo of a Manchester street scene.

It was Dancer's skill as a scientific instrument maker which enabled James Prescott Joule to determine the mechanical equivalent of heat. Donald Cardwell was Curator of the collection of Joule's apparatus housed in a building on Salford Crescent. Donald transferred the exhibits to 97 Grosvenor Street. There were highly accurate thermometers made by Dancer which Joule read through a special microscope with a moveable head, again made by Dancer. Professor Jack Diamond pointed out the mistake I had made in the notice when I stated that Joule measured temperature with a travelling microscope. This collection is remarkably complete with a variety of Joule's apparatus for his different experiments and certainly is of international significance.

But to return to photography for a moment. The textile industry needed chemists in the dyeing and bleaching works. Such people had the knowledge and skills for manipulating the early photographic processes. Strines Works was one such place where photography was practised very early. Perhaps they hoped to use photographic processes as a medium to print on cloth. I have always been intrigued by the portrait of John Mercer printed on cloth which came as part of the Flatters and Garnett collection. Manchester soon became a centre for the manufacture of cameras. Not only was there Dancer but a firm which became more important was Thornton and Pickard of Altrincham. Harry Milligan, photographer at the Central Library and staunch supporter of the Manchester Region Industrial Archaeology Society, retired to Grosvenor Street where he puffed away on his pipe at the same time as he assembled a fine collection of cameras and other photographic apparatus based on the collection from J.T. Chapman from their photographic shop in Albert Square.

Harry Milligan also drew my attention to the importance of James Mudd as a local photographer who was noted for his landscape and portrait work. Just after I arrived in Manchester in the autumn of 1965, the locomotive engineers, Beyer, Peacock and Co. Ltd., announced its closure of Gorton Foundry. They had made major contributions to locomotive development and I recognised that any archives they had must be saved. To cut a long story short, with the help of the local publican whose pub was just outside Beyer, Peacock's main gate and who also worked at UMIST, I was kept informed of what was happening inside Gorton Foundry. Lord Bowden hosted a lunch and assured some of the Directors that no profit would be made from any of the archives and photographs. So I was able to carry off as much historical material as I could even though we had no museum at that time. Harry Milligan was delighted to find among the ton and a half of glass plate negatives which he took to the Central Library that the early photographs of locomotives beginning in 1856 had been taken by James Mudd and that three of the earliest negatives were paper. This collection must be the earliest surviving industrial photographs used as advertisements of a firm's products. Not quite so pleased was the UMIST Librarian who agreed to store the rolls of general arrangement drawings which I brought back in triumph from Gorton nor were my colleagues so delighted who had to share their rooms in the History of Science and Technology Department with Cost of Work books and other archives. Although much was scrapped, the Beyer, Peacock collection must be among the most comprehensive of any of the private locomotive builders in Britain. When we did acquire 97 Grosvenor Street, the entire collection was moved there and cataloguing carried out by members of M.R.I.A.S. such as Chris Makepeace.

I always regarded the archives as a very important part of our collections. We would be lucky to display an actual artefact made by any company, particularly among the technological exhibits, and that artefact would have to be a small one through removal costs and space restrictions. But a firm's archives could show the range of that firm's products from the prototype, through modifications, to the final last products. The Beyer, Peacock collection was a good example of this, especially with the design and development of the Garratt locomotive. Also archives could preserve the achievements of a company where no exhibits were available. Space in the basement at Grosvenor Street soon became at a premium as we acquired drawings of mill engines, photographs of Cockshoot's coachbuilt motor cars, Crossley buses, Glover's Cable archives and much more. Some were literally rescued from waste paper collections.

We have had a quick glimpse on the top floor and the basement of 97 Grosvenor Street so now we must turn to see what could be found on the ground and first floors. Ahead of you as you entered the hallway was a section of the Bedson continuous rod rolling mill, a world first for the firm of Richard Johnson and Nephew. At the top of the stairs leading to the basement was a Midlands Railway signal lever frame, manually operated, adjacent to part of an electrically operated frame from Central Station and part of a very early electronic signalling panel from Brunswick Junction. A lecturer in the adjacent Metallurgy Department, Dr. Paul Spriggs, was a railway signalling fanatic and nearly brought the Altrincham line to a stand-still when we had failed to appreciate the difficulty of moving a large very heavy lump of signalling frame from Brooklands Road box across both running lines. But to return to Grosvenor Street - linking the basement to the top of the building was a Foucault pendulum, a source of endless fascination to young and old alike. It was fabricated in the Physics Department of UMIST and was set swinging at regular times.

