The North Western Museum of Science and Industry, Some Reminiscences.

By

Richard L. Hills,

M.A., D.I.C., Ph.D., C.I.Mech.E., F.M.A., Dip.Ed.

Contents

Introduction

Donald Cardwell, Professor in History of Science and Technology, University of Manchester Institute of Science and Technology, wrote:-

"The principal aim of the Museum [would be] to explain the major discoveries and inventions of history of science and technology using wherever possible exhibits made in or linked with the North West, establishing a valuable tool for school and universities…

"Thus the Manchester Science Museum should give prominence to textiles, electrical engineering and computers among other things, but pay much less to motorcars, cycles and firearms. One must always remember that the Manchester region was, at the beginning of the nineteenth century, an area of 'high technology' that attracted able scientists and engineers from all over the civilised world. The great textile industry had stimulated the power technologies of steam and water and had brought about revolutionary advances in building technology for cotton mills had to be strong enough to bear the weights of heavy machines and be as well lit as possible. The last requirement expedited the development of the gas industry, while the demand for very large numbers of textile machines brought about the rise of the local machine tool industry. The finished cloth had to be bleached, mordanted and dyed or printed so that, at the final stage, the services of the chemist and the chemical industry were called for. A very wide range of advanced technologies sprang up as a consequence of the revolutionary growth of the textile industry. And it is, I think, no accident that at the very heart of this area of high technology there grew up one of the great schools of world science with John Dalton and then James Prescott Joule as its first standard bearers. Plainly this remarkable pattern of events must to some extent determine the form of the North Western Museum of Science and Industry and it is quite impossible to see how a national museum of technology, if not in Manchester, could do justice to it. Equally it would be wrong to suppose that Manchester could interpret the technologies of Birmingham or London. Regional museums of technology have, I believe, four main purposes: (1) to conserve historically important machines, apparatus, records and drawings; (2) to advise on, or to help with, the conservation of outside exhibits that cannot be put in the museum; (3) to teach at all levels; and (4) to carry out research and publish monographs."

Such was the vision behind the establishment of a museum of science and technology in Manchester. It briefly outlined the worldwide importance of the inventions and industries in both science and technology that the area had made to our present civilization. It is with considerable justification the Manchester has been called "The First Industrial City". The following brief history of the North Western Museum of Science and Industry shows how much of that vision was achieved in spite of very limited resources. The story is divided into two parts. The first gives a general outline of the development of the Museum in its early years. The reasons behind selecting and moving some exhibits are outlined. The second part contains more detailed lists of what was collected and when. While the exhibits mostly had local connections, the collections assembled soon acquired more than local significance, some being worthy of international recognition. All this was achieved through the dedication of the few members of the Museum staff.

This account of the early days of the original Manchester Museum of Science and Technology and then the North Western Museum of Science and Industry shows how they developed into the present Museum of Science and Industry in Manchester. It is based on the original foundation documents establishing the Museum as well as the first annual reports. These are supplemented by descriptions of some events to the best of my recollections but much has had to be omitted. It has been necessary to write this before all those involved have either left the area or passed away. I have been encouraged by Anthony Goldstone, former Chairman, to record our strenuous efforts in the face of very limited budgets, inadequate premises and in times of financial constraints. We acted just in time to preserve so many significant historical exhibits which was possible only through the generosity of so many companies, institutions and individuals. Without them, MOSI be but a shadow of itself. To cover the full scope of the collections we assembled is way beyond what can be contained in such a short essay. Therefore I apologise to those people whom I should have mentioned but have failed to do so. However I wish to thank Bernard and Jill Champness for their support in the production of this account, particularly in copying the illustrations since this record would be the poorer without them. I must also thank Chris Makepeace and others who have lent pictures.

Richard L. Hills.

Historical Introduction

The idea for having a display of industrial and scientific artefacts in Manchester 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 Sciences. 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'. It would present experimental demonstrations which, in particular, would arouse the interest of young people. Alas, it was short-lived and its apparatus disappeared. Yet its founding concepts were similar to those embodied later in various reports for a museum. It would not be until 20 October 1969 that Lord Rhodes of Saddleworth formally declared the Manchester Museum of Science and Technology open at a ceremony held in its temporary home, the Oddfellows Hall, 97 Grosvenor Street.

Opening of Grosvenor Street Museum with left to right, Lady Rhodes, Lord Rhodes (Lord Lieutenant, Lancashire), Lord Bowden (principle U.M.I.S.T.), Dr. Richard Hills and Joe Flowett looking at Joe Flowett's models from the Mechanical Engineering Department, U.M.I.S.T.

In the intervening years, the Science Museum had been opened in London following the Great Exhibition of 1851. However this example was not followed in the provinces until there was one at Newcastle upon Tyne in the 1930s and one at Birmingham in the 1950s. There were some specialised collections such as the Railway Museum and Castle Museum at York or Salford with its Buile Hill Mining Museum and its street of shops and the collection of early textile machinery in the

Tonge Moor Library, Bolton. There were also the open air museums started at Iron Bridge and Beamish in the late 1950s. The 1950s and 1960s saw the rise of Industrial Archaeology as well as university departments for history of science and technology. Perhaps the powers-that-be realised the extent of the interest in industrial history for the examples of Birmingham and Manchester were quickly followed by Bradford, Leeds and Sheffield. There was a need for museums to reflect the wide range of industries in these areas. The one in Manchester would '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'. (Annual Report, 1977)

Throughout the difficult financial period of the later 1950s, the idea of a science museum for Manchester was kept alive by the late Alderman Sir Maurice Pariser and a few members of the University staff. (See UMIST Annual Report 1982 – 3 for list) When Dr. Donald S.L. Cardwell was appointed Reader in the History of Science and Technology at UMIST in 1963, the Principal, Lord Bowden, suggested 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 for Science and Technology was established. The Education Department of the City was a strong supporter in spite of one Councillor asking at a meeting why such a museum was necessary when people could look at machines in UMIST – which didn't go down very well in some quarters. This Committee drew up a report which was presented on 31 October 1966 and became the foundation document for the Museum.

The Vision

The report described the function of such a museum as acquisition, conservation, research and, of course, exhibition. Without research, there could be no rational policy of acquisition; without conservation, display would be ineffective and display must be in its proper context to acquire new depth of meaning. To be effective, the collections had to be a representative selection of the more important machines and scientific instruments, or exact replicas of them, which characterised and determined the scientific, technical and industrial history of this country, and more particularly the North West region.

In addition, it was envisaged that, whenever and wherever possible, the exhibits would be restored to full working order and be demonstrated from time to time.

> "All such exhibits should, moreover, be so erected that they can be driven by their original motive agents: steam engines by steam power and not by concealed electric motors. In this way the feeling of anti-climax, or even fraud, associated with cased-up, push button models is avoided. Also some sort of audience participation carefully prescribed should be encouraged."

Part of the reason for running and demonstrating the exhibits was to keep the skills and know-how alive. In a rapidly changing technical and industrial world, running these machines would show the problems which the original inventors faced, the expertise needed to develop and work them and also help to recreate the environmental and social conditions of the Industrial Revolution.

Educational Purpose

This would be linked to the educational function of the Museum which was seen as applying to a very wide public.

> "Possibly the most important educational function of the Museum would be to help arouse at as early an age as possible the latent interests of youngsters who happen to have natural aptitudes for technology or science and, the interest being aroused, to assist in fostering it while providing what help it can for formal education in these fields. In this way, the Museum would play a valuable role in helping to increase the recruitment and training of scientists and technologists. It would be permissible, indeed desirable, for the Museum to provide facilities to enable the arts students to understand the scientific and technological basis of the age in which he is living – for the Museum in other words to provide a convenient place for the meeting of arts and science minds."

So the exhibits would be used to tell the tale of the historical development of their particular subject and, if appropriate, to enable a manufacturing process to be carried out. Most visitors would never have seen these historic machines at work and would have no idea of what they did.

The Museum would of course cater for the ordinary visitor and explain to him much of the background of the scientific and technical world in which we live. Courses would be provided for a wide range of educational classes ranging from schools, industrial training, university courses as well as adult courses. There would be special lectures on say recent aspects of science and technology for the general public. There would also be leaflets and pamphlets printed to explain specific exhibits, biographies of famous local inventors and scientists as well as industries. The 1966 report envisaged that a new museum and planetarium would need an area of some 170,000 sq. ft., based on that being proposed for Birmingham. The capital cost would be around £1,750,000. Staff needed including five keepers and twenty eight attendants would be about 52 people. Running costs would be £140,000 per annum.

Potential Sites

Over the years, many sites were suggested for the permanent home. Basic ideas were drawn up for levels of staffing, workshop facilities, lecture and other rooms for the Education Service, archive and record space as well as the main exhibition areas. The weights and sizes of some of the exhibits were pointed out. Owing to the support from UMIST, the University and the Education Service of the City, the most favoured site was on the corner of Oxford Road and Booth Street East, opposite to the Royal Northern College of Music where the School of Management now stands. Its advantage would have been a completely new building which would have been purposely designed for access of exhibits, weight bearing floors, services for lecture rooms, etc. But the cost was way beyond any funding in the foreseeable future.

Quarry Bank Mill Styal.

The National Trust offered the former cotton mill, Quarry Bank, Styal. However this was outside the boundary of the City of Manchester so there was no interest from that partner. In addition, access for the heavy mill engines would have been virtually impossible and the wooden floor beams, low ceilings, etc. would have limited display of some exhibits. The National Trust has turned it into a nineteenth century cotton spinning and weaving mill and not a Museum of Science and Industry.

The City suggested the fine, listed Cook and Watts Warehouse in the centre of Manchester close to Piccadilly Gardens, a magnificent site but again suffering from the same problems as Quarry Bank. The internal cast iron pillars were closely spaced, supporting wooden floors. Floor loadings would have been very low for a reason the City architects had not realised. To allow more light to reach the centre of each floor, the warehouse had been built with light-wells reaching right down the building. These had been covered in with light flooring. Yet the building had a magnificent grand sweeping staircase at the entrance. It is now an hotel.

At the other extreme was Central Station. Access magnificent, weight loadings excellent, plenty of space and headroom, good situation. The suggestion was to house the Museum inside box-like structures below the great roof span. It would have made a wonderful National Museum of Technology with railway exhibits at the platforms and aeroplanes suspended from the great arch. There was no interest or money for something on this scale.

Another more serious suggestion was the warehouse No. 101 Princess Street. While major exhibits could not have been accommodated due to restricted ground floor area, it might have been suitable for textile machinery and scientific instruments. Next door was the former College of Technology building with a large lecture theatre which might have been added to the Museum. This second building is now the Museum of Trade Union History.

Interest in developing a science museum in this area was stimulated by J.F. D'Urso and John Bishop, students at the School of Architecture. They were impressed by a near-by cloth warehouse, York House in Major Street, which had one elevation almost entirely glass. This would have formed the centrepiece of a museum stretching down to the Rochdale Canal. Their imaginative designs helped to keep the idea of a science museum alive at a time of financial cutbacks.

Later Potential Sites

The future did not seem so bleak when local government was reorganised in the two-tier system including the Greater Manchester Council. The GMC saw in the Museum something that would serve the whole area and so were willing to support it. On the other hand, they did not want to be seen favouring the City of Manchester to the detriment of the other ten Councils. So the GMC looked for a site beyond the centre of Manchester. One suggestion was to split the collections, retaining a basic educational museum in the city centre on the University site, with a more open-air type elsewhere. Astley Green colliery was suggested as a possible second site where the large steam winding engine had been preserved.

Astley Green Colliery Headgear.

Then along came British Rail and Liverpool Road Station. Jack Diamond, Professor of Mechanical Engineering at the University, Dr. David Owen, Director of the Manchester Museum, and myself visited this station in 1968. While we admired the magnificent structure of the 1830 Warehouse, with its wooden floors, wooden beams and wooden columns, we realised how inadequate it would be due to limited floor loadings, close spacing of the columns, access problems for both exhibits and visitors. In addition, lead flashings and guttering had been stripped off the roofs so rain was pouring in. We trod with great caution on some of the rotting floors. Parts of some of the internal walls were collapsing. We were glad to escape into the fresh open air away from the smell of dry rot.

The building had deteriorated further when GMC bought it off British Rail for the bargain sum of £1. People probably wondered why I was unenthusiastic about creating a museum in such a prime historic site of the Industrial Revolution but I knew that the 1830 buildings alone would be unsuitable to do justice to the engineering heritage of the region. Luckily, at my prompting, the GMC purchased the Goods Shed and area under the adjoining gantry for a sum considerably in excess of £1. The Goods Shed would be used first for the Great Railway Exposition to mark the 150 Anniversary of the opening of the Liverpool & Manchester Railway on 15 September 1830 and afterwards as the Power Hall to house the major large exhibits of the Museum.

Sir Nigel Gresley at Liverpool Road Station during the Great Railway Exposition, August 1980. Left to Right, Councillor Fieldhouse, Chairman G.M.C., possibly an insurance representative, Dr. Richard Hills, Sidney Weighell, National Union of Railway Men and David Sumner, Festival Organiser.

Starting the Museum

At the same time as the 1966 report was submitted, a start was being made forming contacts and collecting exhibits by Dr. Cardwell and members of his Department for the History of Science and Technology. A pillar slotting machine and a wooden framed Jacquard hand loom found their way into a railway arch in Charles Street which may be considered as the start of the Museum. In the autumn of 1965, Richard Hills, myself, was appointed Research Assistant in the History of Textile Technology with the secondary aim of assisting the Museum. Soon the rooms in the Department itself began to fill with exhibits and archives and more storage was lent in a house and a chapel in Rosamund Street. Liaison with potential donors continued and it became evident that a wealth of material was available, waiting to be put on display.

The financial situation in the years following 1966 prevented any start being made on a new building or even the adaptation of an old one. What was happening behind the scenes will never be known. Perhaps it was fortuitous that I was living in one of the National Trust properties of Styal while the UMIST Bursar, Geoffrey McComas, lived near-by. I got to know him through travelling together in the train into Manchester when we discussed progress on the Museum. He had close contact with the Principal, Lord Bowden. One of the properties which UMIST purchased for demolition was the headquarters of the Manchester Unity of Oddfellows, 97 Grosvenor Street. Luckily the proposed second phase of the extension of the Joint Metallurgy Department of UMIST and the University that would have extended across the site of 97 was not scheduled for some years so there was no immediate need to knock down the Oddfellows building.

At the same time, Manchester University was seeking a temporary home for the Methodist Chaplaincy because their building was being redeveloped. It was suggested that the Methodists could use part of the Oddfellows building while a start could be made to set up the Museum in the rest. We were shown round by John Crosby, UMIST Buildings Officer, who whispered in my ear that perhaps the Methodists could occupy the whole of the ground floor while the Museum could have the basement and the upper two floors. I had to point out the weight of most of our exhibits and how could we carry them up the stairs. At the front of the building was a magnificent staircase, sweeping round three sides of the light well. Because each floor was stepped back, there was no possibility of spanning the space with a lifting beam. Also everything would have to be carried up the flight of steps through the front door. In the end, it was agreed that the entrance hall would be shared. The Museum had the basement, part of the ground floor, the loading bay at the rear, the front of the first floor and all the second.

These proposals were maturing during the second half of 1967. I wrote to an aunt on 16 July that year, ‘The Science Museum seems to be coming to life again up here, although whether there will be any permanent result is too early to know yet’. Things were looking up a little in August when UMIST was about to purchase Oddfellows Hall for demolition in three years time. However the building would not be ready till January. There must have been a meeting of the Working Party at the end of August when it was agreed to recommend proceeding with the Museum. Finance would be forthcoming from UMIST and the University. There was another meeting on 22 September, possibly again of the Working Party, for which estimates of costs may have been prepared. These proposals were laid before the Joint Committee which met on 9 November. McComas was confident that the City would find its third share because they would receive back half of their £4,000 as rates. (Letter to Kath Tomson, No. 66, 19 Oct. 1967) The Joint Committee sent its report to its constituent authorities:

> "So that our recommendations to start the Museum are to be considered officially by the City Council and the University & the Institute. The last two have the money and our Bursar, and Bursars as a race are not given to over optimism, feels the City will find its share, though possibly not till April." (Letter to Kath Tomson, No. 67, 12 Nov. 1967)

It is not known when the agreement was finally ratified by all parties.

The Oddfellows Hall provided about 18,000 sq. ft. of space, of which, in the event, a little more than 3,000 sq. ft. was allocated to the Methodists. The costs of the Museum for the first two years were estimated as follows:

Rent	Nominal
Staff (Lecturer in charge, 2 technicians and secretary)	£4,200 p.a.
Rates, heating, insurance, cleaning, etc.	£4,670 p.a.
Repairs & maintenance of building,	£1,000 p.a.
Exhibitions (£1,800 over the first two years)	£ 900 p.a.
Expenditure on furnishing, equipping and rehabilitating the Building (£3,800 over the first two years)	£1,900 p.a.
TOTAL	£12,670 p.a.

> "It would be possible to present exhibitions of textile machinery, machine tools, steam engines, astronomical and scientific instruments, exhibits showing the use of steam, internal combustion and electricity, and exhibits relating to Manchester scientists such as Dalton, Joule, Priestley, Rutherford and Roscoe as well as photographic collections, archives and technical and scientific records." (Report of the Working Party, 2 Nov. 1967)

The financial year was based on university funding, ending in July.

First Staff Appointments

A meeting of the Proposed Museum of Science and Technology Joint Committee with representatives from Manchester City Council, the University of Manchester and the University of Manchester Institute of Science and Technology was held on 10 April 1968. Their recommendation that a temporary Museum be provided in the Oddfellows Hall was submitted and accepted by the Councils of the three constituent bodies. A start could be made. Salvation had come through the Methodists. Today health and safety would rule out this building. R.L. Hills was appointed lecturer-in-charge but only officially in September 1968. Two technicians, Messrs. F.F. Wightman and J.A. McCullen, were engaged at the end of June 1968. Mr. McCullen had to leave for domestic reasons in November and was replaced in March 1969 by

Mr. H. Applebee. In the same month, Mrs. M.E. Howell was appointed secretary and Mr. L. Leather cleaner and porter.