This brings us to another point made principally by Donald Cardwell in that Foundation Document of 1966 - that the exhibits should be able to be demonstrated to make the Museum a living place and not a mausoleum. This presented many problems through the cramped space, the age of the machines, their condition, historic importance and so on. I dearly would have loved to run Mr. Royce's second two cylinder motor car engine, but wiser counsels prevailed. Those machines taken from working environments did satisfy health and safety regulations at the time. It quickly became evident that demonstrations on hand-operated machines gave the demonstrator a better opportunity to explain the processes and principles involved. I hoped that whatever museum eventually replaced 97 Grosvenor Street would concentrate on explaining the basic principles. This would leave other museums, such as perhaps ones at Bolton or Rochdale, able to develop the industries special to them.

Of those industries, cotton textiles was the obvious one. It was the great spinning inventions of James Hargreaves, Richard Arkwright and Samuel Crompton together with John Kay's flying shuttle which so dramatically changed that whole industry during the latter part of the eighteenth century and so launched the Industrial Revolution. Obviously it was important for us to be able to demonstrate their inventions. At first, we could show the principles only on hand spinning wheels. We were very lucky that Dr. David Owen at the Manchester Museum not only had long recognised that, if he attempted to collect industrial artefacts, he would soon find the tail wagging the dog and that his own collections would be swamped. But he also had a few industrial exhibits which he passed over to us.

Among them was an example of the Great Spinning wheel, the ancestor of the inventions of Hargreaves and Crompton. A pair of hand cards was soon acquired and we were in business - at least we could produce a lumpy, coarse length of cotton with some resemblance to yarn. Hargreaves' Spinning Jenny had long disappeared so we built a replica - a back breaking, frustrating machine to demonstrate on which we could never spin more than a couple of yarns out of the sixteen without constant breakages. Our spinning demonstrations were soon complimented with the treadle flyer wheel. This still needed skill to manipulate the fibres but quickly became an attraction when demonstrated at our 'Working Days' as well as to the education school parties. Here again I must express my thanks to members of M.R.I.A.S. such as Charles Wragg for their valiant demonstrations on these special days.

We were very lucky to be lent by Tootals Ltd. their original Arkwright waterframe of about 1775. We made this run on special occasions and were amazed at how well and how simply it spun. The skill had been taken out of the final drafting of the fibres by Arkwright's rollers. One interesting point was the need for heavy weighting of the front pair of rollers. As the machine came to us, this was too light, but, once these weights had been increased, the machine spun very well. Later we had a replica built for Liverpool Road Station. The original machine remained in its glass case at 97 Grosvenor Street while the public could operate the development of Arkwright's waterframe, the ring spinning frame, through a push-button timer. This was a shortened Platt's machine of 1901 from the Hall Lane Mill at Leigh.

The simplicity of the action of the ring frame was contrasted with the immense complexity of a self-acting spinning mule. Later I was able to have a demonstration hand mule constructed from parts of a modern one which had been vandalised. This was so much easier to work than the Jenny but even so skill was needed to wind on a nice cop. The self-acting mule had for so long been the mainstay of the Lancashire cotton industry that it was imperative to be able to demonstrate one. We did take out a full length one of over a thousand spindles from Bowker and Ball Ltd., at Stalybridge which was passed on to Higher Mill, Helmshore, but I fear some parts were lost after I had left the Museum. The departure of the Methodists from 97 Grosvenor Street coincided with the scrapping of the last medium counts, Oldham style mule at the Elk Mill of Shiloh Spinners, Chadderton. I had realised that we could never afford the cotton to spin on a thousand spindles so decided to shorten the one we took from Elk to a mere one hundred spindles. This was easier said than done because the mule did not break down into separate sections and we had to cut up parts to make them fit. Luckily Platts lent us the mule erector who, as a young man in 1926, had helped install these mules at Elk, probably the last of their kind. I had it erected on steel framing so it could be moved easily again without total dismantling - something which has proved to be a great boon in two subsequent removals.

One day, as our Platts fitter was struggling to make this mule work properly, in walked Fred Hilditch to see what we had done to his mule which he had worked at Elk. Between the two of them, the mule was soon running again. The Platts fitter went into happy retirement as this was his last job - we never did receive the bill for his services from Platts! We employed Fred Hilditch for some years to demonstrate his mule a couple of afternoons a week and sort out the mess we had made of trying to operate it ourselves. I never learnt how to piece up the broken yarns while the mule was spinning before the carriage moved out! The mule was a great attraction because so few people had ever seen one at work in a mill even though we ran it more slowly than when it was in full production. At 97 Grosvenor Street, we also demonstrated a shortened roving frame to supply the mule but it was not until more space could be acquired at Liverpool Road Station that the full range of machinery a in spinning mill could be displayed, starting with a bale breaker.

Now we had our yarn, we had to do something with it. Three inventions concerning weaving are remembered by most people from their history lessons - John Kay's flying shuttle, Edmund Cartwright's power loom and Jacquard's pattern selection mechanism. Through seeing an early ribbon loom in Basel, I realised that Kay may have drawn his inspiration for his flying shuttle from the way the shuttles were hit by pegs and sent through the warp on these looms. There had been ribbon weaving mills in Manchester so we acquired and shortened a ribbon loom for weaving plain ribbon, perhaps red tape, from a mill in north Manchester. For Kay's flying shuttle itself, we were fortunate to be given a loom by Bury Museum Service. It was an old wooden one stored in the basement beside the coke-fired boiler. When we erected it, we discovered it was complete and no parts had been fed into the furnace. Moreover it was a fly shuttle loom fitted with drop boxes to house three or four shuttles. We set this up to demonstrate the basic principles of weaving plain cloth. The warp consisted of two colours so that when one pair of heddles was raised, all the threads of the first colour were raised and when the other pair of heddles was raised, the threads of the other colour appeared on top. Hence people could easily see the alternate threads being raised and lowered and the shuttle with the weft sent across. There was a knack in weaving with the flying shuttle to prevent it bouncing back into the warp out of the shuttle box.

The Jacquard machine we demonstrated on a hand pattern loom donated by UMIST Textile Technology Department. It had drop boxes so here we could show how shuttles with weft of differing colours or textures could be selected. Warping this led to another steep learning curve through the various ways the Jacquard head could be used in extending a pattern across the width of the cloth with either direct or reverse repeats. I got it wrong at first. This hand loom was complimented by the Jacquard ribbon loom, originally from Cash's name tape company. We set it up to weave the name, 'North Western Museum of Science and Industry' as well as an outline of the flywheel from the Durn Mill engine. The idea was excellent, the product a headache to prevent the flywheel becoming oval.

I still wonder the extent to which Edmund Cartwright's power loom was the father of the loom which evolved into the much later Lancashire loom. Here again it was necessary to take economy of later demonstrations into consideration when selecting an example. The closure of Pennington Mill, Leigh, presented the opportunity of acquiring a loom which wove a relatively narrow width of about a couple of feet. However the snag was that their product was cloth for typewriter ribbons, using some of the finest cotton yarn with small shuttles. Luckily we were able to substitute coarser heddles and reeds and, more importantly, adapt our spinning mule so that the cops spun on it could fit into the shuttle of one of these looms. Once again, we reduced the speed at which we demonstrated the loom but it still made an immense racket because the shuttle had to be hit hard enough to send it through the warp. I had the warp made from a plied or doubled yarn to avoid the necessity of sizing it. Our all-cotton calico cloth proved to be a popular sales line.

Another of our very popular demonstrations to both school parties and the general public was hand papermaking. The original National Paper Museum was housed at the Vegetable Parchment Mills at St. Mary Cray, Kent. When that mill closed, the Paper Science Department at UMIST was approached about a new home for it. This coincided with the acquisition of 97 Grosvenor Street for the Museum. The papermaking exhibits had been transferred to the nearby Nash's Mill where they had been flooded by the River Darenth. Beneath the layer of silt, I could see exhibits showing principles of technology which we would be unlikely to acquire from elsewhere. Lack of storage made us turn down some large exhibits but those we took, such as for example the pulp preparation stampers, the papermaking vat, the screw press, the frame for the drying loft and demonstration moulds, enabled us to show the principles of papermaking by hand. Acquisition of a small laboratory beater reduced our dependence on UMIST Paper Science Department for supplying the essential pulp for any demonstration so we and the visitors could make our own sheets of paper on small moulds. The problem of how to dry them was solved by using electrically heated photographic drying plates so that a sheet of sufficiently dry paper could be taken across to the printing presses to have something printed on it. The change from hand making into the machine age was represented by a working model of a Fourdrinier papermachine, showing the important developments added by Bryan Donkin and T.B. Crompton. While we had the necessary steam, water and electricity services laid onto it at 97 Grosvenor Street, the Museum there closed before we could try to produce paper on this machine.