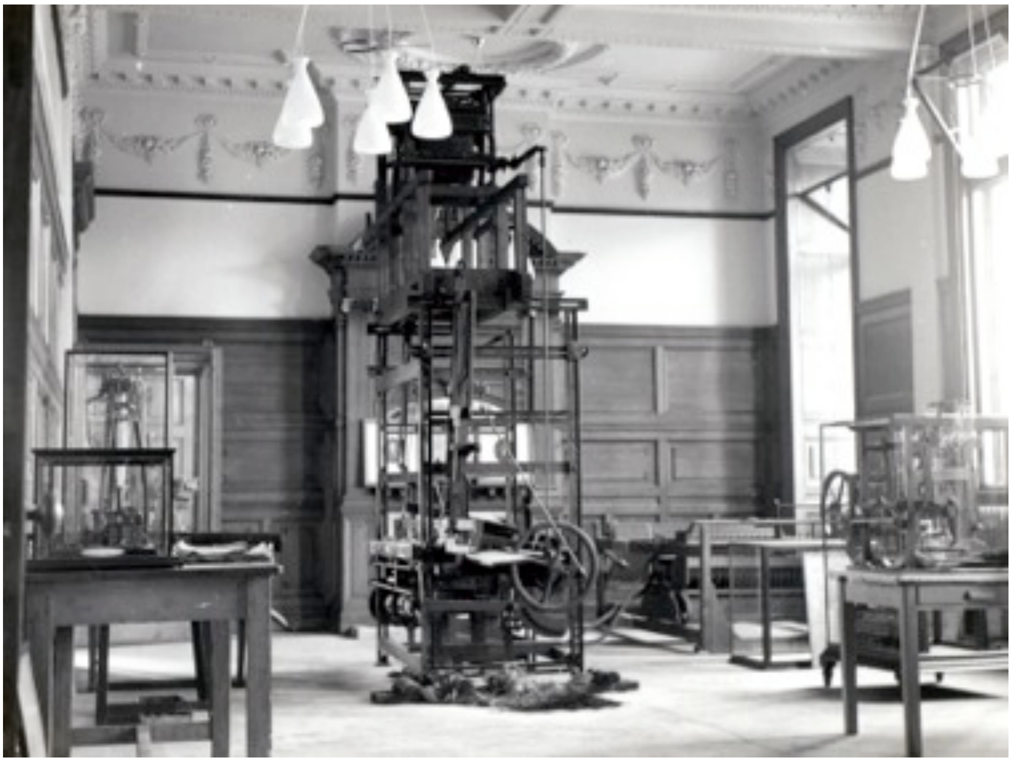
Early Exhibits

A small temporary workshop was established in the basement of the Rosamund Street chapel in the summer of 1968 while the basement at Grosvenor Street was cleaned and repainted ready to receive the archives, principally those of Beyer, Peacock, stores and a photographic dark room where Harry Milligan, the Central Library photographer, worked after his retirement. The technicians had to be diverted during the summer to dismantle the Haydock beam engine in order to save that. This was always a dilemma, how much effort should be channelled into collecting exhibits that could never be displayed at Grosvenor Street yet were essential for the future. This was particularly the case with the Elm Street Mill engine because so much of Frank Wightman's time had to be spent at Burnley while we were endeavouring to prepare for the opening of the initial displays. In the end, collecting these major exhibits for the Power Hall has been justified through the popularity of those engines running under steam. At the same time, the Charles Street railway arch store had to be vacated, wasting time moving those exhibits.

In March 1969, the fire precautions at Grosvenor Street were completed so that the first Governors' meeting could be held there on 18 April. The Manchester Town Clerk's department handled the official secretarial side of running the Museum while the financial side was covered by the Bursar's department at UMIST. These arrangements meant that the day to day Museum administration could be handled by one secretary. Owing to the limited staffing, it was suggested that at first the Museum should be open only for organised parties but finance was raised to fund two more porter-cleaners so that the Museum could be open five days a week to the general public after the initial opening on 20 October 1969. For a long time afterwards, people thought that the Museum accepted only parties.

The Official Opening

The Manchester Museum of Science and Technology was opened by Lord Hervy Rhodes of Saddleworth, Lord Lieutenant of Lancashire, in the presence of Lord Bowden and other dignitaries from the constituent authorities. Alderman Bobby Rogers was the Chairman. What did they see? On the ground floor was the unfinished Newcomen engine, a couple of small steam engines, the three Crossley engines, the Royce car engine, Rolls Royce Merlin and Derwent aero engines, the horsewheel and papermaking exhibits. On the first floor was the lecture room and textile display together with the general and director's offices. Another small room was used for temporary displays, at first on Beyer, Peacock. For the opening, the top floor was laid out with replicas of Joseph Priestley's chemical and electrical apparatus. There was the collection of Joule's apparatus for his thermodynamic experiments. J.B. Dancer's microscopes, telescopes, etc. and Foxall & Chapman's photographic collection. For the opening, a collection of working model steam engines was borrowed from the Mechanical Engineering Department of UMIST. The Librarian of Eccles kindly sent a list of spelling mistakes on the labels. At first, the top floor was closed to the public until the New Year 1971 owing to lack of showcases for the exhibits.



Textile Gallery in Grosvenor Street before opening with calico printing left, ribbon loom centre and replica slubbing billy right.

Power Gallery in Grosvenor Street before opening with left to right, Rolls Royce Merlin, Crossley atmospheric in background and steam engine models to right.

Pressure on the small number of staff running the Museum was eased in October 1969 by the secondment of Robert Bracegirdle, Research Assistant in Colour Chemistry, from Prof. Cardwell's Department. Numbers of school parties increased so that in September 1970 Robert G. Manders was appointed teacher-in-charge, funded by the Education Department of the City of Manchester. That November, a Senior Porter was appointed to cope with opening the top floor. With these additional staff and extra displays, the number of visitors in the year ending July 1971 rose to 10,113.

Collecting exhibits continued, made easier by leasing a good store at Oporto House, Stelling Street, Gorton, in June 1971 from the City for three years. By this time, the collections were assuming more than local significance. Just before Christmas 1971, the Museum was visited by Mr. T.A. Walden, Director of Leicester Museums, and Miss M.K. Weston from the Science Museum to prepare a report on the future of the Museum for the Carnegie United Kingdom Trust. In June 1972, members of Lord Eccles' committee studying the needs of provincial museums were impressed with the progress made. The importance of the Museum was recognised by the Joint Committee changing the name to The North Western Museum of Science and Industry in May 1972.

By this time, visitor figures had topped 15,000 per annum and the displays were becoming dangerously overcrowded. When the Museum had been established in 1968, it was envisaged that the Methodists would occupy their share of the building for only a couple of years until the new chaplaincy was finished. But by the beginning of 1972 there was no date envisaged for completion. Therefore the original agreement had to be terminated and the Methodists were able to find alternative accommodation in the Roman Catholic chaplaincy. The Museum was able to occupy the whole of Grosvenor Street from July 1972. However this good news was overshadowed by the City repossessing the store at Stelling Street. After much searching, Constantine Lloyds offered part of their premises at Newton Heath. This was much poorer but had to suffice. Having to move the exhibits once more wasted time, money and effort, as well as damaging some pieces.

Museum Occupies All Grosvenor Street

Being able to occupy the whole of Grosvenor Street opened the way for displaying the major part of the exhibits. This was assisted through the appointment of Mr. R.G. Manders as Deputy Director in September 1972, slightly easing the staffing shortage. The Newcomen engine had been finished for some time and was demonstrated regularly. A small steam boiler was installed in the back basement so that two small steam engines could be run under steam. The Metropolitan-Vickers steam turbine was also fitted into the space vacated by the internal combustion engines. The steam supply was carried through into the papermaking area for the small paper machine and the floor here was waterproofed with special non-slip linoleum so that papermaking by hand could be demonstrated.

Machine tools were exhibited in the two central sections of the ground floor. Steel girders were inserted into the ceilings so that some of the tools could be driven off overhead lineshafting. Onto the other section of the ground floor that was solid, we moved the internal combustion engines. This coincided with the change from town to North Sea gas. Dr. K.A. Barlow was able to convert most of the engines to work on this new type of gas with the exception of the atmospheric gas engine. Some of the other later engines could also be run.

The extra space at the rear of the building was just large enough to fit in the shortened spinning mule that we took out from Elk Mill. It was also possible to include a carding engine so it was kept in dry conditions for a future museum. A roving frame was shortened and motorised so it could supply rovings for the mule and 1901 ring frame. Earlier methods of spinning on the Jenny and waterframe were fitted in as well. The mule and roving frame were mounted on steel subframes so that they could be moved to a new museum without having to be completely dismantled. This foresight has been well justified because these machines have been moved twice at Liverpool Road.

Towards the front of the building, a small display was arranged to show the development of electric generation with working dynamos lighting up light bulbs and an arc lamp. In the front room, the printing presses were installed so that the transition from hand presses through treadle platens to a flat-bed Wharfdale could be explained. These were demonstrated regularly and were used to print items for sale as well as posters advertising our Working Days and temporary exhibitions.

Extra rooms on the first floor at the back of the building became staff rooms, the main office and the Education Service office, thus freeing the original offices for small electrical exhibits. The original textile room concentrated on weaving, with the large hand loom, Jacquard hand loom, calico power loom and Jacquard ribbon loom. A Leesona pirn winder was adjusted to supply the packages of weft for the various shuttles on the looms. A small circular knitting machine and a braiding machine could be operated by the visitor through push buttons. There was also a display on calico printing.

Saturday Opening and Working Days

While it took time to fully utilise the additional space, it was decided to open Grosvenor Street regularly on Saturdays from 17 November 1973. By July 1974, visitor numbers had risen to 10,744 casual visitors and 6,678 in parties, making a total of 17,422. It was noticed that pupils in school parties often returned later with their parents. Because the gas supply was due to be changed to North Sea gas, in case these engines could not be converted, it was decided to run the engines on three Saturdays in May and June 1975. This proved to be so popular that it was agreed to hold 'Working Saturdays' once a month when as many of the exhibits as possible would be demonstrated with the help of volunteers from the Manchester Region Industrial Archaeology Society. These 'Working Saturdays' became exceedingly popular. Special ones were held on New Years Days when in 1976 a record of over 2,000 people came. Total visitors in the year ending July 1976 were 25,702 casual and 19,393 in parties, giving 45,095 in all.

New Constitution Includes GMC

In July 1975, there were sixteen Museum staff which included four technicians, one of them being photographic, and seven portering staff. A woodworking technician was recruited in March 1976. While the total budget for 1975 was £62,500, this had almost doubled to £121,669 for 1976. The rise reflected the new constitution agreed in 1975/6 with the newly formed Greater Manchester Council. The GMC provided

5/12, the City of Manchester 2/12 and the Universities, which now included Salford, 5/12. The general economic prospects stopped any proposals for a new building so it was decided to rehabilitate Grosvenor Street. Cleaning the exterior revealed a dramatic frontage. With the construction of the University Metallurgy Building at the rear finished, the land around the Museum was landscaped where the Museum's Lancashire boiler was mounted on the bed of the Barnes Mill engine. The roof was repaired, new electric mains brought in and much of the interior redecorated. Sale of a small range of light refreshments was started. Work continued with improving displays so that in 1977 visitor numbers rose to 62,666 including 37,869 casual. In 1978, the total was 69,902, probably the highest recorded for Grosvenor Street in a year.

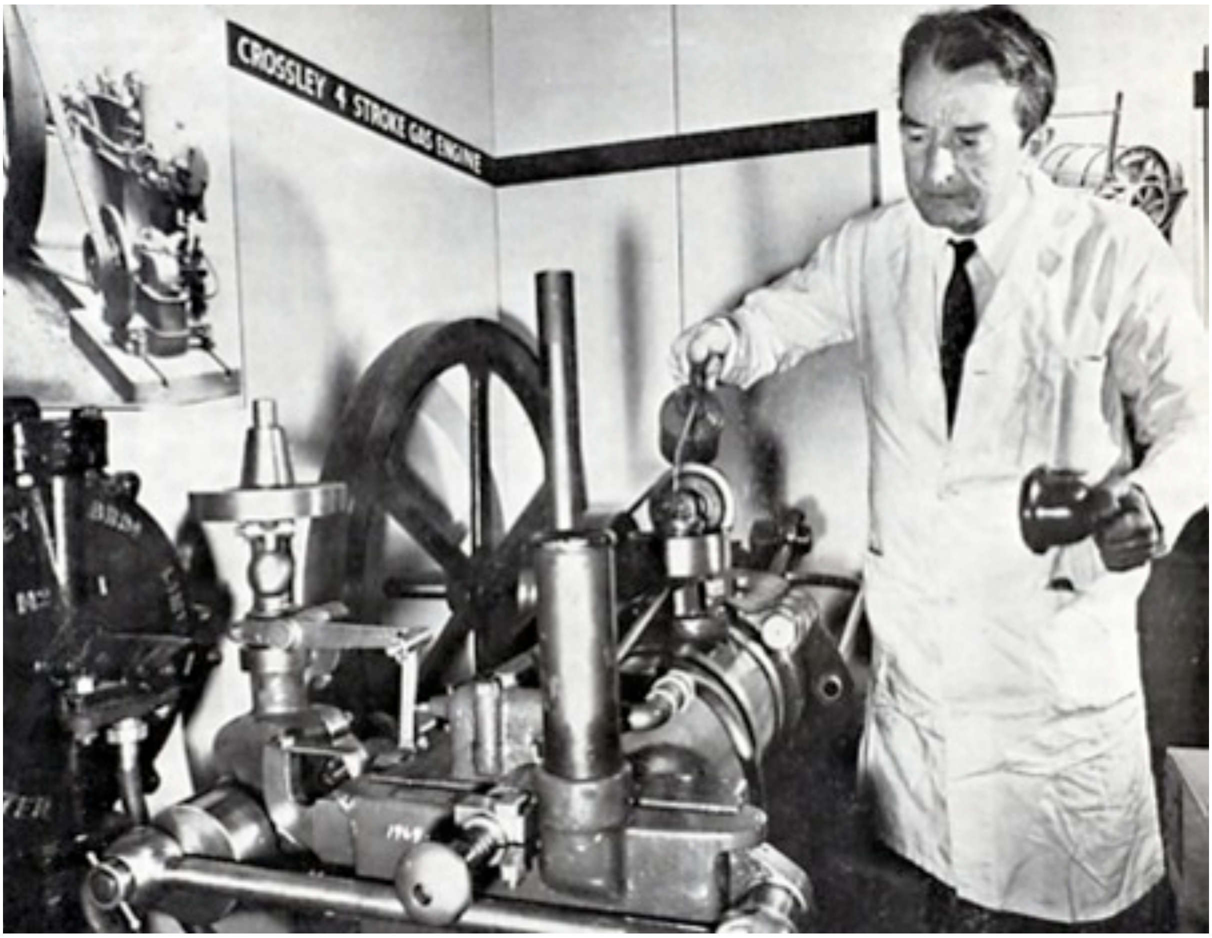
What was Achieved?

The visitor numbers for the first full year of opening on weekdays only in 1971 was 10,113. In 1978 this had risen to 69,902. The initial annual budget was £12,670, rising to £124,357 in 1977. By then we had appointed an Archivist, Christine Heap, and an assistant secretary, making a total staff of seventeen. We had acquired a remarkable collection of exhibits with a great many in store. These covered a wide range of industries with many historic working machines. Not only were machines put back into good order and the skills learnt how to operate them but they were also ready to be moved to a new museum. From 1980, the staff had to concentrate their attention on developing the new home for the Museum at Liverpool Road Station. Working Saturdays ceased so that visitor numbers tailed off in 1983 to 43,000. Grosvenor Street closed its doors to the public on 22 July 1983 by which time there had been 560,000 visitors since opening in 1969.

Chapter 2. Problems Facing The Museum.

Storage

How do you start a science museum from nothing? One problem was how to acquire sufficient exhibits to make a reasonable initial display and what to do with them until there was somewhere to display them. People and companies might offer suitable exhibits and offer to retain them until there was display space available but this rarely happened. Generally an exhibit was offered because the firm was closing down and vacating the building. Hence if an exhibit were to be saved, secure storage was a necessity. This was made more difficult through a non-existent budget for storage as well as not knowing when any exhibit might be displayed. Another problem was that the collections had to be based on the industries of the region and that meant collecting items of comparatively heavy engineering. This in turn should have meant reasonable vehicular access for lorries as well as lifting facilities. The places we had to use lacked such amenities. Most places were only temporary solutions so some exhibits had to be moved three or four times.



Sid Barnes, chief technician, preparing the Crossley four-stroke engine for demonstration.

The first store was one of the railway arches on Charles Street which we retained until the UMIST multi-storey car park had to be built in front of it. Most of the rain percolating through the brick arch was diverted by a layer of corrugated iron sheets but atmospheric conditions were far from ideal for preserving any exhibits of wood and iron. A small loading bay did assist with unloading but everything had to be manhandled to its temporary resting place. Another early store was one of the houses on Rosamund Street, later demolished to make way for the student residences of Grosvenor Place. Steps up to the front door meant it could be used only for lighter parts of machines such as a spinning mule. It had a yard at the back where mill engine parts found a temporary home as it could be accessed by a mobile crane. Near-by was a chapel in which we were offered the basement. Access for exhibits was through a small door onto the street and down a steep ramp. It was in this basement that the first workshop for the Museum was established and exhibits prepared for display in Grosvenor Street.

That brings us to Grosvenor Street itself which had been built for meetings and offices. We were able to occupy the loading bay at the rear that was quite extensive. Part was turned into a metal workshop and part for woodwork. Above the loading bay, we were able to install an overhead gantry. The main beam on which the pulley block travelled stretched right across from the loading bay door to the wall on the other side of the workshop. This enabled a small lorry to be reversed in, an exhibit picked up and carried across to the floor at the back of the workshop. From there, further movement was by skates or the like and brute force. Block and tackle suspended from the gantry enabled us to assemble exhibits for display both for Grosvenor Street itself and later for Liverpool Road.

Access to the basement stores at Grosvenor Street was by wooden stairs at the rear or the main stairs at the front. Therefore all the archives and smaller exhibits not wanted on display had to be carried down. It was impossible to install any lifting apparatus. What health and safety would say today about our methods as well as access for the disabled is best left to the imagination. Once we were faced with the dilemma with how to unload the 4ft. diameter piston of the atmospheric steam engine from Reelfitz Pit, Bridgefoot, Cumbria. A local haulage contractor offered to deliver it for us. It arrived on a long open flat articulated lorry. There was no hope of getting the lorry into one of our other stores nor round the back at Grosvenor Street. So the lorry was parked on the pavement outside the front door, planks stretched across from the lorry to the main steps and the two parts of the piston slid across. The chip marks in the steps can probably still be seen.