Manufacture of printing presses came late to Manchester, with none of the early iron hand presses being made here. We commissioned a replica wooden press of the 1690s to celebrate the 500 Anniversary in 1975 of Caxton establishing printing in England. It was fascinating to work this press with its sloppiness and then change to the solidity of a cast iron one. We had examples of the first iron press, the Stanhope from the 1790s, the ornate Columbian with its snakes and eagle, the Albion and the Britannia. Through the enthusiastic assistance of Dr. Derek Nuttall of the Northern Printing Historical Society, we acquired not only these but also examples of the next stage in printing, the Cropper Treadle Platen and then a much later Manchester-made example of a Thomson automatic platen which was the mainstay of the small local jobbing printer. I realised that we should concentrate on preserving examples of letterpress printing because we could see that offset-litho was gaining in popularity. Computers were just being introduced in the 1970s but we could not foresee that traditional forms of printing would be totally obliterated.

I searched for locally made flat-bed printing presses on which we could produce some larger work. From Blackburn College of Technology came a Wharfedale press made by Furnivals of Reddish. We had another volunteer, Jack Richardson, a trained printer, who used this Wharfedale not only to print posters for the Museum but also replicas of the first page of the Manchester Guardian from 1820 and much else for sale. The Miehle press from Leeds Technical College never was re-erected at 97 Grosvenor Street though it was made by Linotype of Altrincham. Linotype was better known for its machines used to produce type. Their Square Base preceded their Model 1 and we were able to obtain examples of both. In addition we had examples of other type-casting machines such as the fascinating Typograph and the important Monotype of Preston. With sets of type, our printing collection was both comprehensive for letterpress as well as practical for printing demonstrations.

I still think that we were exceptionally lucky with our internal combustion engines through the generosity of Messrs Crossley Brothers. They had pioneered the introduction of internal combustion engines in the 1860s and 1870s based on the German, Nikolaus A. Otto's patents. In 1867 he had patented an atmospheric gas engine, an example of which Crossleys had preserved in the powerhouse of their Gorton Works. We acquired 97 Grosvenor Street just in time to prevent this suffering a fate worse than death by going to the Birmingham Science Museum. When we took over the whole of 97 Grosvenor Street, we piped it up to the gas supply which had not been converted to North Sea gas. Then we found that the equivalent of the crankshaft was twisted, so we complained to Crossley's service engineer, Frank Beard, that this was a bit poor for a machine only an hundred years old. We received a replacement! The way this atmospheric gas engine performed with its irregular dramatic explosions and miniscule power output for its great size explained why it was a dead-end development.

The contrast with the Crossley Otto silent four-stroke gas engine patented in 1876 was extraordinary. It was this engine that really launched the internal combustion engine. We did adapt this to run partially on North Sea gas but we never dared to try doing this with the atmospheric gas engine through fear of sending the free piston through the roof. The other engines were converted by Dr. Ken Barlow, Keeper of Industry. We acquired different types of National, Crossley, Robinson and Gardner stationary internal combustion engines to show the development of gas, petrol and heavy oil engines. Then from the Mechanical Engineering Department, UMIST, came examples of Rolls Royce Merlin piston and Derwent jet aero engines taking us into the jet age. Both these had been sectioned to show how they worked.