When the Museum was finally established, many offers of exhibits were received which could not be accommodated in the existing stores and in any case many were too large to fit in. Appeals were made for storage areas. It was difficult to convince people of the size and weight even of some of our smallest exhibits. The Estates Department of the City suggested the arches under Victoria Street outside the Cathedral. There used to be public toilets underneath. The only way to get down the cylinders of the mill engines would have been to crane them over the River Irwell and haul them horizontally across. Another suggestion was the magnificent St. Georges church where the Mancunian Way passes under Chester Road. The entrance doors were too small to allow access for lorries or even small mobile cranes. One place offered was the top floor of a mill in Rochdale. Our mill engine parts might have fallen through the floor onto the racks of pet food stored there. Another was one of the stores near Bury which had been part of the Ministry of Defence workshops in the Second World War. I was given a cup of coffee in the gatehouse and noticed the teaspoon was blackened in a peculiar manner. I turned it over and saw silver marks. Presumably it had once graced the officers' mess. Our budget did not extend to their prices.

The situation was temporarily solved by the offer from Vita Foam of a store in a mill up one of the valleys beyond Rochdale. It was well away from scrap dealers so fairly secure. Access was reasonable but it was a long way from the Museum in Manchester. Here parts of the Elm Street mill engine and papermaking exhibits were carefully tucked away. But our good fortune did not last long and we had to move out.

Then we had a more convenient place in Gorton at Oporto House, Stelling Street. The single storey weaving shed had been used as a bakery so had a nice smooth tiled floor. It was well lit with its north light roofing. As a bakery, it had been quite well protected against vandalism. Reasonable size lorries and low loaders could access the yard while the small 5 ton mobile Iron Fairy cranes could get inside. The larger engine beds and the little Lancashire boiler were left outside. Its proximity to Grosvenor Street enabled us to do some maintenance work on the exhibits. We purchased a mobile gantry with block and tackle which was a help unloading parts as well as assembling some exhibits. This proved to be an invaluable piece of equipment at Liverpool Road.

But once again, our luck did not hold because this site was wanted for redevelopment. All we could afford was part of Constantine Lloyd's packing works at Miles Platting. Once it had been part of West's Gas Equipment foundry. The broken roof lights were filled in with boards. It was far from ideal, with earth floor, leaking roof and little light. An entrance door had to be cut in the wall to give access from the road and a ramp installed. Medium size lorries and low loaders could only just back down this ramp but not into the main storage area. An Iron Fairy had to be positioned inside first before any unloading could commence. Its movement raised clouds of dust. It was a depressing place, causing much deterioration to the exhibits. Yet, without it and the exhibits stored there, the present Museum of Science and Industry in Manchester would be the poorer today.

Moving The Exhibits

Science and technology exhibits may range in size from a glass slide for a microscope to an aircraft or a railway locomotive weighing over an hundred tons. From the very beginning, it was realised that exhibits must be saved for a future permanent home even if they were too large to fit into 97 Grosvenor Street. Because in the early days it was not envisaged that the Museum would have a large transport collection, the main emphasis would be on power sources for industry, and, in particular, the textile mill engine. Representative examples of medium size ones would be collected. These could be separated into parts that could weigh up to five tons or more. Hence appropriate lifting tackle would be necessary and people with appropriate skills. Gradually the Museum acquired its own chain blocks, pull lifts, turfas, slings, hydraulic jacks, skates and so on. Tangye's five ton hydraulic jacks were compact, light and easy to use. Our mobile gantry was another great asset.

Chief Technicians

Frank Wightman

Without skilled leadership, such as Frank Wightman our first chief technician, much of the Museum's collections especially the mill engines would not exist. The three main engines, Haydock, Barnes and Elm Street would have been scrapped. It is a typical British under-statement that Frank had a passion for mill engines. He had been brought up in Ardwick and used to go swimming with his friends in the near-by canals. They would shut the bottom gates, fill up the lock and lo and behold their own swimming pool until they were chased away by the lock keepers. He was probably an apprentice at George Saxon, engineers and mill engine builders of Openshaw. He must have been trained in the drawing office as well as in the machine shop. It is a pity that there was a dispute about ownership and copyright of his drawings on his death because he sketched local scenes of the Ancoats, Ardwick and Belle Vue areas in a sort of Lowry style. The Greater Manchester Record Office would have charged too much to make it worth anyone's while publishing them.

Frank always called himself a millwright through being a good all-rounder, able to draw as well as work with wood and metal. However his experience was very different from most millwrights. When driving into Norfolk, I took him to see the 8-sailed Heckington windmill. It was his first visit to a windmill and he was amazed at its massive shafting and gears. He became chief millwright at Greengate & Irwell Rubber Factory in Salford. He was a familiar figure in his black oily beret and blue denim overalls covered in grease. Most of his friends also had links with engineering, particularly textiles, and shared their enthusiasm with others. One such was little George Watkins from Bristol who photographed so many mill engines.

Frank came to us with his millwrighting tackle. How much of it was 'borrowed' we never asked. For example, there was the wooden ladder he borrowed from Greengate so he could decorate the front of his house. The postman called and, as Frank was descending, the ladder broke three feet from the ground. Luckily he didn't fall very far. Normally Frank was very thorough and took few risks in spite of the heavy lumps he had to move. Most of his tackle was old-fashioned but his loan of it helped the Museum to get started. For example, his Duff Norton jacks lifted through a ratchet mechanism. To lower, you had to raise the head, free the catch and then lower which could be difficult. His heavy chain blocks were excellent for being suspended overhead and giving a direct lift but very difficult for pulling horizontally. He also had a 15 cwt. lorry which was invaluable for moving equipment and small exhibits. Perhaps his most vital pieces of equipment were his bridge rails on which parts could be slid out of a building to be lifted by mobile cranes.

Frank was very loyal, but, if you asked him about removing an exhibit, he would never say it couldn't be done. Removing the Barnes and Elm Street mill engines was a challenge to his millwrighting ability, so he accepted such tasks, stretching our meagre resources of manpower and money. Examples were the supporting frames for moving the crankshaft and one flywheel half of the Elm Street engine which had to be specially fabricated and welded. Luckily he was able to design such equipment and, if necessary, make it for he had his own oxy-acetylene welding and cutting equipment. I tried to insist that there were always two men on the job. One time, our Senior Porter volunteered to help at the Barnes Mill because our other technician, Harry Applebee, was suffering from a bad back. I learnt a lot by helping from time to time as well as going to the various sites to see that everything was proceeding satisfactorily. I was always amazed at Frank's strength. He had a back/stomach belt and could lift very heavy parts as well as work long hours. The present Museum's collection of mill engines owes its existence to Frank. The Northern Mill Engine Society published a small biography about him.

Sid Barnes
Frank Wightman was replaced by Sid Barnes. He had served in the Royal Navy in the Second World War. He had the great asset of being trained in both mechanical and electrical engineering. Through his skills and enthusiasm, the various visitor push-button demonstrations were prepared. He pioneered some with sequential switching. He also had a wicked sense of humour and was able to lead and inspire the many men on Community Industry schemes working under him. His experience carried the installation of the mill engines and other exhibits to a successful conclusion. At one time, he was supervising restoration work with Community Industry labour at Grosvenor Street, Gaythorn Gas Works, Beyer, Peacock's old boiler shop at Gorton as well as at Liverpool Road itself. He well merited the award of an M.B.E.

Museum Transport
One of the first vehicles used by the Museum was UMIST's Ford transit van. It went to North Wales to bring back a cast iron horse wheel from Waenfawr. Another load was the Whitworth planning machine given by Arthur Bebbington at Crewe. Rolls of Beyer, Peacock drawings were carried in the van from Gorton back to UMIST while other archives came from there in my 1924 Lancia Lambda. A local transport firm, Buckleys, had a small lorry of about a ton capacity which was very useful as it fitted inside the loading bay at Grosvenor Street. For large exhibits the 5 ton mobile Iron Fairy crane was used extensively. However, on one type, the crane had only a limited sideway reach which was a disadvantage in our stores. When unloading the Lancashire boiler at Stelling Street, its weight set the overload bells ringing on the crane so that its rear wheels were in danger of lifting. With the help of a counterbalance in the form of a couple of museum technicians, the boiler was successfully lifted off a Pickfords' low loader.

Pickfords' Heavy Haulage based at Farnworth gave invaluable help with heavier exhibits. The manager was very interested in the Museum and arranged very favourable quotes. It sometimes happened that a vehicle was returning empty to Farnworth and could be diverted to pick up something for the Museum. This is how the Lancashire boiler was delivered from Holt near Trowbridge to Manchester. We were fortunate that one of Pickfords' heavy trailers just fitted into the loading bay at Elm Street Mill where it could be left a few days while a ramp was built on it down which parts of the engine could be slid. Parts of this engine remained for a while at Farnworth until suitable storage could be found. Another example was the storage of 'Pender' in a container on their site between bringing her back from the Isle of Man and refurbishing her at Gorton Foundry.

We soon leant how to assess access for vehicles to difficult sites, turning circles, length of lorries, reach of mobile cranes, etc. It seemed be difficult to get the right lorry and the right crane to the same site at the same time. The art of slinging difficult shaped pieces had to be learnt to avoid anything slipping, and of course the art of estimating weights. Some of these problems will be covered with the appropriate exhibit.

Museum Mural

The Greater Manchester Council decided to brighten up some areas by sponsoring murals to be painted on the blank ends of buildings. When the Metallurgy Building was completed, the builders' site huts were removed from the land between 97 Grosvenor Street and Upper Brook Street, leaving that side of the Museum building exposed. The GMC agreed to sponsor a mural on this wall.

The Museum always had a storage problem for its exhibits, particularly the heavy parts for its mill engine collection. One such was the flywheel of the Durn Mill engine which was a single casting about 12 ft. diameter. It would not fit through the door into the store at Constantine Lloyds. Where to put it? The answer was to lean it against the wall of 97 Grosvenor Street, hidden by the site huts. When the huts were removed leaving the wheel exposed, someone rang and asked if it came off a Roman chariot!

Storage of a couple of other large bits still remained a problem. UMIST agreed to incorporate them into landscaping the area between the Museum and the road. One part was the main bed of the Barnes engine containing the low pressure cylinder mounting and crosshead slides. As the ground was very soft, a couple of spare concrete pipes were sunk vertically and filled with concrete. The bed was placed across them. Then the little Galloway Lancashire boiler was placed on top of the bed with painted on it the name, 'North Western Museum of Science and Industry'.

The mural itself, designed by Ken Billyard, would feature objects to be seen in the Museum such as the Newcomen engine, spinning mule spindles, a planning machine and much more. Then tragedy struck. Ken was sitting in the front passenger seat, being driven with the window open. The driver failed to notice an iron bar sticking out of the rear of a parked lorry. As the driver pulled out, the bar came through the window and struck Ken on the head, killing him. Walter Kershaw agreed to paint the mural as a memorial to Ken.

The wall was rendered to give a smooth surface and scaffolding erected. One fascinated observer was the cat belonging to the Museum caretaker which sat for hours on the fire-escape. So Walter incorporated puss into the mural. Most of us thought this added a touch of humour into the picture but Ken's parents objected, asking for it to be removed. Walter duly obliged, but touched it out with a slightly different coloured paint, leaving the ghostly shape of the cat still to be seen.

When the mural was almost finished, Walter pointed out that Ken's design did not cover the highest point of the wall near the front of the building. Might he incorporate the name of the Museum up there? It was Friday afternoon. I said I had not heard him, knowing full well that this would turn the mural into an advertisement for which we did not have permission. I said I hoped he would finish painting the mural over the weekend and I looked forward to seeing it on the Monday with the scaffolding removed. When I arrived on the Monday morning, I admired the mural, complete now with our name on it. Then about ten past nine, the phone rang. Someone from the Town Hall was enquiring about whether we had permission for the Museum's name to be included. I said that it had appeared over the weekend while I was away. We heard no more about it and, in any case, I was not going to have all the scaffolding re-erected to paint it out.

Chapter 3, The Power Hall At Liverpool Road.

Planning The Power Hall

The early years of collecting exhibits culminated at long last in the development of the Power Hall at Liverpool Road Station and planning its layout. Once the Goods Shed and the adjoining railway track under the gantry had been acquired, the best access to the whole site was the entrance from Byrom Street. Accordingly a new brick entrance hall was built facing onto that street adjacent to the Goods Shed into which a new entrance was built turning it into the Power Hall. It was decided to have some impressive feature on the pavement outside. Ferranti were vacating their Hollinwood site where a pair of pillars from the original Deptford Power Station of c. 1888 had been taken for preservation. These were offered to the Museum and duly installed. The Deptford building itself must have been even more impressive in height because these two columns now reach up only as far as where the rails for the overhead crane would have been fixed and there would have been an even higher section supporting the roof. The sort of mock gearwheel is obviously not part of the original Deptford Power Station.

A Crossley two cylinder horizontal engine with flywheel in between the cylinders.

The other exhibit outside is a two cylinder horizontal Crossley engine. It was removed for preservation with the help of a grant from the Science Museum Preservation Fund as it must be one of the few engines with flywheel between the twin cylinders to have been preserved. Our original intention had been to display it in a glass case and turn it over with an electric motor. However this scheme was vetoed by the Museum designer on the grounds that such a structure would be out of keeping artistically so the engine now languishes, static with several parts having been vandalised. The grant had to be returned.

Originally the interior of the Goods Shed was laid out with a pair of adjacent railway tracks running the full length of one side. The railway wagons were unloaded onto a central wooden platform also running the full length. Road vehicles could access this platform from Liverpool Road itself through large doorways. We fitted these with glazing so the exhibits could be viewed from the road. The rail tracks entered the Goods Shed on a series of brick arches but towards Byrom Street these gave way to solid ground. This area was the only part of the whole site capable of supporting the massive foundations for the mill engines. To save excavating deep pits, it was decided that the mill engines would be viewed from the platform level. The rail tracks were cut short to accommodate the mill engine layout. The remaining part of the platform would be narrowed and the tracks splayed to give a better space between them to view railway exhibits. A ramp down from the platform on the road side had to be installed for disabled access. Access for exhibits lay through doors at the corner of Liverpool Road and Byrom Street. At the other end, the rail tracks themselves provided one entrance to one side of the platform while on the other a large door was left for access. Immediately outside this end, fronting onto Liverpool Road was an office block with large upstairs room taken over by the Education Service.

In the Power Hall, the exhibits were laid out in historical order according to subjects. On entering from Byrom Street, it was possible to look down the full length along the side where the rail tracks had been. We had a small model made to show what the Goods Shed would have looked like with railway vans being unloaded. The visitor next passed by two exhibits showing natural sources of power, the horse wheel from Waenfawr and the waterwheel from Otley. We had a fibreglass horse linked up to the horse wheel but someone said it was the wrong type so it was later removed to the chagrin of children. The basin for the waterwheel had coins thrown into it – good luck to the visitor or the Museum? To the right was the outer wall of the Haydock engine towering up into the rafters.

The Power Hall had been crossed to the Liverpool Road side where a space was left for parties to assemble in front of the 1/3 scale replica of Thomas Newcomen's engine of 1712, the first successful heat engine in the world. The size some of these atmospheric engines reached was shown by the cast iron piston from the Reelfitz Pit pumping engine c. 1780 located in a coal mine near Cockermouth. In this corner could be demonstrated various ways in which the power of the atmosphere itself could be used. In the case of the Newcomen engine, the pressure of the atmosphere pushed the piston into a vacuum created by the condensation of steam. The two hot air engines showed the expansion of heated air and its contraction by cooling. In the atmospheric gas engine, a charge of gas and air was ignited that forced the piston up fast enough to create a partial vacuum underneath into which the atmosphere could push the piston down again. This was the first really successful internal combustion engine.

At this point, the story divided, to the right, steam engines and to the left internal combustion engines. The centre piece of steam power was the Haydock engine showing James Watt's development of the first successful rotative steam engine. Again, a party could be gathered round here before deciding which of two routes to go. One went past the single cylinder Durn Mill engine also passed some electricity generating engines before coming to the Elm Street Mill engine. The other went past the compound Barnes Mill engine with its Corliss valve gear to reach the other side of the Elm Street Mill engine. At this point we had rival sources of power in the form of the Uniflow Elm Street Mill engine with rope drive, the alternator on the Ferranti inverted vertical cross compound, the Metropolitan-Vickers steam turbine, the Mirrlees air blast diesel engine and the National single solid fuel injection diesel engine driving its generator. This was a wonderful display linking all these power sources.

By this time, the internal combustion engine display along the Liverpool Road side had, as it were, caught up with the mill engines. History here was outlined by gas and oil engines from Crossleys. The display originally led into one or two early motor car exhibits including the Royce two cylinder engine and a Manchester built 1904 Belsize. Back in the centre, the visitor moved onto the original wooden platform with the rail display to the right. On the platform there was some equipment illustrating hydraulic power. Then followed items of early electrical equipment for trains with locomotives on the other side. On the further track were steam railway locomotives. It had been hoped to start the rail display by the mill engines with models of early locomotives leading into those of the Liverpool & Manchester Railway. Then came steps down to rail level. These were demountable so that a lorry could be backed along the rail tracks and positioned below the overhead crane for moving mill engine parts for repair. It had been a struggle with GMC officers to install these cranes on either side of Power Hall above the mill engines because they had no conception of the weights of even small parts and the difficulty of fitting them. These cranes have certainly earned their keep subsequently.

Dr. Richard Hills showing Her Majesty Queen Elizabeth II the Belsize motor car during her visit to Manchester in what would become the Power Hall.

The steps down have provided a sitting or standing area for groups to view the sectioned Isle of Man locomotive ‘Pender’. The idea was taken from the Swiss Museum of Transport at Lucerne. Passing round ‘Pender’, the visitor viewed the other rail exhibits. In order not to compete with York Railway Museum and to contribute another aspect to the railway preservation scene, it was decided to concentrate on exhibits that had been exported. This could be linked to locomotive builders in the region that had sent so much of their production abroad. At the end of the Power Hall, some of the railway signalling equipment was displayed initially. It was hoped to install a signal box at the exit door with a lever frame to operate some signals on the running tracks with block instruments as well.

Exhibits in the Power Hall

Natural Sources of Power
In the Manchester region, there was extensive use of natural sources of power in the early Industrial Revolution. For spinning cotton, wind was too unreliable although Samuel Oldknow had a windmill at his mill on Hillgate in Stockport. I therefore decided not to include wind power in the Museum.

Horse power
On the other hand, horses were used extensively both for transport hauling barges and carts as well as for working machines in mills. When we were offered a horsewheel from a farm in North Wales, I decided to accept. It had turned a chaff-cutter and a butter churn. We borrowed the UMIST van and drove to Waenfawr just south of Caernarfon. The wheel was cast iron, made in North Wales. It had been situated in a compound outside the barn with a low shaft connecting to gearing inside. Even though it was a small, low wheel, the parts were quite heavy but, with the farmer’s help, we were able to lift them into the van and return home in triumph. The draw-beam pulled round by the horse just fitted into the van. Back at Grosvenor Street, it proved to be a very useful exhibit because, although there was no space to display it with a full circle, we were able to arrange it so it could be demonstrated to school parties by turning it only a little way. This was possible because it incorporated a ratchet, presumably to prevent the draw beam hitting the horse’s legs should the horse suddenly stop. It was displayed at Liverpool Road but later given away because it had not been made locally. Yet the chaff-cutting machine that went with it was kept.