The remaining challenge was the diesel engine, another German invention developing out of the work of Rudolph C.K. Diesel. Mirrlees Watson of Glasgow acquired the patent rights for Britain and decided to set up a new manufacturing company, Mirrlees Bickerton and Day, at Stockport. A single cylinder engine, one of the earliest they built was displayed outside the Stockport Works but not in runnable condition. When the move to Liverpool Road Station was being discussed, the Mid-Kent Water Board was replacing their Mirrlees engines with electric pumps. The opportunity was too good to miss because, although dating from the mid 1920s, they were the original type with air-blast injection. These were quite large vertical engines with three cylinders and the compressor for providing the air-blast at around 1,000 p.s.i. The Mid-Kent Water Board generously agreed to present one, provided we removed it. At least here the crane in the engine room had the capacity to lift the parts but there was a snag because the building had settled through extraction of water underneath it so there were gaps in the rails on which the crane ran. We learnt how to jump the crane wheels over the gaps. The sump was grouted onto a concrete base. The concrete had been made with flint nodules and defied attempts with compressed air quango hammers to break it up. Luckily the grouting had not run far under the edges of the sump so we were able to lift it off the bed without breaking it. We took the light parts away in the Museum lorry and we had all the rest lined up ready for Pickfords to load up. The complexity of the air-blast injection contrasts with the simplicity of later injection systems.

I have deliberately omitted mention of steam engines and have kept them to the end because this was the form of power that enabled the cotton textile industry to expand so dramatically. We first reminded people that sources of industrial power really started with human or animal muscles. So we collected a horsewheel from a farm at Waunfawr near Caernarfon. Although at 97 Grosvenor Street there was insufficient space for it to be demonstrated for its full circle, we could show education parties the basic idea. The other important early form of industrial power was water. B. & S. Whiteley, papermakers near Otley, offered to the National Paper Museum a small cast iron waterwheel which we erected at Liverpool Road Station and had splashing round. It served to point out the importance of waterpower in the early paper, textile and so many other industries.

Waterpower was of course the first major source of power in the Industrial Revolution. Soon it was supplemented through steam engines pumping water over the waterwheel as happened at Arkwright's mill at Shudehill in Manchester. However the last example in the Manchester area of the first type of steam engine, Thomas Newcomen's atmospheric pumping engine, had been taken away around 1925 to Henry Ford's museum at Dearborn in the United States where it is still proudly displayed. If we were to explain the complete history of the steam engine, we had to fill this gap. Once again, UMIST came to the rescue through Professor Bill Johnson and the Mechanical Engineering Department. They agreed to construct a 1/3 scale replica of the first known of Newcomen's engines, that built in 1712 close to Dudley Castle then in Staffordshire. Barney's drawing of 1719 was not an engineering drawing in the modern sense and left a lot to the imagination. However perseverance on the part of the Mechanical Engineering Technicians, Joe Flowett and Jerry Needham, resulted in a working atmospheric steam engine.

But once again, this was not without problems. Having carefully calculated the expected number of strokes per minute, the volume of water to be raised and the height, a couple of 4 kW immersion heaters were installed in the boiler. Eventually we had 16 kW to make the engine work properly! I am still amazed that Newcomen succeeded in getting his engine to work. From his success, we knew that it should operate but it took over three months of adjustments to the valve gear and other parts before we had ours running smoothly. Working it brought home to us the crucial importance of the direct injection of cold water into the cylinder for condensation of the steam to form the partial vacuum. Without it, the engine barely operates. With it the engine performs splendidly. Steam power soon became one of our most important topics for education parties. On working days, Mr. Taylor, the father of Muriel, was one of a group of M.R.I.A.S. members who explained the mysteries of our Newcomen engine.

After the departure of the Methodists from Grosvenor Street, we installed a small steam boiler in the basement which enabled us to power the grasshopper and vertical engines both of which are still working at Liverpool Road Station. Running the grasshopper explained why this type of compact beam engine was not more popular. The half beam, the connecting rod to the crank and the piston with its rod are all the same side of the beam pivot so that the engine is wildly out of balance. Also we found that the top of the cylinder had worked bell-mouth. This had been caused by the 'A' frames supporting the radius links being mounted incorrectly, probably from new!

What should we do about later development of the steam engine since there was as yet no prospect of and permanent home for the Museum and no space at 97 Grosvenor Street? I had decided that working mill engines run off a modern steam package boiler would be a major visitor attraction, as indeed they have proved to be. In view of this, and realising that preserving large engines would be exceedingly costly, I looked round for suitable medium size ones that would cover as many technical features as possible. While textile machines might be shortened and small examples of machine tools displayed to show the principles, the mill engines would portray the glory, and to some extent, the scale of Victorian engineering in Manchester.

After Newcomen came James Watt, who not only dramatically improved the efficiency of the Newcomen engine with his separate condenser, but also changed it into a rotative engine that was the basis of steam power in the textile industry from say 1790 to about 1850. Where might we find a Watt engine? Reg Platt, who had saved the grasshopper engine from being scrapped, pleaded with us to save the Watt type beam engine that once had driven the maintenance workshops of the Richard Evans Collieries at Haydock. The National Coal Board was willing to let us have it provided we took it out. Moreover Reg Platt was willing to store it for us at his iron foundry in Widnes, provide transport to get the parts there as well as persuade a friend to lend a mobile crane. One little snag was that, since the framing of this engine was supported by the engine house, we would have first to knock that down and build another for eventual re-erection. I remember sitting on the roof one summer day lifting off slates, not as idyllic as it sounds because the wind stirred up one hundred years of black slate dust. Another disturbing moment was when we were dismantling the flywheel. Each section of the rim was brought to the top position, moved sideways to free it from the 'T' arms on the ends of the spokes and then lowered. With one section out, the flywheel was out of balance. As we manoeuvred another section out, the spoke came with it because the spoke had broken off at the bottom in the boss. We had not calculated on moving both parts together.

We were lucky once more because vandals did not discover this engine as we were dismantling it and we had to leave loose parts lying there overnight. Reg Platt did not feed any parts into his furnaces although he did have a brake-in into his non-ferrous store so some brasses were lost. These would have needed replacing anyway but this made their redesign more difficult. We were exceedingly fortunate that the Goods Shed at Liverpool Road Station had sufficient height to fit a mock-up of a beam engine house so that the Haydock engine could be re-erected in such a way that one side showed a typical beam engine house while the other could be left exposed to show Watt's separate condenser, his parallel motion, the centrifugal governor and the flywheel with gear drive around its rim. This engine was so much easier to demonstrate than the temperamental Newcomen.

The single cylinder horizontal engine from A. & J. Law's Durn Mill at Littleborough shows how much more compact is this form of engine which developed more power than the Haydock. The Haydock engine rests on one brick pillar for the cylinder, another for the pillar supporting the beam and a third for the crankshaft pedestal. High above all these is the framing supporting the working beam. The Durn Mill engine has a single horizontal cast iron frame for cylinder, crosshead slides and crank pedestal secured to the brick and stone engine bed so there is nothing to be supported by any engine house. This engine has a single short slide valve, different from the arrangement on the Haydock engine. The flywheel is a single casting about 12 ft. diameter which was too large to fit into our stores. At the time of its dismantling, site huts for the builders constructing the Metallurgy Building next door to us at Grosvenor Street had been placed between ourselves and Upper Brook Street but a small gap had been left. One dark night - actually one day - the flywheel was surreptitiously slipped into this gap and lent against the wall of 97 Grosvenor Street. It appeared in all its glory when the site huts were removed. Somebody phoned to ask if it were a wheel off a Roman chariot! Another technical feature on the Durn Mill engine is the gear drive through a gearwheel made of a single casting. Separating this and the flywheel from the crankshaft when dismantling proved a difficulty because the keys had been driven in from opposite sides and access to their inner ends was obscured by the wall of the mill.

The Durn Mill engine should have shown another feature different from the Haydock engine. Watt placed his condensing apparatus in a tank of cold water from where he drew the water to supply the condensing jet. His condensing water would have become warm, reducing efficiency. The Durn Mill engine had no cold tank, but we did not remove the condensing apparatus because it was too far corroded. However this feature of jet only condensing can be seen on the next engine in the series, the one from Richard Barnes Mill, Firgrove. So far the engines discussed have used the steam in a single cylinder. As boiler pressures rose, greater economy could be obtained by expanding the steam first in a small high pressure cylinder and then in a larger low pressure one. This feature can be seen on the Barnes Mill engine where the cylinders are placed one behind the other in the tandem compound layout. This was quite a popular form of layout in spite of there being only one crank pin and journal.

The Barnes engine shows another feature that became very popular on later mill engines - the Corliss valve gear, first patented by the American George H. Corliss in 1849. When the paired inlet valves were linked to the governor, they gave a very precise control of steam admission and so helped to regulate the speed of the engine. Power was transmitted from this engine to the various line shafts in the mill through ropes spaced around the grooves on the flywheel. This form of driving originated in Northern Ireland through Combe Barbour and was employed in all the larger textile mills after 1900. The polished wooden lagging on the sides of the flywheel helped to lessen wind turbulence caused by rotation of the wheel. As the size of engines increased, so the mill engineers faced increasing difficulty in barring them round to a starting position. Therefore barring engines became a standard fitting as on the Barnes engine.