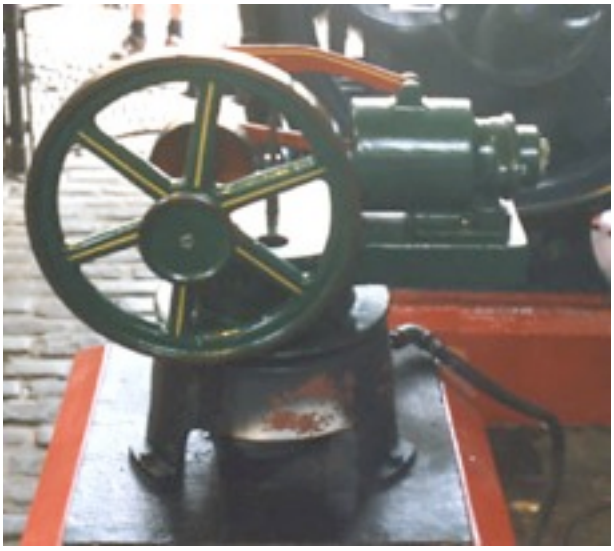
Waterpower
In early cotton spinning mills, water was the main source of power. To incorporate a waterwheel at Grosvenor Street was obviously a non-starter but once Liverpool Road became the definite choice, a waterwheel in the Power Hall would remind people of this natural source of power. We were fortunate that B. & S. Whitley, near Otley, were rationalising part of their paper mill and offered a small waterwheel for the National Paper Museum collection. I went over to see it and found it was a cast iron wheel made in two halves. It could be reached by a crane so it could be easily transported back to Manchester. A bed was designed for it incorporating a small pool of water. Originally we installed a pump and electric motor to recirculate the water to turn the wheel but this did not raise enough water. We found we could turn the wheel through its gearing with another electric motor so that the float boards splashed into

the pool which gave an effective look. We also put on display a small Pelton wheel made by Gunters of Oldham to show a later industrial type.

Hot Air Engines

The cold end of the Bailey hot air engine with operating mechanism, the furnace was situated to the left.

When heated, air expands and contracts when cooled. This could be used to move a piston in and out of a cylinder to drive something through suitable linkages. The power developed was minimal because the air had to be circulated from the heat source to a cold part by a second displacer piston. We acquired two types, the larger made by W.H. Bailey of Salford and later Eccles, based on the Lehmann principle. The advantage claimed for it was that virtually anything burnable could be shoved into its furnace to heat the end of a large cast iron horizontal cylinder so that the air inside expanded and pushed out the power piston at the far end. The piston was linked by rods to drive a flywheel and so the machinery as well as the displacer piston, a sort of large tin can. As this displacer piston moved back into the heated end of the long cylinder, it pushed the air from the hot end into the water-cooled part at the power piston end, so allowing that piston to return. This engine, about 6 ft. long and weighing around a ton, probably produced less than one horsepower. We were approached by a person who wanted to build one of 15 horsepower so we pointed out how large such a one would be. This engine was probably presented by Bailey's so we painted it in the correct shade of Bailey blue which has since been changed to a dreary dark grey. It came complete with framing and door for the brick furnace so it could be displayed in the way it would have been set to work. Let us hope these additional parts have survived. We also produced a leaflet about it.



The little Robinson hot air engine. The displacer piston is placed underneath.

The other hot air engine was sometimes called the Robinson type. The smaller power piston was horizontal coupled to a crankshaft and through further links to the vertical larger displacer piston. This might be cooled by either air or water. The heat source generally came from the local gas supply. Such engines produced only a fraction of a horsepower but were useful for driving extractor fans or in some cases an extraordinary contraption of a rotary hair brush for men's hair driven by a long elastic rubber rope. Small electric motors, once they became available, soon replaced these little hot air engines.

Hydraulic Power

The Victorians developed an ingenious system of power distribution from a central generating station using water under pressure. While Manchester was comparatively late developing this, for it was not introduced until the 1890s, the system launched by the City authorities had the high pressure of 1,000 p.s.i. This was used in many of the warehouses to work the cloth baling presses, lifts, loading cranes as well as to wind the Town Hall clock, raise the safety curtain in the Opera House and much more. It became quite an extensive system with three pumping stations and a distribution grid through cast iron pipes laid below the streets. It was made possible through William Armstong's invention of the hydraulic accumulator which helped to equalise the pressure and iron out fluctuations in demand. This had to have a place in the Power Hall.

Initially a small display was planned at the start of the platform that remained unfinished when I had to leave. From the Avon Moseley Rubber Company came a Bellhouse hydraulic twin ram pump, originally hand-operated but which had been converted to work off lineshafting through the addition of two side frames supporting an overhead crankshaft. I wanted to motorise this so it could be a source of hydraulic pressure to work exhibits. The City of Manchester Waterworks Department presented samples of the massive cast iron pipes used to distribute the water. A pipe joint was cut away to show how they were connected with a spigot sealed with a gutta percha ring. To split the joint, the pipe had to be lifted up which required a long trench to be dug in the road. This caused much disruption of traffic and that, together with rusting and so weakening of the two securing bolts, were reasons for the demise of the system. Another exhibit was the water meter in a massive cast iron casing. Each customer had to have one. They were trundled through the streets on a handcart. Preservation of a cloth baling press was impossible through its size so instead we acquired a small Tangye press.

From an office block in Marsden Street, we rescued a lift cage with fine mahogany panelling. While this got as far as the Constantine Lloyd store, it never seems to have reached Liverpool Road. It was preserved because it was an early type and had survived in spite of having only one safety feature. It was situated in the well of an open staircase and worked by an hydraulic jigger and wire rope. The cage itself had no inner doors so a passenger could stick out a hand or a foot and get it trapped between floors. The wrought iron gates on the landings could be opened by anyone at any time, whether the lift was there or not, so it would have been possible for someone to open the gates and fall down. Operation was by a continuous rope which passed round a wheel at the bottom to operate the hydraulic valve, up to the top of the building, round a jockey pulley, back down through the lift itself, round the lower jockey pulley and back to the wheel on the valve. To bring the lift to your floor, you reached over the railings and pulled up the rope to open the hydraulic valve. To stop the lift, you pulled down on the rope to close the valve. As the rope also passed through the interior of the lift cage, you could work the lift yourself from the inside. The only safety feature was that, if the suspension wire broke, spring loaded grippers would seize the sides of the vertical guide bars and prevent the lift falling down.

I had hoped to mount the jib of a warehouse crane against one of the central pillars of the Power Hall so it reached across to a railway truck. A bale of cotton would be placed in the truck and lifted by the crane worked by a vertical hydraulic jigger. The display was moved later to the side of the Power Hall where a small accumulator and one of the original Chester Hydraulic pumping engines were added. This was originally a triple expansion inverted vertical condensing steam engine. It was modified to be driven by a D.C. electric motor by having the cylinders removed and the flywheel replaced by a gearwheel meshing with that on the motor. The engine now at Liverpool Road was taken to Salford University campus where it was displayed in a glass case before being moved to the Museum.

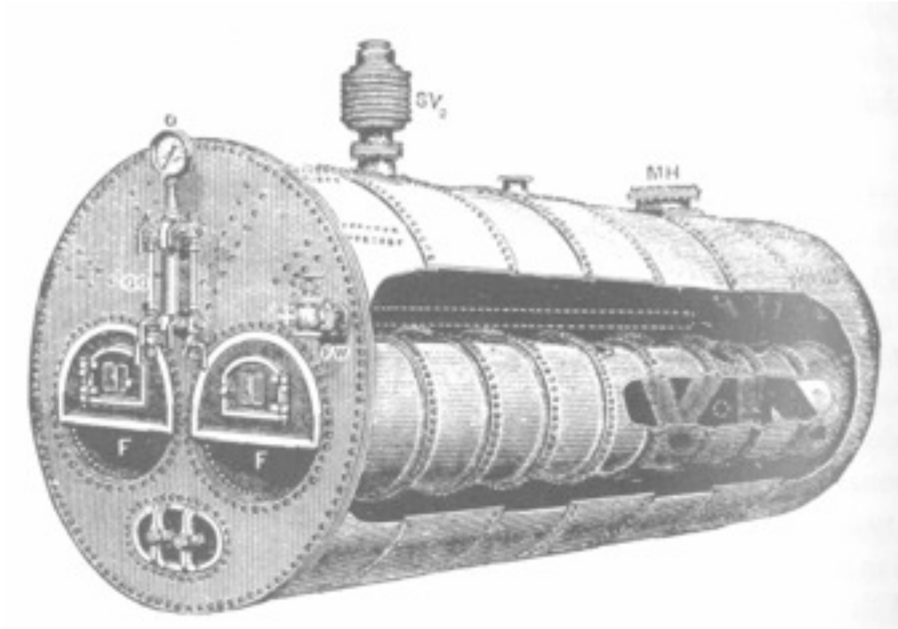
Chapter 4, The Mill Engine Collection.

The Background to the Mill Engines

The purpose of the Museum was to explain the development of the history of science and technology. The Manchester region was changed into the leading industrial area through steam engines driving its textile mills. Therefore the history of steam power had to be covered. It quickly became evident that, with the dramatic shrinkage of the textile industry, those mills that still had working steam engines might soon be closed. I was suitably impressed by the size of the largest ones, running so quietly compared with electric motors or internal combustion engines. Then there was the gleaming polished brass and ironwork as well as their stately revolutions. I realised that the largest ones would be too costly to remove and re-erect. I feared, as indeed time has proved me correct, that site preservation would be impossible except in a few isolated cases and even those that have been saved on their original sites face a bleak future today.

Therefore I decided to make mill engines the main example of the heavy engineering industry of the region. They would have to be able to run again but I realised that it would be impracticable to link one to drive say the textile gallery because the times at which either might need to be demonstrated could be different. Small examples of machine tools such as lathes or planning machines could be found. Spinning machines could be shortened to a few spindles. So I decided to search for medium size mill engines which would still impress the general public who had never seen one in a mill. The few engines we could accommodate would have to show as many technical features and layouts as possible, something that we were able to achieve. The examples preserved were nearly all manufactured by local firms.

Another reason for selecting mill engines as the main regular demonstration experience at the Museum was that people could easily watch them. Steam could be supplied from an automatic modern boiler that needed only the minimum of supervision. Frank Wightman always wanted a Lancashire boiler but its flues and chimney would have been prohibitively expensive. Yet a Lancashire boiler should be on display to show the most common type in all later textile mills. It was brought into general use by William Fairbairn and John Hetherington patenting a special way of firing in 1844. With its twin fire tubes, it proved to be both economical and also able to withstand high pressures. But most mill boilers could be up to 10 ft. diam. and 30 ft. long.



A Lancashire boiler with part of one side cut away to show the fire tube with cross tubes.

Luckily a small one was offered through John Sawtell of Holt where it supplied steam for curling feathers for stuffing the pillows they manufactured. It was made by Galloways of Manchester in 1889 with their special type of kidney shaped flue and water tubes to give better heating and circulation. It was small enough to fit onto a Pickfords' low loader. It was at ground level and not in a basement. The low loader could be manoeuvred alongside and, after the flue at the side had been demolished, it could be rolled onto the low loader without any cranage. I went down with Arthur Bebbington to prepare it for removal, such as knocking down the side flues and saving some of the special firebricks on which it would be supporter later. I expected problems freeing the rusty bolts securing the steam pipes but Arthur, a heating engineer, knew age would have made them brittle and broke them off with a hammer.

At first the boiler was stored at Stelling Street. When it had to be moved from there, it was mounted on the main frame of the Barnes engine outside Grosvenor Street with the Museum's name painted on it. For display at Liverpool Road I had a section taken out of the side to expose the internal flues. I wanted to put a mock fire in one tube and show how the gases passed through the flues, heating the water. I wanted to show where the water level would have been with steam bubbles passing through it into the steam space above but this was never done.

Once the former Goods Shed at Liverpool Road had been selected for the place to display the mill engines, it became possible to start detailed planning. What evolved was not ideal because it was not possible to devise a layout where the historical development could be followed in a continuous line. However it was possible to give more generous space for visitors, particularly school parties to gather in front of exhibits featuring crucial inventions. It was intended to run the exhibits in the way they would have been worked originally. Hence the need for steam at varying pressures, for cooling water for condensing and for disposal of condensate and waste water from drain cocks and elsewhere. Owing to the costs and budget constraints, the GMC did not want to install all these services initially but, when it was pointed out how much it would cost to provide them later, it was agreed to have the engines running at the initial opening.

The place first suggested for the steam boiler was in an arch at the end of the undercroft area. From here the steam would have been taken at its highest pressure direct to the Elm Street Mill engine. This was necessary through the Uniflow cylinder on this engine. I speculated on the possibility of taking a branch off to the Pakistan locomotive which might have been mounted on rollers and turned over gently. From the Elm Street Mill engine, the steam pipe would pass to the Barnes engine which needed less pressure and finally to the Haydock engine which needed least of all. As it was the boiler was installed in the bottom of the Byrom Street warehouse and taken first to the Haydock, and Durn Mill engines before reaching the Elm Street Mill engine last. The Elm Street Mill, the Barnes and the Haydock engines all had their own condensing apparatus. The Durn Mill, the Ferranti and small engines had to exhaust to a combined condensing unit situated just outside the building. I would have liked to have seen this turned more into a feature with the water being cooled perhaps as it descended a column of cataract tumbling buckets.

As we had been unable to preserve the original stone blocks on which the engines had been mounted, massed reinforced concrete beds were cast. Instead of levelling the engine bed down onto the stones, the beds were levelled up off the concrete with wedges and filled in with grout afterwards. Holes had to be left in the concrete for the engine holding-down bolts. Polystyrene blocks were used to form the holes because they were easily removed after casting. However one or two of these shifted as the concrete was poured so the bolts had to be cranked. For the Barnes engine, we had some dimensions off the original McNaught drawings but for all the others we had to measure up the parts. For the Elm Street Mill engine, we were able to check these against the engine bed itself. I insisted that overhead cranes be installed both for erection and subsequent maintenance. The cranes were designed with six tons capacity. Access was planned so that lorries could deliver the parts and be off-loaded by the gantry cranes to avoid hiring mobile ones. Partly for conservation reasons and partly for safety, I decided that the engines should not be run at either their original working pressures or their full speed. The speed was to be only about a third of that in the mill. Incoming steam pressure was about 60 p.s.i. reduced to less than 8 p.s.i. for the Haydock engine.

The Newcomen Engine

When the councils of the City of Manchester, the University of Manchester Institute of Science and Technology has agreed jointly to support a Museum of Science and Technology, those responsible for running it decided to see if a replica Newcomen engine could be built. The last Newcomen type in the Manchester region had been taken away from Fairbottom Bobs and re-erected in America by Henry Ford. Without an atmospheric engine, the history of the steam engine could not be explained properly, so Dr. Cardwell, Reader in History of Science and Technology at the Institute and Dr. Hills, Director of the Museum, approached Professor Johnson in the Mechanical Engineering Department, UMIST, to see if he would support the idea of building a small Newcomen or atmospheric steam engine.

The engine would have to be large enough to avoid the 'scale effects' which prevented model Newcomen engines from working properly. As we had to start a completely new engine, we decided to reconstruct the very first successful steam engine on which all later development was based, the one built by Thomas Newcomen in 1712 near Dudley Castle in Staffordshire. In this way we could discover the problems which Newcomen faced but the engine had to be scaled down to one-third size in order to fit it into the Museum. Dr. Boucher of the Department of Building redrew Thomas Barney's engraving of this first engine so that proper working drawings could be made. Mr. Flowett of the Mechanical Engineering Department built a small model to find out how the engine really worked. His difficulties in making it run properly warned us what to expect from the large engine but we built it as closely as possible to the original design to see what modifications would be necessary.

Making a one-third scale replica brought problems in size in two different ways. First the engine is still quite large, over 14 ft. high with an 8 ft. beam. The cylinder is 2 ft. stroke approximately by 7 ins. bore so the engineering work to build it was considerable. But the one-third size meant that the feed system to the boiler, the original type of safety valve and a device to control the valve gear would not work while there might not be enough head from the cold-water tank to inject the water for condensing the steam inside the cylinder. Many other problems had to be sorted out, for no one had built an atmospheric engine for a hundred and fifty years at least, and Barney's drawing did not have the same precision as modern engineering diagrams.

Because the engine would have to be moved from the Museum's temporary home, it was mounted on an iron plate and was supported by iron girders which were covered with mock brickwork. The iron frame was built by the Estates Department and the wooden beam and archheads by Mr. Dean in the Joiners' shop. All the rest of the engine was built by Mr. Needham and Mr. Robinson in the Mechanical Engineering Department. We owe a great debt to these two for seeing the project through to a successful conclusion, particularly to Mr. Needham who made all the working drawings and overcame all the difficulties.

The engine was partially erected in the Museum for the official opening in October 1969 but the pump had not been completed. When that was finished, the long and frustrating business of making the engine run smoothly began. The two 4-kilowatt immersion heaters used to raise steam proved insufficient and the heating capacity was raised to 16. The valve settings, size of openings for steam and water all proved critical. The slightest variation in any one of these would affect the running and stop the engine. The difficulties the Museum had in getting the engine to work properly highlighted the very great technical achievement of Thomas Newcomen.

The way I used to demonstrate the engine was to start with steam up and a cold cylinder. The weight of the pump rods pulled the steam piston to the top of its cylinder. Open the steam valve to blow out the air. Close the valve and the engine would make a stroke. This could be repeated a few times until the cylinder became too hot to condense the steam and form a partial vacuum. Another problem soon manifested itself. As the piston descended, air could be heard being sucked past it into the cylinder. Newcomen solved this by pouring cold water on top of the piston. This was essential on our engine too, even though our cylinder was an accurately drawn brass tube with a turned brass piston and better packing.

Still the engine would not work properly. We had to balance the snifting valve at the base of the cylinder so that the incoming steam could puff out any accumulated air left in the cylinder at each stroke in order to create as good a vacuum as possible. Yet the engine only performed sluggishly. Newcomen found the answer accidentally. One account is that he tried to cool his cylinder by encasing it with a jacket of cold water. A defect in the cylinder wall that had been filled with solder gave way. The cold water squirted into the steam filled cylinder, creating a much better vacuum than ever before. The piston shot down, smashing the bottom of the cylinder, so that 'water flowed everywhere'. Newcomen recognised what had caused this accident. He fitted a water valve that gave a direct injection into the cylinder. This was the key to the success of Newcomen's engine. On our model, the engine barely works without it, but performs magnificently once the direct injection is coupled up. Newcomen no doubt found the same.