The Barnes engine had been supplied by J. & W. McNaught from their foundry a little way along the Rochdale Canal and, no doubt, was shipped on barges to the coal stage at the mill. There was no vehicle access but this engine seemed too good to miss when Courtaulds offered it to us. Luckily Rochdale Council decided to widen the road bridge over the canal so that we could park a mobile crane on it from where it could reach to the stage and lift bits from there onto a lorry without obstructing other road traffic too much. The engine room crane lacked capacity to lift the heavier parts so it took all the skill of my Chief Technician, Frank Wightman, to jack and slide parts out of the engine house to within reach of the mobile crane. Particularly difficult was the lower half of the flywheel which had to be turned through 1800 so it could slide out on the faces that bolted it to the other half. The main engine bed was too large to fit into our stores so it was placed on concrete supports outside 97 Grosvenor Street. The supports are still there.

Having the bed there proved to be a convenient resting place for the W. & J. Galloway Lancashire boiler which had been supplied to a mill in Holt in 1889. Not only did it have the twin firetubes advocated by William Fairbairn in 1844 but also had the later Galloway cross tubes which gave a greater heating surface. This design of boiler could withstand greater steam pressures than earlier ones, and, when they were made of steel, could take pressures up to at least 200 p.s.i. They were to be found in virtually all textile mills. It was offered to us by John Sawtell and was accepted because it was short for this type and was situated in a place where, once the side flue walls had been demolished, could be rolled onto Pickfords low loader alongside with no cranage necessary. For display at Liverpool Road Station, I had holes cut in it to show how it worked.

While we were playing with a sort of jigsaw puzzle to fit all the pieces of our engine collections together in the Goods Shed at Liverpool Road Station, now designated the Power Hall, Ferranti announced the closure of their Hollinwood Works. They had preserved a small example of their reciprocating steam engines that once drove flywheel alternators for electric power supply. It was a cross-compound with a cylinder on either side of the flywheel, in this case high up in the inverted vertical position. The engine had been supplied in 1898 to the Lambeth Electricity Supply Company but survived there for only a couple of years when it was found to be too small due to increasing demand. It was then moved to the weaving shed of J.H. Gillett at Chorley where the flywheel alternator was replaced with a smaller flywheel grooved for ten ropes. It was preserved in this state at Hollinwood where it was occasionally demonstrated under steam. It had many interesting technical features, such as balanced crankshaft, fully enclosed motion with forced oil lubrication to accommodate the high speed of 150 r.p.m. at the mill and possibly 300 r.p.m. at Lambeth. It would show an early type of steam engine used for electric generation so was worth displaying at Liverpool Road Station - but it had no alternator.

We found that we could fit it into the steam engine display so I went to Hollinwood to see the parts since by that time it had been dismantled. At the same time, some testing equipment was being scrapped which included a Siemens flywheel alternator used to generate variable frequencies. I had been told this was eighteen feet in diameter so I knew that it would not fit the Ferranti engine. But when I went to have a final look at it, I realised it was much smaller. Charles Somers, the Ferranti archivist, produced a tape measure so we scrambled over the engine parts and the Siemens alternator. There were inches in it - it might just fit the Ferranti engine. We took the risk and had the engine bed prepared in concrete. The Central Electricity Generating Board machined the crankshaft to fit the alternator hub. One tie bar across the top of the alternator static coils had to be cut away and - hey presto - we had a steam powered zig-zag flywheel alternator once more. This engine also introduced the inverted vertical type to our collection.

The largest reciprocating steam engine we saved covered the final thermodynamic principles and the final technical developments. Hence it was a great prize to be won but also gave us the greatest challenges. In 1926, Galloways spent six weeks at Elm Street Mill in Burnley removing the former engine and replacing it with probably their last engine for a textile mill. It drove a ‘room and power’ mill where four different concerns had their looms driven by it. It was situated between the loom sheds and the two storey building fronting the road used for storage and preparation areas. Mobile cranes could not reach it. Access was through the boiler house and up through a small gap in the main mill wall. The overhead crane in the engine room could handle only the smallest pieces. It was a cross-compound engine with a cylinder either side of the flywheel of typically massive Galloway construction. Unusually the main beds lay on two levels, which of course needed to be accurately laid out later.