Newcomen made his boiler with a domed lead cover. This would have been too dangerous for modern conditions, so the boiler was made from copper sheet, tinned to look like lead. To avoid burning out the immersion heaters, a gauge glass was fitted so the water level could be watched. Newcomen's method of filling the boiler through a standpipe would not work due to the reduced scale of our engine. Ours had to be filled with a supply from the mains. The 16 kilowatts of the immersion heaters was insufficient to heat up this incoming cold water as well as maintain the steam supply. Therefore the boiler was filled before starting any demonstration. The engine had to be stopped about fifteen minutes later before the water level had dropped far enough to expose the immersion heater elements.

The condensate passed down a copper pipe to an outlet valve at the bottom situated in a small tank of water to form a seal. The correct weight of this valve had to be found by trial and error. Likewise the weight of the pump rod in the mine pump had to be determined by trial and error to help control the speed of the engine. Although the main beam was made from seasoned oak, it twisted so that the chains to the piston and pump rods barely fitted onto the archheads. The links in the chains had to be twisted so that they laid flat. The bucket in the mine pump was changed to one with a pair of flap valves to give maximum passage for water as well as quick closing. Often the children found the water flowing down the chute from the pump more interesting than the steam side.

The valve gear took a lot of patience to form the curves and shapes properly. Newcomen's genius is shown by his method of working the valves. The steam valve is called the 'Y' lever from its shape. Newcomen pivoted it where the prongs joined with the prongs pointing down. On the end of the other leg, was a weight so that levers operated by the up and down movement of the plug tree would move the valve slowly until the weight overbalanced and opened the steam valve quickly. At the other end of the stroke, another lever moved the 'Y' lever slowly till it overbalanced the other way to snap the steam valve shut. This was copied by John Smeaton sixty years later and in some ways was better than James Watt's. Newcomen's water injection valve was different, operated by a lever in the shape of an 'F', mounted horizontally, pivoted at the end of the lower prong and weighted at the upper. It is held off by a catch at the top of the main stalk. As the plug tree rises, the catch is released so the valve opens through the weight falling. This gives the maximum opening for the initial injection. It is closed slowly by a peg on the plug tree pressing the tail of the 'F' lever down. Newcomen had found the ideal way of operating his valve gear to give the best method of letting the steam into the cylinder and condensing it. We ended up with profound respect for Thomas Newcomen's genius in developing his steam engine. It was a fascinating, if sometimes frustrating experience, building and setting this engine to work.

In the Power Hall is a piston from the atmospheric engine at Reel Fitz Coal Mine near Cockermouth. It was left lying in a near-by field with a crack nearly across its full diameter. The site was to be obliterated by a new route of the A66 so, with the help of MRIAS and students from Manchester Polytechnic, the site of the engine house was excavated and measured. Foundations for two circular boilers were revealed on either side of the engine house as well as the top of the oval mineshaft. Moving the piston for transport to Manchester finally broke it in two.

The piston from the Newcomen engine at Reel Fitz Colliery Cumbria

The Haydock Beam Engine

The first major removal task undertaken by the Museum was the beam engine at Haydock. It was realised that the explanation of the development of the steam engine in any Museum of Science and Technology in Manchester would be incomplete without a beam engine for two reasons. One was that it would show the crucial inventions of James Watt, turning Newcomen's pumping engine into one that could drive machines directly. The second was that Watt's rotative beam engine became the standard source of power in the textile industry from the 1790s. It replaced horse and waterwheels and was instrumental in moving the cotton spinning industry from riverside locations in the country into the urban townships of Lancashire.

Through the help of Reg Platt, an iron founder in Widnes, the National Coal board offered the beam engine at the Richard Evans & Sons colliery maintenance depot at Haydock. It may have been moved here around 1860 for the number 1863 was found on a brass plate on part of the control valve for the cold water injection. It has been suggested that this engine could have been one of those used to wind wagons up the railway inclines at Edge Hill in Liverpool but this seems unlikely. A drawing of one of these engines shows it had a 6 ft. stroke while that on the Haydock is only 5 ft. with 25 ins. bore. The winding engines were the side lever type while that at Haydock has the beam overhead. Then the engines at Liverpool were designed for a steam pressure of 35 p.s.i. whereas the slide valves on the Haydock are for the low pressure of perhaps 10 p.s.i. (M.R. Bailey, 'Robert Stephenson & Co., 1823 – 1829', *Trans. Newcomen Soc.*, 50, 1978 – 9, p. 127 and Wishaw, (1842), pp. 196 – 7)

The Haydock engine is a typical later Watt type dating from around 1830 as used in textile mills and other applications from say 1800 to 1840, fabricated entirely from cast iron except for wrought iron piston and pump rods, bolts, beam trunions and crankshaft. It is double-acting with Watt's separate condenser, his parallel motion to connect piston rod to the beam and his centrifugal governor to control the speed. However the slide valves are a later type than Watt's plug ones with separate 'D' valves at each end of the cylinder with rope packing around their backs. Similar ones were fitted to the Butterley engine at Stretham, near Ely, dating to 1831. This type, with short steam passages to the cylinder, was good thermodynamically but the pressure from the packing round the backs of the valves had caused bad wear to the valves as well as to the valve and port faces, necessitating much rebuilding of these parts. The main beam, 15 ft. long, had been plated at the cylinder end. As no fracture could be observed, this was assumed to have been added to balance the heavy cast iron connecting rod. In its house at Haydock, wooden panelling covered the 15 ft. diam. 6 ton flywheel which had gear teeth cast into the six segments of its rim. The geared flywheel is claimed to have been introduced by William Fairbairn after 1832. The drive to the workshop was through a pinion beneath the flywheel although the crankshaft is long enough to have had a gearwheel fitted to its end beyond the main bearing. The wooden panelling was not preserved due to lack of storage space. When the engine was offered, it was accepted as a step of faith because the Museum was housed only in a temporary building with no adequate storage space for such a large exhibit nor any prospect of a permanent home. But Reg Platt offered not only outdoor storage for the heavier parts but transport on his lorry and help lifting parts out through a friend with a mobile crane. All this help proved too good to refuse, so the National Coal Board's offer of the engine was accepted.

Access was along a disused railway line beside the workshop. We were lucky that no vandalism happened while dismantling was in progress for the engine house was tucked away, out of sight. The building which protected the engine from the weather also formed the supporting structure. It was recognised that such a 'house-built' engine might cause problems when it came to re-erection later, but, since there was little prospect of finding another such beam engine, it was decided to go ahead and remove the iron parts. Luckily the building was due for demolition so that we were able to free parts by removing the roof and knocking down the walls. Lifting the slates off the roof was a filthy job because gusts of wind had rubbed them against each other, leaving a fine black dust which blew everywhere. The view from the rooftop was spectacular, compensating for the exposure as the slates were taken off and passed down. The brick walls had been built with lime mortar so came apart quite easily. Luckily the engine house was almost detached from the rest of the workshop so we could demolish those sections which were needed to free the engine parts.

The lower parts of the engine were supported on brick columns capped with blocks of ashlar. It would have been nice to have preserved the stones but once again lack of storage made this impossible. The columns had holes running down them to pockets at the bottom through which passed the bolts securing the various parts. The bottom of the condenser tank was the lowest part of the engine. Then came the crank pedestal followed by those for the pillar supporting the entablature and the cylinder. The level of the floor round the cylinder top was not critical but of course the beams resting on the entablature carried the pedestal bearings for the main beam. All these different levels meant there were problems of vertical alignment as well as horizontal to ensure that the centre lines of cylinder, air pump, beam and crank pin would all be correct and at the right height.

The crank pedestal, the cylinder, the pillar supporting the beam and the entablature under the beam were secured by long bolts passing right down the holes in the supporting masonry pillars. While this allowed for a little sideways movement for accurate alignment, with most bolts it was impossible to access the lower ends and hold them so that once a nut at the top had been loosened, the bolt dropped and turned freely. Reg Platt was a dab hand at cutting the nuts off with oxy-acetylene. The small parts such as the parallel motion were dismantled and taken off to Widnes. A sequence for stripping the rest had to be worked out so as not to block the removal of others. The roof had a lifting beam running below the apex so block and tackle on that could be used to free the connecting rod, piston and rod, cylinder cover, etc. An eye bolt below the beam floor above the flywheel was used to dismantle the rim sections and spokes but this meant that the beam floor had to remain intact until the flywheel had been laid in segments on the crank floor. Lifting these out with the mobile crane was much easier than using block and tackle, especially once the roof was off with its lifting beams removed. The flywheel spokes ended in a ‘T’ shape which meant that each rim section had to be taken to the top position and pulled out sideways before it could be lowered. This was a difficult balancing act, made more so when one spoke was discovered to be broken at its base.

The mobile crane could only just reach the main beam which was the heaviest single part. With the beam away, the walls could be lowered and flooring removed to expose the cast iron framing around the beam and the entablature. The ends of all these parts were supported on more stone slabs built into the brickwork. The tie rods for the main entablature crossbeam ran a long way down through the walls and could not be removed so the entablature had to be lifted off them carefully. It had been cast for an engine with only one cylinder and beam. With the beam and floor removed, the pillar, the crank and its pedestal could be taken out and carried away. The cylinder and valve chest were lifted out in one piece, to be followed by the condenser and air pump from the very bottom of the engine. No attempt was made to preserve the condenser tank through its condition.

The cylinder of the Haydock engine being removed from the engine house at Haydock.

The parts remained at Reg Platt's foundry, the larger ones in the open at the end of his crane gantry. The smaller ones were locked away in his brass store. This was broken into and some of the bearing brasses stolen. Perhaps good came out of this for it meant that, when the time came for re-erection, new patterns were made and new brasses cast and machined. So the Haydock engine started her third life with a new set of bearings. The downside was that lack of brasses made measuring the parts a little more difficult.

The good fortune of this engine continued when the GMC acquired the Goods Shed at Liverpool Road Station because it proved possible to fit inside it the required height for the Haydock engine. It was necessary to visit Widnes to measure all the parts to prepare plans for the structure to support this 'house-built' engine. Accordingly it was arranged so that a visitor entering the top end of what would become the Power Hall would see the tall end brick wall and one side of a beam engine house with appropriate 'chapel' style round-topped windows. Walking to the other side, the visitor found the structure cut away to reveal the engine. Health and safety would not allow visitors up the stairs to the beam floor even when the engine was stationary.

The outer ends of the framing round the beam floor were supported by steel girders encased in brickwork. The wooden beam floor was partially cut away to give a better view of the beam from ground level. The crankshaft, flywheel and governor were mounted on one massed concrete block, as were the pillar supporting the entablature and the cylinder on others.

Installation of the Haydock engine at Liverpool Road showing the cylinder with parallel motion above it.

The walls around the cylinder were cut back to give a view of Watt's crucial separate condenser in the basement and his parallel motion below the beam. The condenser was equipped with its own cold water supply to enable the engine to run fully condensing as it would have done in a mill. A roof was installed over the cylinder end complete with lifting beam for maintenance purposes. Stairs were reinstated to enable the demonstrators to reach the beam floor. Because the Haydock engine was too tall to fit under the crane gantries over the other engines, the re-erection had to be carefully phased while it was still possible to have access for mobile cranes.

View of the flywheel of the Haydock engine being installed at Liverpool Road.

The engine could not have been retained in situ so this was the only way of preserving this historic machine. Its removal and subsequent erection showed early engineering techniques, such as the method of aligning bearings by first positioning a sole plate and then mounting the pedestal more accurately on top with wedges. It also brought home the massive structure of the mainly cast iron parts for the comparatively little power produced, probably about 20 h.p. at about 20 r.p.m. When we had re-erected this engine and started to run it, we found one error in Watt's design. He had immersed his separate condenser in a tank of cold water both to act as a surface condenser and also to prevent air entering the condensing chamber and destroying the vacuum. When he changed to jet condensing, he drew the cold water from this source, which we found became warm through the heat of the steam going into the condenser, thus reducing the efficiency of the jet. We also noticed at the top of the governor an addition to Watt's design in the form of a cast iron ball. This could have been added as a fail-safe feature to close the throttle valve in the event of the governor failing. Also it would work as a weight to prevent the governor balls rising and closing the throttle valve until a pre-determined speed had been attained. If this were its reason, then it anticipated the American Charles Porter's weighted or 'loaded' governors by many years. This engine is certainly much easier to control than the Newcomen and is a fitting tribute to the genius of Watt and the early pioneers.

The Grasshopper Engine
The rotative beam engine takes up a great deal of space and needs to be housed in a large building so people began to design other types. A more compact form of beam engine called the 'grasshopper' can be traced back to 1805 when Oliver Evans installed one in a boat in America. It had a vertical cylinder. The piston rod was jointed to one end of a beam above the cylinder. Radius rods from brackets on top of the cylinder to the beam kept the piston rod moving vertically in a straight line. The beam was only half a normal one, terminating at the central point where it met a vertical support which could oscillate a little. The connecting rod and crankshaft were placed between cylinder and beam support. This type of engine became nicknamed 'grasshopper' from its action that mimicked the rear legs of that insect.

When the Methodists left Grosvenor Street, it became possible to install a small vertical steam boiler in the basement to power a couple of small steam engines. One was a grasshopper presented by Reg Platt which he saved from being scrapped by Widnes Technical College. It could date to around 1840. It has a bore 7 ins., stroke 1 ft. 6 ins. and a flywheel 6 ft. diam. For display, it had to be mounted on a 3 ft. high plinth. We decided to construct one from concrete and narrowly averted disaster. Shuttering in the form of a plywood box was erected. Concrete was barrowed in from a lorry at the front door. In spite of Frank Wightman's assurances that it would be strong enough, the shuttering bulged ominously and nearly gave way. More supports were added and the plywood held, averting concrete flowing all over the parquet flooring. The outside of the plinth was faced with bricks.

While the engine was being re-conditioned for erection, I noticed that the top of the cylinder had worn bell-mouthed. My suspicions of misalignment proved correct for we found that the brackets supporting the radius rods had been set too low, probably from new. This was corrected and the engine with its heavy flywheel ran well on less than 15 p.s.i. of steam. However running the engine showed why this type never achieved much popularity. It is inherently unbalanced, with the weights of the piston, connecting rod and beam, all being on the same side of the beam support. It became a useful demonstration engine, particularly on Working Days. It was transferred to Liverpool Road where it was run regularly on most days when there was steam available.

The Vertical Engine
Another small engine that was demonstrated with steam from the small boiler at Grosvenor Street was a true vertical engine with cylinder 8 ½ ins. bore and 15 ins. stroke. It was lent by Bury Museum but the crankshaft was missing which could be replaced easily. The type possibly takes its name after the beam engine where the cylinder is secured to the foundations with the piston rod working vertically upwards. It was a compact design which could stand independently since it had a cast iron bedplate and the crankshaft bearings were supported on a pair of 'A' frames with the flywheel and eccentric situated between them. The crank overhung one end above the cylinder with the slide valve on the inside. A Watt type governor controlled the speed through a throttle valve. The crosshead moved between a pair of flat vertical guides with smooth faces. We found that the oil on these soon rubbed away and the engine slowed down through the friction. For the sake of greater longevity and lessened wear, we cut oil channels in the faces and had no more trouble. Likewise for the cylinder itself, I had a mechanical lubricator fitted, injecting oil into the steam

pipe. I saw that similar ones were fitted on all the working steam engines at Liverpool Road. This little engine has continued to run satisfactorily in its new home.

The vertical engine is on the left with the double diagonal engine on the right in the Power Hall.

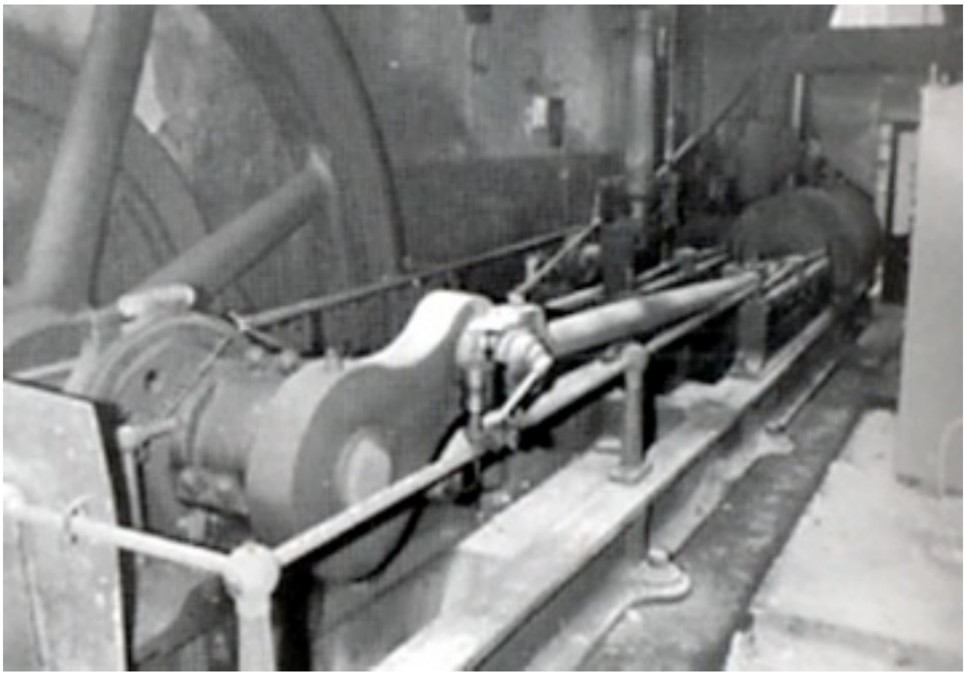
Other Small Engines

A few more small engines were preserved. In the background was the idea that one might be sectioned and slowly turned over to show how the valve gear worked but this was never done. Another theme was the need to supply boilers with water. One such was a Pearn pump; another was a Cameron pump which was displayed at Grosvenor Street. It had twin columns containing the pump valves. The pump was centre bottom driven by the steam cylinder centre top. The pistons were linked by a banjo-shaped connecting rod, joined also to a crankshaft in the middle which turned a flywheel to keep the engine running steadily.

A link with the textile gallery was a double diagonal slide valve engine. The double-acting cylinders were placed at right angles connected to a single crankshaft so that there was no dead position in the rotation with the steam always pushing on one piston. Such engines were used on calico printing machines which had to be driven very slowly at first when the printing rollers had to be set very accurately to ensure that the colours were in proper register. This was installed in the Power Hall and connected to the steam supply.

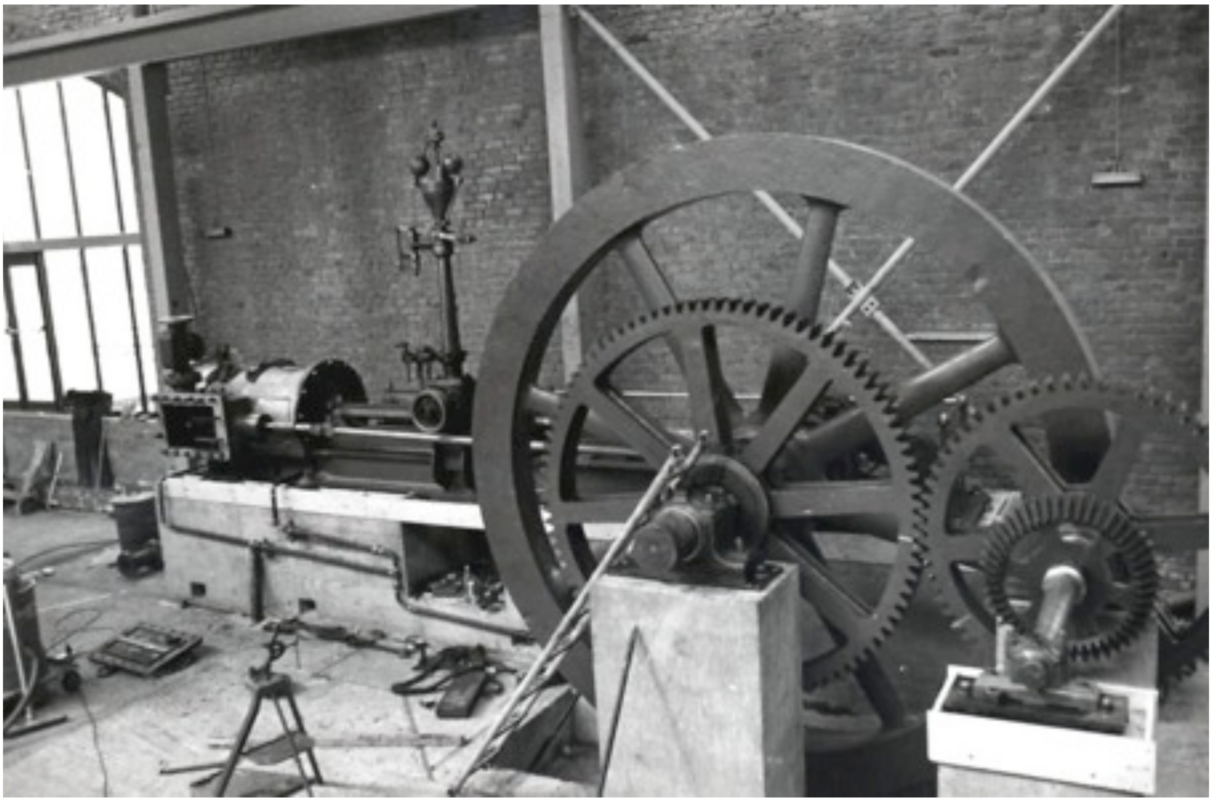
In the Power Hall, these small engines were situated in the middle of the large ones. The architect wanted to have a suspended steel floor throughout this area for flexibility in the display. It was necessary to point out to him that a floor of this type would flex under the weight of some of these engines which might cause the cast iron frames to crack. In the end, the heavier engines were placed on secure plinths.

The Durn Mill Engine



The Durn Mill Engine in situ before removal.

This engine was offered for preservation at a time when the GMC was suggesting that the Museum be split into two parts, one on the University site and another elsewhere. My idea was to have the Haydock engine in one place and the Durn Mill engine at the other to show early engines. A. & J. Law used Durn Mill, Littleborough, to weave tartans. This single cylinder horizontal engine was supplied by Earnshaw & Holt of Rochdale in 1864 so was an early example of this layout. The cylinder was 28 ins, diam. by 4 ft. stroke. At a boiler pressure of 60 p.s.i. and at 63 r.p.m., it probably developed 50 n.h.p. or 250 i.h.p. This was a little more than double that of the Haydock engine, showing the advantage of its more compact design and higher boiler pressure. It was worthy of preservation in any event because it showed different features from the other engines we had in store. The cylinder was mounted on a long bed that stretched from under the cylinder, below the crosshead guides and over the condenser to the pedestal bearing for the crankshaft. This meant it was much easier to align and the forces from the steam on the piston acted directly on the crankshaft so it was essentially self-contained. The valve gear was a short slide valve. While this necessitated long steam passages to either end of the cylinder so was not so efficient thermodynamically, the short valve was easier to move against the higher steam pressure. It was driven by a single eccentric on the crankshaft so there was no variable cut-off. The connecting rod was forged with an integral strap to contain the bearing brasses. The condenser and air pump were situated in front of the cylinder below the crosshead guides. They were not placed in a tank of water so relied entirely on jet condensing, something common by 1860. When designing the engine bed for Liverpool Road, the gap for the bell-crank lever was put in the wrong place. The crosshead guides were fitted with upper guide bars, another distinctive feature.



The Durn Mill engine in course of re-erection in the Power Hall showing the gearing to drive the vertical shaft into the mill on the right.

The power was transmitted by the crankshaft to gearing on the other side of the main mill wall. The massive 12 ft. diam. open flywheel weighing 8 tons was mounted on this shaft on the engine side of the wall. It was a single casting. At that size, lying flat on a lorry, it was became an abnormal load. It was too big to fit through the doorway into our store at Constantine Lloyds so it was taken to Grosvenor Street and lent up against the wall of 97 itself, partially hidden by the site huts of the contractor building the new Metallurgy Department. The flywheel had been staked onto the crankshaft with wedges driven in from the engine side. The wall prevented access to their other ends. The hole in the wall was blocked by the gearing which was staked on from the other direction. There was no way that the wedges could be driven out by hitting their narrow tapered ends. For a closer inspection, I descended into the flywheel pit in my new brown shoes into six inches of grease accumulated over nearly an hundred years. I was not pleased.

The gearing on the far side of the wall was arranged to speed up the drive to the vertical shaft by a larger wheel turning a smaller one. These spur gears had unequal numbers of teeth, a ‘hunting tooth’, so the gears would process round each other and all would wear equally. The vertical shaft with its gear was not removed for I had intended to show the arrangement by a large drawing. A Lumb type governor was added in 1921 at a cost of £300 but otherwise the engine remained much as it had been built. However it had deteriorated over the years when it was not in use. The rear cylinder cover was badly rusted and the connecting rod was deeply pitted. The condenser and air pump seemed to be very badly corroded so they were not removed for preservation. Removal was undertaken by outside labour, one of the few instances of my Museum staff not being directly involved in handling an exhibit. It too was stored at Constantine Lloyds. At Liverpool Road, it was connected up to exhaust into the central condensing system. The cylinder was clad with mahogany as it would have been originally. It has proved to be a very useful exhibit, being demonstrated most days.

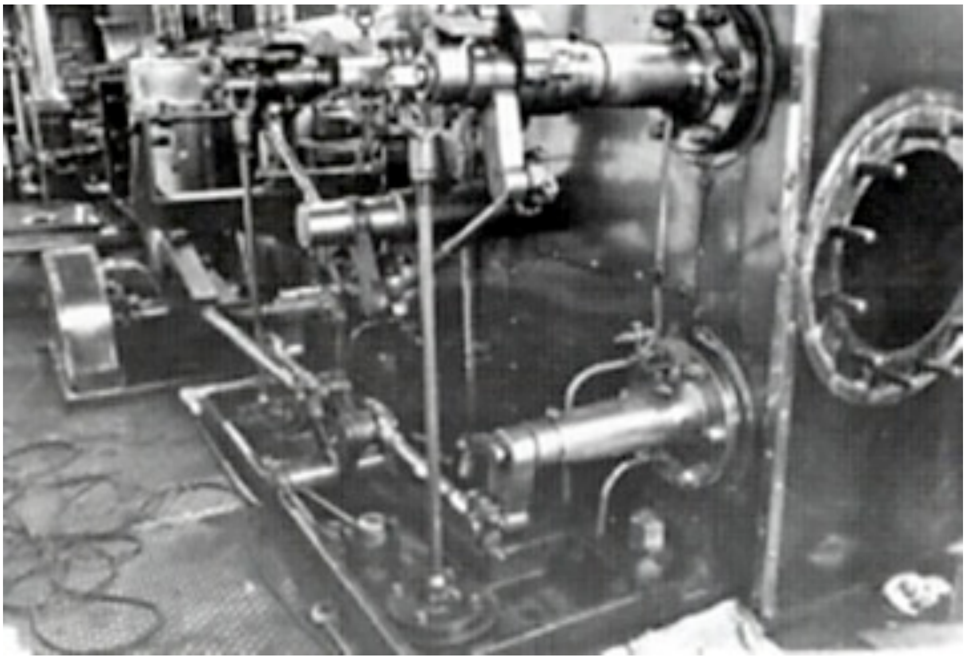
The Firgrove Mill Engine or Barnes Engine

The second half of the nineteenth century saw two important developments that improved the efficiency of mill engines. These were the increasing steam pressures which enabled the steam to be expanded in two stages, or compounding, and the better control of the steam through improved valve gears. The Lancashire boiler was an efficient steam generator that became the most common type in textile mills. Henry Bessemer patented his method of making steel in 1855. Once steel sheets became available, pressures could rise to 150 p.s.i. and beyond. To achieve the economies possible, the steam was expanded first in a small high pressure cylinder followed by a larger low pressure cylinder – compounding. However, the amount of steam passing into the engine needed to be controlled very precisely if a constant speed were to be maintained. Also for greatest economy, this steam needed to be admitted as close as possible to full boiler pressure, then cut-off and allowed to expand as much as possible. The most popular form of cut-off valve gear that achieved this was patented in 1849 by an American, George Corliss.

Having taken into store the early Haydock beam engine and the most up to date Elm Street Mill engine, I began searching for an engine that would fill the gap to show late nineteen century developments. Ideally this would have horizontal cylinders in the tandem configuration with a high pressure cylinder in line with a low pressure. Around 1900, the most powerful mill engines generally consisted of a pair of such engines, linked to a common crankshaft either side of a central flywheel. These large engines could be represented by a single tandem compound. The engine that was finally chosen because it contained so many technical features was a tandem compound supplied in 1907 by J. & W. McNaught, St. George's Foundry, Rochdale, based on a well-tried design to replace a beam engine at the Firgrove Mill of Richard Barnes & Co. The mill spun and wove cotton flannelette sheeting. It was part of Courtaulds Ltd. who were willing to donate the engine to the Museum provided we removed it. But this presented problems. The engine had been erected in a new building beside the beam engine house at the side of the Rochdale Canal. No doubt it was shipped in on barges just the short distance from the foundry on the other side of the canal. While this stretch of canal was still filled with water to supply engines like this one, it was closed to navigation so no barges were available. To take the engine out through the mill itself would have been too difficult. But there was a small wharf where coal had been delivered. This could be within reach of a crane on the road bridge over the canal about 50 ft. away. The snag was that this was still the original hump-backed narrow bridge to John Rennie's design. It carried a busy main road and to use it for loading engine parts would have caused a major obstruction.

Luckily the local Council rebuilt the bridge just before we were due to take out the engine so that we could position a crane and lorry on the much wider bridge.

Even then we faced other problems. While there was a gantry over the engine, this was only a single track girder over the centre line of the engine. Its nominal capacity was only about one ton but at the further end it was less because part of the mill chimney had blown down in a storm onto the engine house. In any case, this gantry did not project onto the coal wharf. Therefore all the parts had to be dismantled, jacked up and slid out onto temporary staging on the wharf from where they could be picked up by a mobile crane, swung out over the canal and round to the waiting lorry to be carted off to store. Inside the engine house, additional lifting gear had to be arranged for parts like the flywheel halves, and the air pump and condenser. The 15 ft. diam. 12 ton flywheel split into two halves. The lower half had to be turned through 180 deg. in the pit before it could be lifted out and slid out on the narrow faces, a tricky operation. One half had to be inverted again for erection. The mobile crane to do this only just fitted below the beams of the Power Hall and in fact hit one of them.



Corliss value gear of the Barnes Mill engine photographed at Firgrove Mill.

The high pressure cylinder, 15 ins. diam. by 4 ft. stroke was furthest from the crankshaft. Steam pressure was 180 p.s.i. The main steam pipe and admission valve were above the cylinder, the valve being fitted with Tate's stop motion. Should there be an emergency in the mill, a small glass panel could be broken which released a button switch, activating an electric current to close the valve. The steam pipe branched to the Corliss valves at the top of either end of the cylinder. The trip gear was McNaught's own pattern, actuated by a rod from the governor and Lumb regulator. The Lumb regulator would have replaced an earlier type. The dashpots were mounted in a plate at the bottom of the cylinder. While this allowed longer springs to be fitted, they were in a position to accumulate oil and water dripping out of the valve bonnets, which happened when the engine was not so well maintained in

the Museum. A pair of eccentrics, placed near the high pressure cylinder and driven by the same shaft as the governor, operated both inlet and exhaust Corliss valves. The exhaust valves had no trip mechanism. They exhausted into a common pipe below the cylinder which passed under the
floor to the low pressure cylinder. Some steam might be taken out here at a pressure of around 30 p.s.i. to heat the drying cylinders of the sizing or slashing machines preparing warps for the looms so this engine could be used as a ‘pass out’ engine. This was an economical way of supplying process steam. The high pressure cylinder sat on its own feet on the masonry foundation through which long bolts passed to secure it. Additionally, it was bolted to the rear of the main cast iron engine bed. Provision had to be made in the concrete foundations for the intermediate steam pipe when it came to re-erect the engine.

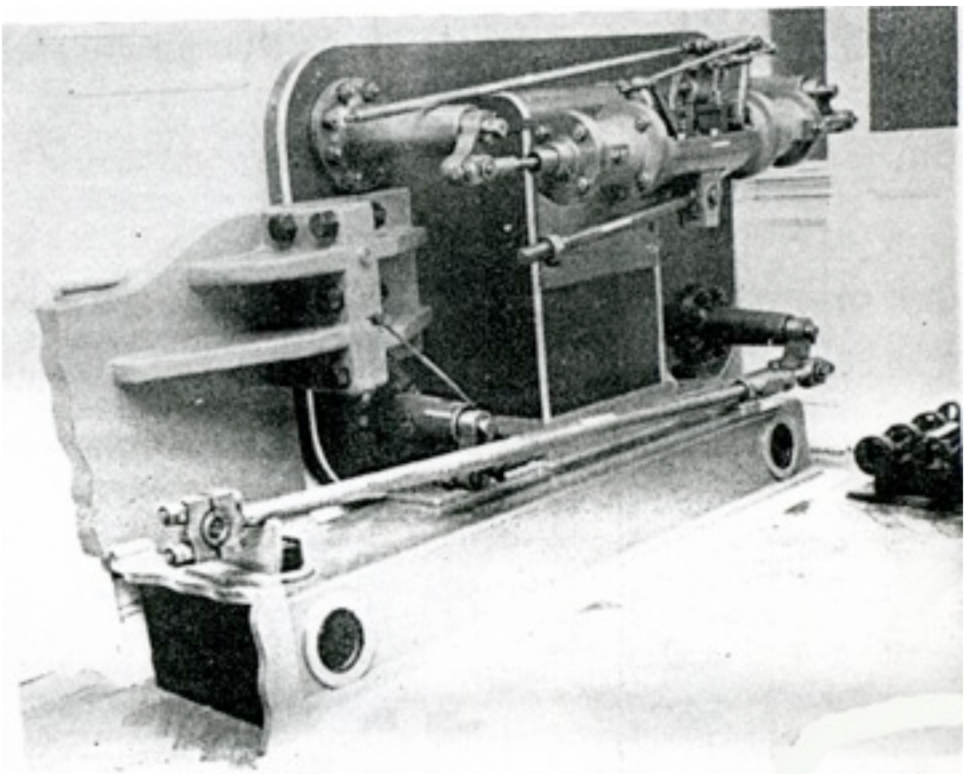
The low pressure cylinder, 31 ins. diam., was bolted to the bed itself with a passage through it for the low pressure exhaust. The securing bolts here underneath the cylinder were particularly inaccessible. I had to wriggle under the cylinder to reach the nuts as I was the only person thin enough. The steam entered the rear of the slide valve chest on the low pressure cylinder. The two large slide valves were driven by their own eccentrics on the crankshaft. One valve gave some cut off on the inlet and worked on the back of the main valve. In this way, the exhaust could remain open much longer. The exhaust passed below floor level to the condenser situated in a pit between the low pressure cylinder and the crank, bridged by the engine bed. The masonry foundations had to be divided to receive it. Condensing was by jet only. At Rochdale, water was drawn from the canal, where the excess was returned by the air pump situated alongside the condenser. The air pump bucket was driven by bell-crank levers off the crosshead. The crosshead slides were open with no upper bars. The big end in the connecting rod was fed with oil through a centrifugal drip-feed device and was surrounded with a planished steel guard to prevent oil splashing. The main bearings were lubricated from ‘aquariums’ by gravity with oil being returned by a small pump driven off the crankshaft.

Re-erection of the Barnes Mill engine at Liverpool Road with the crankshaft being lowered on to its bearings.

The flywheel showed a different way of driving the mill. This was by cotton ropes, in this case ten 2 in. diam., set in grooves, linked to a smaller pulley on the main shaft in the mill. This method is generally considered to have been developed by James Combe of Belfast around 1862. It was introduced into Lancashire in the early 1870s. The Firgrove flywheel was lagged with mahogany boards to lessen the draught resulting from its rotation. This lagging, when polished, gave a fine finish to many an engine. The flywheel was cast with an integral gear around the rim so it could be rotated by a steam barring engine, a feature that became essential with the increasing size of engines. The custom at Firgrove Mill was, when the engine had stopped, to bar it round to the starting position, ready for when it would be needed again. With its boiler pressure of 180 p.s.i., superheated steam and a speed of 70, later 80 r.p.m., this engine gave 410, later 500 h.p. It worked in the mill for over sixty years and continued to run for a further twenty years in the Museum so it has passed its centenary. It is demonstrated regularly as a compound with its own condenser.

Magnet Mill Engine Corliss Valve Gear

Because the Corliss valve and valve gear was so popular in Lancashire mill engines, I decided that an example from another manufacturer ought to be preserved. Therefore we took off the Dobson type used by George Saxon from the 1903 Magnet Mill. This engine was a pair of tandem compounds which, with the speed increased from 60 to 64 r.p.m., gave 2,200 h.p. All four cylinders had Corliss valves but only those in the high pressure had variable trip gear worked by the governor. A set was taken from the right hand high pressure cylinder and at Grosvenor Street was mounted on a strong plywood board to imitate a cylinder. This was taken to Liverpool Road and displayed in the Power Hall joined to the governor from Saxon Mill. A diagrammatic working model of a Lumb regulator was set up alongside. All this has been removed from display subsequently and let us hope that it is safely in some store and not scrapped.