Superheated steam was supplied to the high pressure cylinder through Galloways own design of hydraulically operated drop valves. Corliss valves would not have been satisfactory at the high speed of around 120 r.p.m. This speed also meant that the main bearings, big and little ends on the connecting rods and the crosshead slides had pressure oil lubrication. All these parts had to be enclosed. The steam exhausted through piston valves underneath the high pressure cylinder by which time the steam pressure had fallen from 150 to 35 p.s.i. Some of this steam was ‘passed out’ at this stage to supply the needs of the weaving concerns for size preparation equipment. The rest of the steam went to the low pressure cylinder. Galloways developed special compensation systems to ensure that the pass out steam was kept at the correct pressure while adequate steam could be used in the low pressure cylinder to balance the power being developed in the cylinders in the cross-compound layout.

Steam entered the low pressure cylinder through similar hydraulically operated drop valves to those on the high pressure cylinder. But steam was exhausted through a ring of ports in the middle of the cylinder on the Uniflow principle. As the piston moved back towards the inlet end, the exhaust ports were covered so that the residual steam was compressed and reheated. In this way, the hot inlet areas remained hot and the cold exhaust cold, giving greater economy. Galloways developed special relief valves should the compression of the residual steam create too high a pressure. The exhaust steam was condensed and the condensate removed by an Edwards type airpump, claimed to be very efficient at higher speeds. The front ends of the cylinders were secured to trunk guides, different from those on the other mill engines while the rear ends were supported on pillars that could oscillate when a cylinder lengthened through increasing heat. The weight of the pistons was taken on tail-rod slides, another feature not found on the other engines. Engines like this one at Elm Street, expanding superheated steam in the high pressure cylinder, using the steam at an intermediate pressure for 'pass out' or 'extraction' purposes and finally having a Uniflow low pressure cylinder were claimed to be the most efficient reciprocating steam engines ever designed.

All we had to do was to remove the prize the owner, Brian Melland, had offered us in 1969. But where to store it? We were lent storage space in a mill beyond Rochdale, not knowing we would have to move it twice more before the final move to Liverpool Road Station. How to get it out? This time we received a grant to help with removal costs from the Science Museum Preservation Fund. One of Pickford's trailers was manoeuvred into the boiler house and a ramp had to be built on it each time we had to lower a heavy part out of the small hole in the wall. Special frames had to be assembled on which parts such as the high pressure cylinder, flywheel halves and crankshaft could be mounted. The crankshaft had balance weights and the engine was so finely balanced that, when we disconnected the air pump, the engine gave a quarter turn. The low pressure cylinder was particularly difficult to handle because it was moved complete with its heavy piston and had to be balanced only on the flanges of its exhaust box. It is a tribute to Frank Wightman's skill as a millwright that this engine was removed with slight damage only to one half of the flywheel which slipped when part of the ramp gave way. The flywheel itself weighed around 12 tons, with other parts similarly massive. The parts of all these engines were preserved as well as possible to prevent deterioration while in store.

When the time came for re-erection, mass concrete beds had to be designed since we had made no attempt to remove the huge bedstones. Measurements of the bed at Elm Street Mill were checked but of course the house for the Haydock beam engine had long since disappeared. Therefore all the parts of all the engines were carefully measured and drawings prepared. We were fortunate that we had many of the original drawings from J. & W. McNaught for the Barnes engine. We used imperial measurements, as had the original engineers, but the architect responsible at Liverpool road Station wanted metric. The builders of course wanted imperial. There were only a few instances where cranked holding-down bolts had to be inserted. Knowing our problems with removing these engines, I insisted that adequate overhead cranes be installed at Liverpool road Station which could lift any single piece of any engine. The Haydock engine with its house was the exception, but even here I insisted that the roof beams over the cylinder end be made strong enough to lift up the smaller parts. The initial budget did not stretch to cover installing steam, water and condensate services. I pointed out that to provide these later would be very expensive as well as disruptive. Means were found to cover provision for these services as well as a package boiler so that the engines could be demonstrated under steam from the initial opening to the public. Their popularity ever since has confirmed that my foresight was correct.