The Dobson valve gear from the high pressure cylinder of the George Saxon engine at Magnet Mill showing the Corliss trip mechanism.

Electricity Generating Engines

When Liverpool Road became the site for the Museum, there was no inkling that it would house the major Electricity Generation Gallery so some engines and generators were displayed among the mill engines in the Power Hall. By 1900, electricity was becoming more and more important in textile mills, first for lighting and then for driving the machines themselves. Electric generation and some uses of electricity were displayed in Grosvenor Street but, with the exception of one small horizontal steam engine and a Metropolitan-Vickers steam turbine, there was no space to cover the sources of power used to generate electricity. At Liverpool Road, the small horizontal single cylinder steam engine, about 3 ins. bore and 8 ins. stroke, drove a very early type of Edison dynamo with a pair of tall vertical coils. It had generated current for lighting Dugdale's shop window in Bolton and must have been a source of wonder in its day.

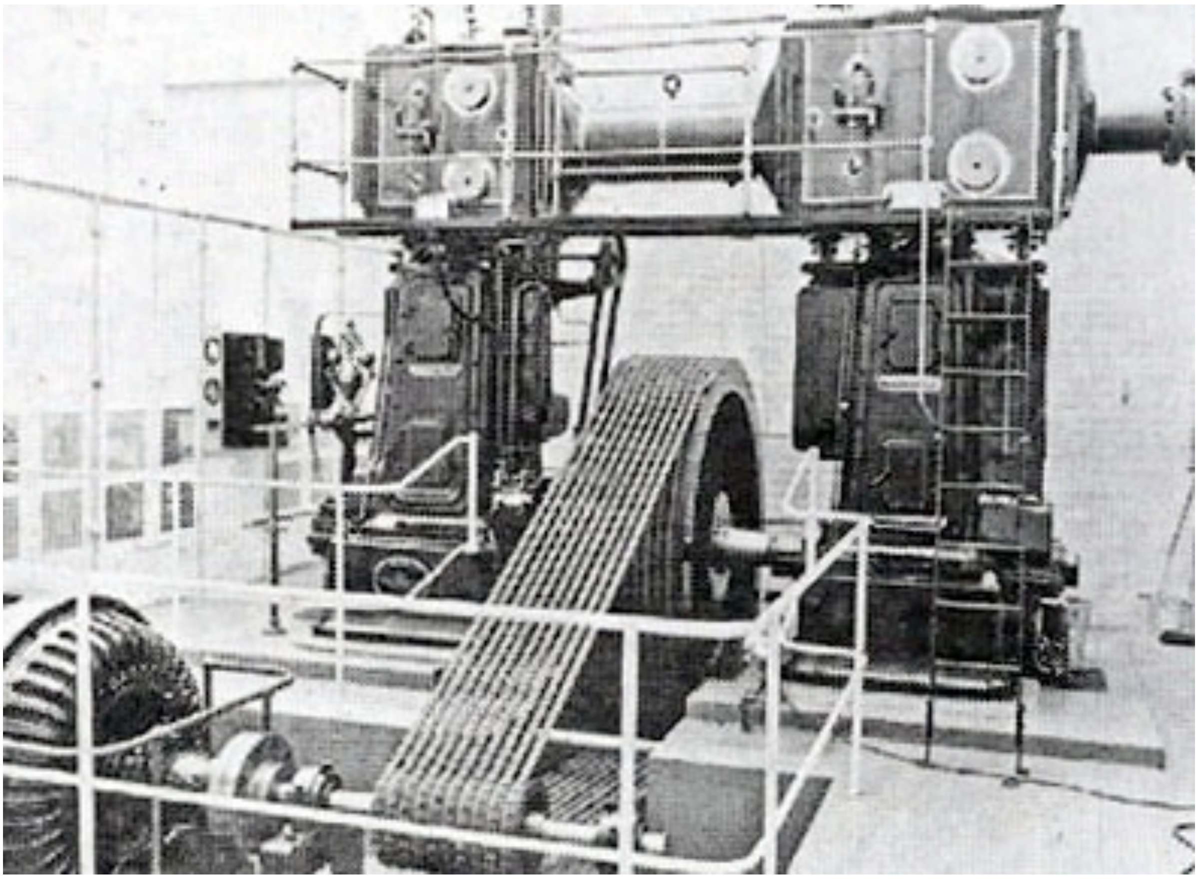
Most textile mills had a small steam engine turning a generator to provide current for lighting at times when the main engine was not running. What became a more or less standard set was a two cylinder inverted vertical compound double-acting engine totally enclosed to prevent oil splashing everywhere. The generators needed to rotate much faster than most other machinery and were coupled directly to the engine. Many steam engine builders offered such engines with electrical equipment supplied by different electrical firms. I wanted to find one with both components built by firms in the North West and was lucky to be offered a set with an engine by W.A. Ashworth and W.S. Parker of Bury coupled to a generator by Mather and Platt of Manchester. When overhauling it for display at Liverpool Road, it was discovered that the rings of one piston had broken and been worn into small sausage-shaped pieces. Luckily it had suffered no major damage although it must have been running in this condition for many years. This set has been running regularly with the cast iron cover plates replaced with Perspex to show the connecting rods. Another type that came from Bury Museum was a twin tandem compound single-acting high speed vertical engine by Alley McLellan. Air buffers were fitted between the lower cylinders and crankcase. It had been sectioned to show how a central valve admitted steam to the cylinders. This is now displayed in the Electricity Generating Gallery.

Alley McLellan steam engine from Bury Museum. It is a single-acting inverted vertical twin tandem compound with central piston valves for both cylinders with air buffers below and centrifugal governor on crank.

The Ferranti Engine

It proved possible to preserve a small example of an early power station electricity generating engine at Liverpool Road. This inverted vertical cross compound led a charmed life because it was moved four times. It was built by S.Z. de Ferranti at Hollinwood in 1898 as one of a pair for order No. 581 to go to Lambeth Electricity Supply Company at a manufacturing cost of £3,395.2.11. It was fitted with an integral 259 kW zig-zag alternator in place of the usual flywheel. This was surrounded on either side by two rings of static electromagnets acting as the field coils. It was one of the smallest of such engines designed by Ferranti. However the load at Lambeth must have grown quickly because the engine was taken out in 1900 by J.H. Gillett & Son Ltd. for their Brunswick Mill at Chorley to drive 850 looms. The alternator was replaced with a heavy flywheel of about 6 ft. diam. grooved for ten ropes although only seven were used at the mill. At Lambeth, the engine speed was about 300 r.p.m. Although this was reduced to 150 at the mill, it was still too fast and had to have a second set of pulleys to reduce the speed further to that of the existing line shafting.

When the mill closed in 1960, Ferranti decided to preserve the engine at their Hollinwood Works among their other historic exhibits. There it was re-erected, still with the rope drive flywheel coupled to an ordinary alternator, and demonstrated with steam from time to time. But then notice was given in 1980 that Hollinwood Works would close and so the engine was dismantled. This coincided with our planning the proposed layout for the mill engines at Liverpool Road. I realised that here was an engine of great historic and technical interest as well as an example of a medium size inverted vertical engine which we did not have. So I went to measure the engine and found that it could be squeezed into the Power Hall.



The Ferranti engine as preserved at Hollinwood works.

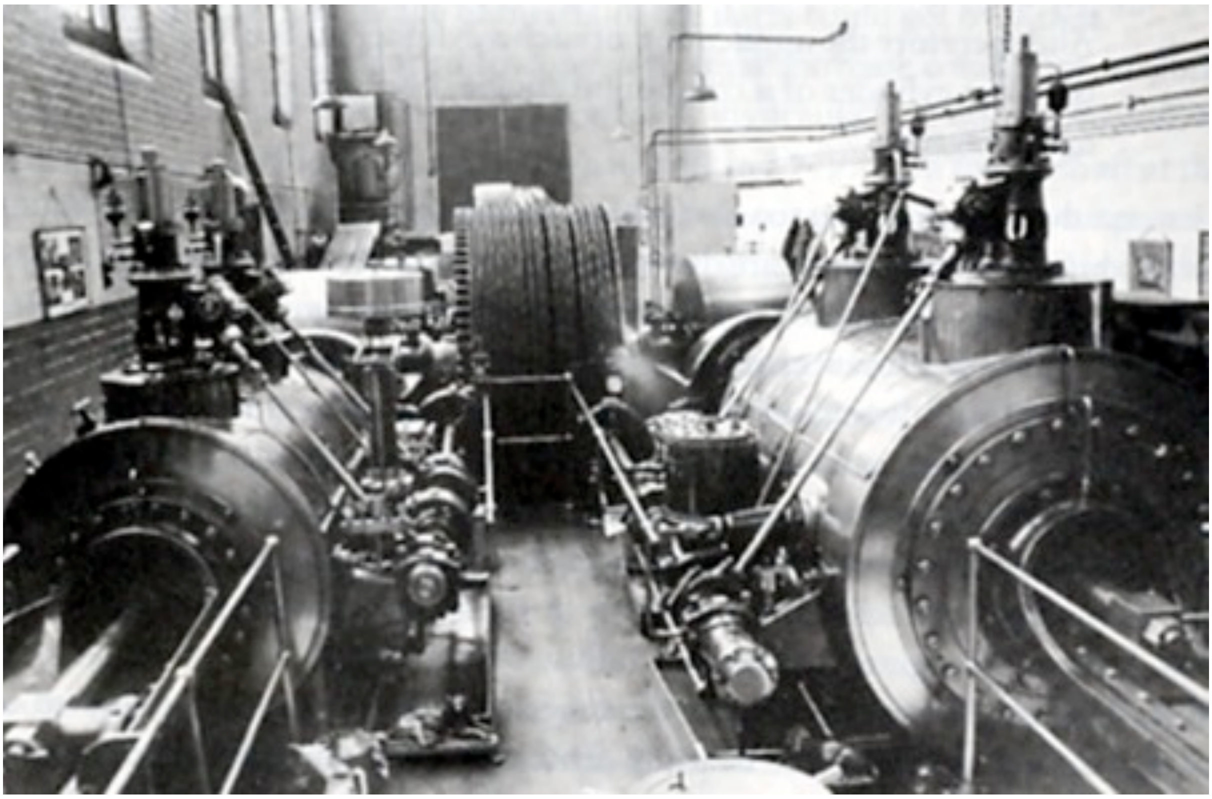
Ferranti's archivist, Charles Somers, asked whether the Museum might be interested in any of the electrical test equipment that would also be scrapped. I thought not, but decided to look for the last time at an 1898 Siemens zig-zag alternator used to produce variable frequencies for testing transformers. I had been told that this was 18 ft. diam, which I knew was larger than the Ferranti engine. When we entered the test house and saw the alternator, I realised it was much smaller. Charles found a tape measure and we crawled over the Siemens alternator and the engine parts. We guessed that it might be possible just to fit the alternator flywheel under the steam pipe connecting the two cylinders of the engine with a couple of inches to spare. We took the risk and designed the foundations for a combination of the Ferranti engine and Siemens alternator.

The bearings for the rotor on the frame of the alternator were cut out, leaving the ends to support the static coils. The alternator shaft was scrapped and the Ferranti engine crankshaft was turned down in its centre by the Central Electricity Generating Board at Barton Power Station to fit the boss of the rotor. While this work was being done, some parts of the engine were erected temporarily to show Her Majesty, Queen Elizabeth II, when she passed through the Goods Shed to visit the Coronation Street set of Granada TV. For final erection, the overhead crane was essential to lift up the higher parts. Our assessment of the sizes of both engine and alternator was correct. The rotor fitted but brackets for a stay on the stator rings had to be removed to clear the steam transfer pipe between the cylinders. Now the engine shows a very early form of alternating current generator. More than that, the engine has many important technical features as well as its layout occupying very little space. The valves are a form of grid slide valve designed by Ferranti to give quick opening to large ports. The valve gear for the inlet is based on some form of Fink mechanism to give variable cut off on the inlet. Cylinder bores are 15 ins. and 30 ins. but the stroke is only 15 ins. for the high speed. The cranks are fitted with balance weights to give smoother running, a very early example. All the moving parts are totally enclosed to prevent the oil from the pressure lubrication system splashing everywhere. The backs of the main bearings are curved to allow for variations in the inclination of the vertical stanchions and the steam transfer pipe as they warm up. The engine runs very smoothly in its present resting place, exhausting into the central condensing system.

The Elm Street Mill Engine

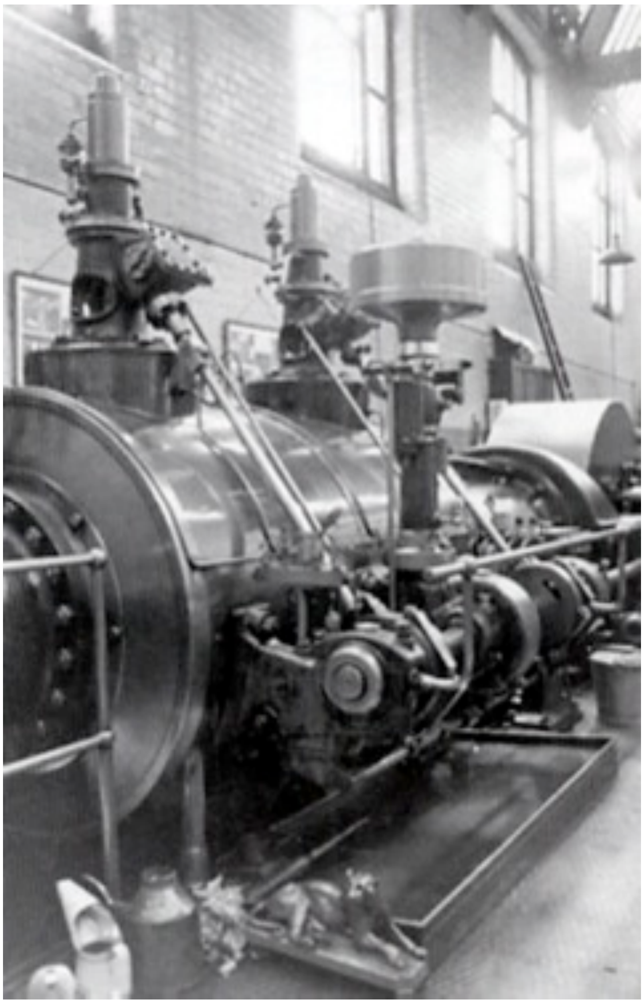
Very early in the Museum's career, we were faced with a major challenge when we were offered the 1926 Galloway cross compound engine at Elm Street Mill, Burnley. We realised that it would be an excellent exhibit since not only was it probably the last new reciprocating steam engine in any cotton weaving shed but it was also the most technically advanced design. It was also medium size so would not cost too much to move and re-erect. While its preservation would be a great prize, it was realised that its removal would be difficult and would require a great deal of sweat, toil and tears. It was a long way to travel from Manchester and it had to be dismantled by our own staff. This was for two reasons. First we could not afford contractors and second I wanted our own people to gain experience of each of our exhibits both for re-erection and subsequent running. The distance meant overnight stays in Burnley doss houses, not quite five star accommodation.

Elm Street Mill was a room and power mill. One person, Brian Melland, owned the mill and the engine. He let space in the mill and power from the engine through line shafting to four separate weaving concerns. The large weaving sheds lay to one side of the two storey mill block in which were situated the stores for the yarn, finished cloth and the warp preparation machines. The engine lay between the two. The crane over the engine had capacity for only the smallest parts and the site was impossible to reach with any mobile crane. The only access from the road was past the single Lancashire boiler and up through a small hole in the wall. We had to jack, slide and carefully lower with block and tackle every part through this hole. Yet Galloway removed the earlier fire-damaged cross compound engine, perhaps by Roberts of Nelson, and installed theirs in six weeks, which was a major achievement. We took much longer just to remove it.



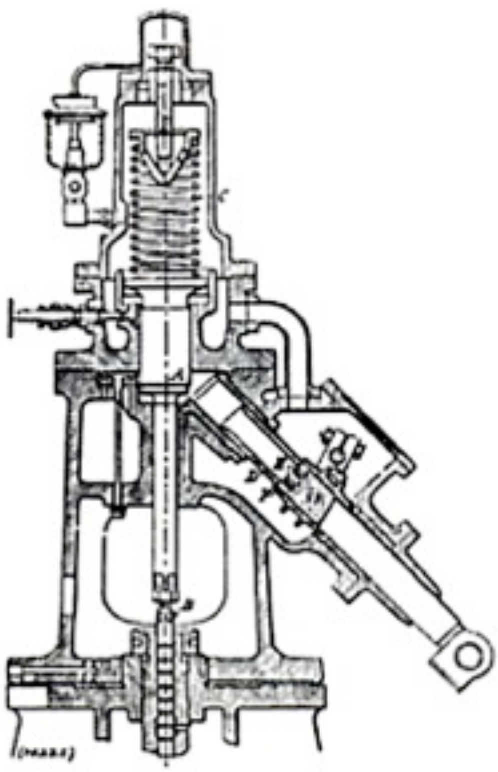
General view of the Elm Street Mill engine when still at work. The high pressure cylinder is on the left and the low pressure to the right.

Galloway had to design an engine that would fit within the space in the building and onto the bed of the earlier one. The result was another cross compound with a 21 ins. diam. counter-flow high pressure cylinder on the left called ‘Brian’. On the right was the 38 ins. diam. Uniflow low pressure cylinder called ‘David’, both 3 ft. stroke. These dimensions have been checked against those of a Galloway single cylinder Uniflow exhibited at the Wembley Exhibition in 1924. It has been suggested that the Elm Street engine was the one at Wembley but the dimensions show that the Elm Street one was larger. Both cylinders had double-beat drop inlet valves while the exhaust valves on the high pressure cylinder were the piston drop type. One of these caused a major stoppage when part of the casing broke. The agreements with the weaving companies allowed for a short period in which to rectify a breakdown after which penalties were incurred by the owner of the mill. In this instance, a repair was cobbled together to enable the engine to carry on for the rest of that day until something more permanent could be fitted during the night. The repair is still there. Otherwise this engine ran satisfactorily for over forty years. Steam at 150 p.s.i. was superheated to 500 or 600°F (265 – 316°C). The speed has been given as both 114 and 125 r.p.m. generating 600 or 1,000 h.p.



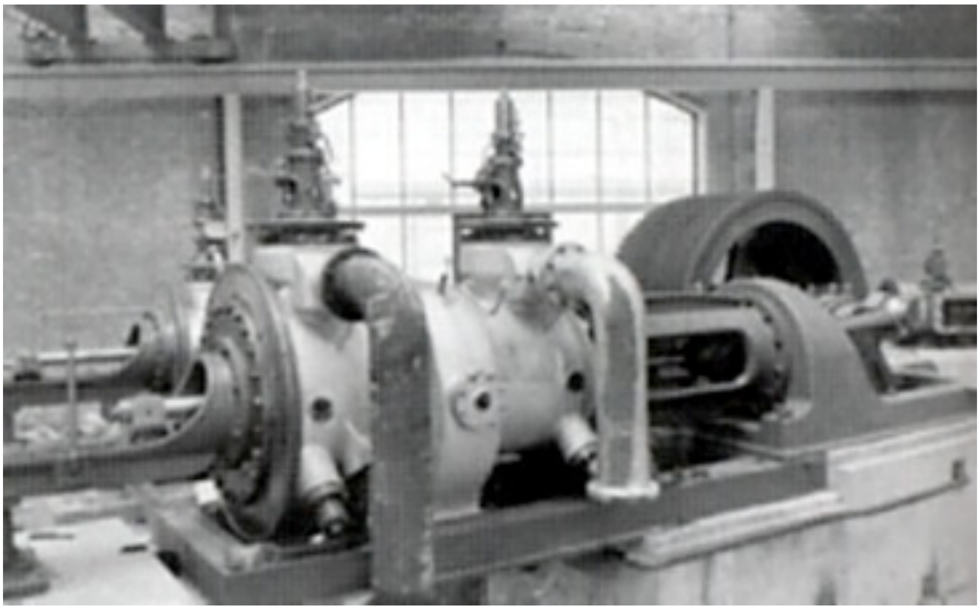
The high pressure cylinder showing the hydraulically operated drop valves on the top.

The Uniflow engine needed a short cut off precisely controlled on the inlet valves. Henry Pilling of Galloway patented a mechanism operated by hydraulic pressure. On the layshaft at the side of the cylinder, an eccentric for each inlet valve operated a plunger pump so oil pressure lifted the valve. The timing was set to give a constant point of valve opening while variable closure was achieved by the governor controlling a release valve. A spring in an oil-filled dashpot closed the valve in the usual way. This hydraulic gear gave remarkably effective control of the cut off from about zero to around sixty per cent of the stroke and needed very little power to operate it. It was fitted to the Elm Street engine and, after forty years use in the mill, needed no attention when replaced on the engine again in the Museum. Eccentrics worked the high pressure cylinder exhaust valves in the usual way. Pass-out steam for use by the weaving concerns was bled off from the steam pipe connecting the two cylinders. To keep this pressure constant, a Galloway pressure regulator controlled the cut off on the low pressure cylinder through similar hydraulically operated inlet valves.



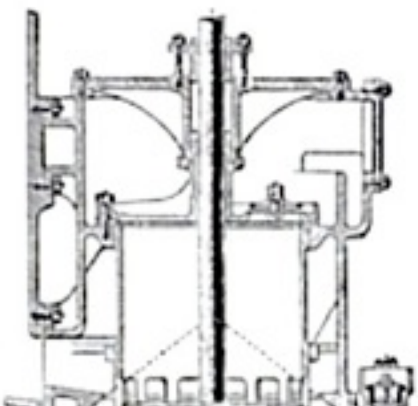
Drawing of Henry Pilling's hydraulic drop valve mechanism

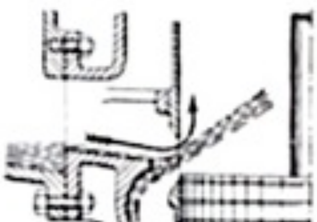
There were no normal exhaust valves on a Uniflow as the steam made its exit through a central ring of ports. But small exhaust compression release valves were fitted to prevent the build-up of excessive pressure. Galloway had a neat arrangement for operating theirs. A small cylinder, with its spring-loaded piston, was linked up to the exhaust pipe, and placed horizontally at the end of the layshaft of the Uniflow cylinder on which were fixed two eccentrics for the inlet valves and two cams to work the compression relief valves. These cams were free to slide along the layshaft and were pushed or pulled along depending upon the degree of vacuum in the small cylinder at the end. These cams were tapered to give maximum lift at one end when there was no vacuum, to no lift at all when the vacuum had been created. On this engine, the mechanism was connected to the exhaust passage round the centre of the cylinder. Pilling and Galloway had developed a compression relief gear which not only gave full opening during starting but also a graduated opening related to the state of the vacuum should the vacuum begin to fail at any time during running.



The Uniflow cylinder being re-erected at Liverpool Road. The casting over the ring of the exhaust ports can be seen in the centre.

The exhaust steam passed to a vertical jet condenser between and below the cylinders. The condensate was extracted by an Edwards ‘squish’ air pump with valveless bucket driven off the tail rod of the high pressure cylinder. Cold water came from the canal on the other side of the road and beyond a mill. The crankshaft was fitted with balance weights, the only example seen in a textile mill, to give smooth running. When we were dismantling the engine and took off the links driving the air pump bucket, the engine gave a quarter turn, so finely was it balanced. To cater for thermal expansion of the cylinders, the tail rod slides on both sides were supported on bearings that could move along the tops of their pedestals. The cylinders themselves were secured rigidly at their front ends to the trunk crosshead guides but were allowed to rock at the back where they were supported on spherical bearings.



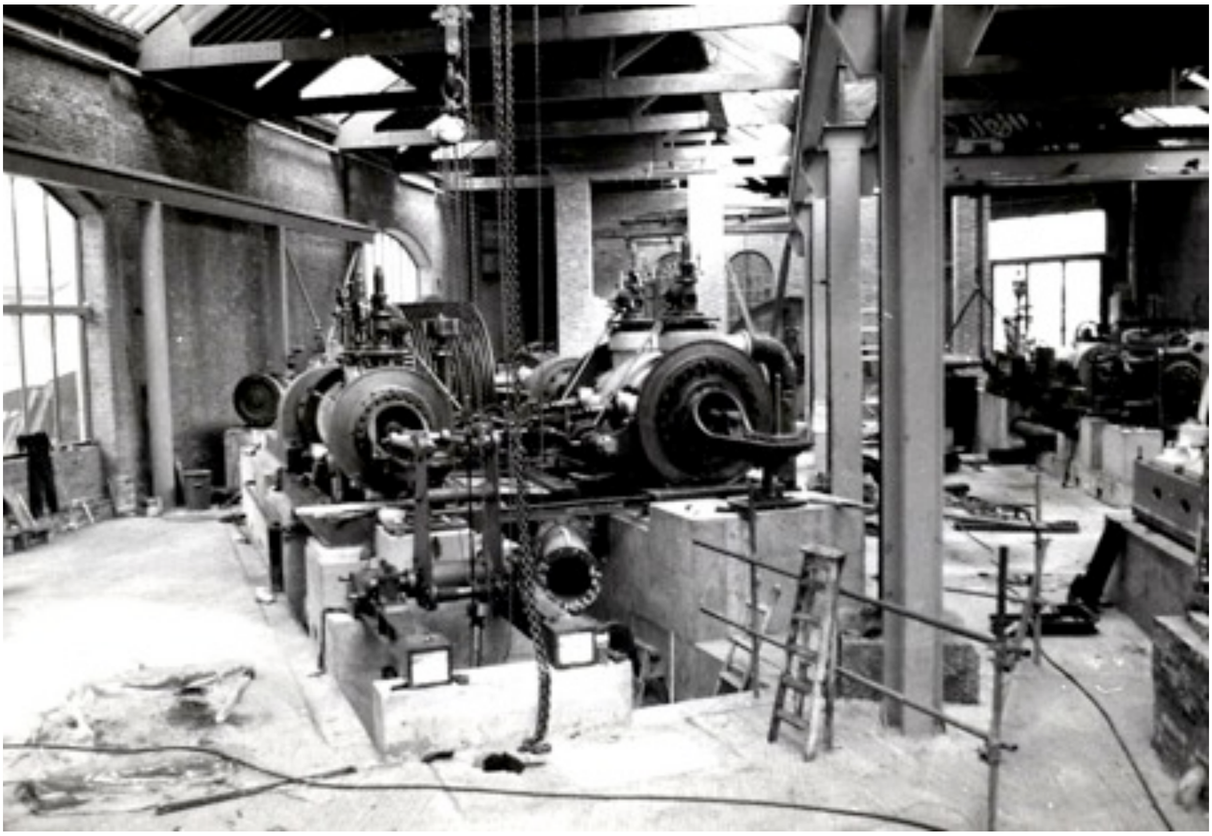


Cross section drawing of the Edwards air pump.

The low pressure cylinder was a single very complex casting with the central ports and the ring of the exhaust steam passage all in one piece. The crossheads, little ends, big ends and main bearings were totally enclosed because they were lubricated with oil at 30 p.s.i. To keep the rope speed down, the 4 ft. wide flywheel was only 11 ft. 6 ins. in diameter, grooved for 16 ropes. The frictional load was 155 b.h.p. yet the engine and all the mill shafting could be turned by a single cylinder barring engine of 15 h.p. To start the mill after the engine had been warmed up, this little engine rotated the big one until an inlet valve in the high pressure cylinder opened when the engineer, Jim Castling, would open the main steam valve. It was an impressive sight as the engine gathered speed and away went the mill.

In 1967, two of the weaving concerns announced that they would close. It proved uneconomic to continue running the engine for the other two so they were given notice that the engine would stop. The offer of the engine by Mr. Melland to the Museum presented me with major problems, having no suitable storage and virtually no finance. Luckily we had employed as technician a highly skilled millwright, Frank Wightman. With the help of a grant from the Science Museum Preservation Fund and Frank using his own millwrighting tackle, we were able to commence dismantling the engine. Storage was solved by the offer of space in a mill near Rochdale, but we had to move this engine to two other stores before it reached Liverpool Road, a soul-destroying task. Space around the engine at Elm Street was limited and soon the floor was filled with small parts which we took to Grosvenor Street. To move the cylinders and other larger parts meant taking up the chequer-plate flooring around the engine, leaving large gaps. Working conditions were not made any easier through Frank managing to set the mill on fire which damaged the roof. During the previous weekend, a new fuel tank had been lifted over the engine and I suspect it had been cleaned out and the volatile residue dumped in the pit beneath the engine. This caught fire when Frank was using oxy-acetylene cutting equipment. Later, I remember breaking up some asbestos lagging to scatter on the wet oily floor so I had something dry to lie on as I undid nuts under the low pressure cylinder. When it came to re-erection, there was nearly a down-tools by the men when they found a small patch of asbestos left on a cylinder.

Small parts could be lowered through the hole in the wall onto a lorry waiting inside the building at the door giving access to the boiler. By this time, the boiler had been cut up for scrap. It was also possible to manoeuvre one of Pickfords' heavy trailers into this space and build a temporary ramp on it with rails. The ramp had to be dismantled after each large part had been loaded, unlike the one we had at Firgrove Mill which could be left in situ. All the large heavy parts, two cylinders, two flywheel halves, crankshaft, two main bearing pedestals, two trunk guides, two bedplates, condenser and air pump had to be jacked up, pulled to the hole in the wall and carefully lowered onto a succession of trailers. It was a long, slow task lowering six-ton pieces, not helped when some second hand railway sleepers used for packing proved to be rotten inside and broke up. One half of the flywheel slipped off the trailer when the packing broke but luckily with no damage to either. Special frames had to be fabricated to support the flywheel halves and crankshaft. The beams supporting the air pump were prised from their seatings with pneumatic drills. It is a great tribute to Frank that eventually all the parts were saved but it all took many weeks of hard work. Moving the low pressure cylinder was particularly difficult because it had to be balanced on the small part of the casting for the exhaust exit.

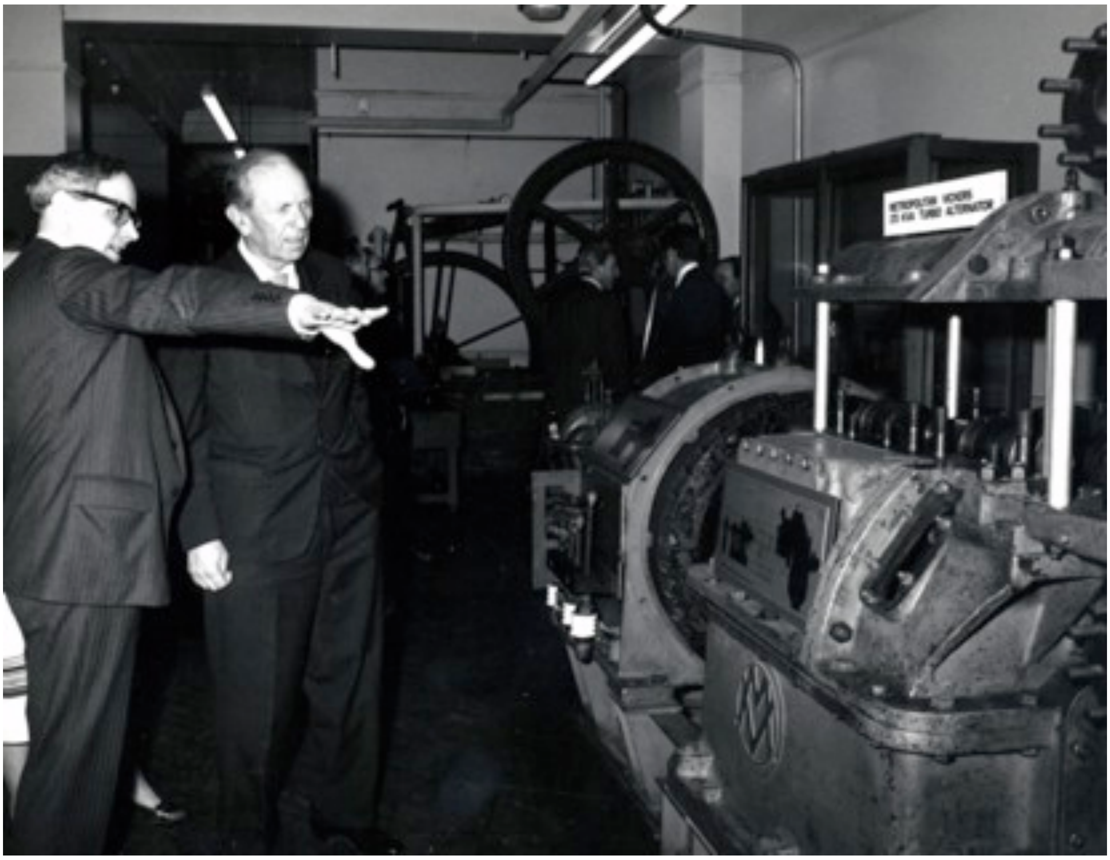


The Elm Street Mill engine being erected in the Power Hall. The Edwards air pump is in the foreground to the left with the high pressure cylinder behind it. The Uniflow low pressure cylinder is on the right.

When at last the longed-for time came for re-erection, we were able to return to Elm Street Mill and check the measurements of the engine beds. We started from the hole for one holding-down bolt and took all our measurements from that, giving the distance in imperial units from it to all the others. The architect wanted metric measurements and the individual distances between each bolt hole. The builder wanted imperial measurements. It was lucky that the final concrete beds could be just modified to fit the engine with only one or two cranked holding-down bolts. There was an added complication because the bedplates under the cylinders were stepped down from the main bearing pedestal castings. Cleaning and checking the parts took place in the Power Hall itself with a Community Industry team. The overhead crane was indispensable. All the parts were located and reassembled so the engine could run again to show the final theoretical and technical development of the reciprocating mill steam engine. The original chequer plating was replaced with open latticework so people could see what went on below floor level.

The Steam Turbine

In 1884, Charles Algernon Parsons patented a reaction steam turbine for driving electric generators for lighting purposes. A little later, Carl Gustaf Patrik de Laval developed a practical impulse turbine by 1889. It took a while before either type found its way into a textile mill. An early example of a conversion to electric generation by a turbine and electric transmission was Ashworth Hadwen's mill at Droylsden where, in 1907, the 1,000 h.p. beam engine and shafting with some ninety pairs of bevel wheels were replaced by a turbo-alternator and numerous electric motors. The type of turbine is not known. One of the very few textile mills to be designed for turbine and rope drive was the last steam-driven cotton spinning mill built in Britain. In 1926, Elk Mill, Royton, was equipped with a Parsons turbine of 2,600 h.p. It was the mill from where we took out our spinning mule. The turbine units and gearbox were only 16 ft. long and so minute compared with an equivalent reciprocating engine.



Inside Grosvenor Street with Dr. Hills explaining the Metropolitan-Vickers steam turbine with the vertical and grasshopper engines in the background.

To show one type of turbine, I accepted one supplied by Metropolitan-Vickers built in 1935 to supply electricity to a brickworks. When the brickworks closed, the turbine was taken back into Metropolitan-Vickers Apprentice School. When that closed, I removed the turbine for display at Grosvenor Street. It was a change to have an engine that could be moved easily. The exhaust passed into an integral condenser, the largest piece. The rotor casing bridged the gap from condenser to gearbox. The alternator, exciter and water circulating pump were mounted at the Apprentice School on short lengths of girders at their respective correct heights. This made for quick re-assembly at Grosvenor Street opposite the Newcomen engine. The upper casing over the steam rotor was raised so visitors could see the blades. A small electric motor was fitted to turn the rotor round. At Liverpool Road, it was situated close by the Elm Street Mill Uniflow engine, the Mirrlees air-blast diesel engine and National solid injection diesel engine to show the competing types in the 1920s and 1930s.

What Was Achieved

The main exhibits in the mill engine collection had a multitude of different technical features. Each cylinder had a different type of valve gear, ranging from early slide valves, through Corliss to the latest drop valves and Uniflow. A beam engine, horizontal engines showing tandem and cross compound layouts and an inverted vertical engine; connecting rods of cast, wrought iron and steel; crosshead guides both flat and trunk; each flywheel was different, plain, geared, rope, open or shrouded with mahogany. The condensing methods showed the condenser immersed in a tank of cold water or relying on a jet. Each air pump had a different type of bucket to remove the condensate with an Edwards type on the Elm Street engine to cover ones for higher speeds. There were cylinders with tail rods or none. Governors ranged from the simple Watt type to the Lumb compensator variety. Oiling methods included open holes into which oil was poured to oil circulating under pressure. All in all, it would have been difficult to find other engines that covered such a wide range and all these engines were installed so they could be demonstrated under steam.

In their bulletin in 1983, the International Stationary Steam Engine Society wrote:

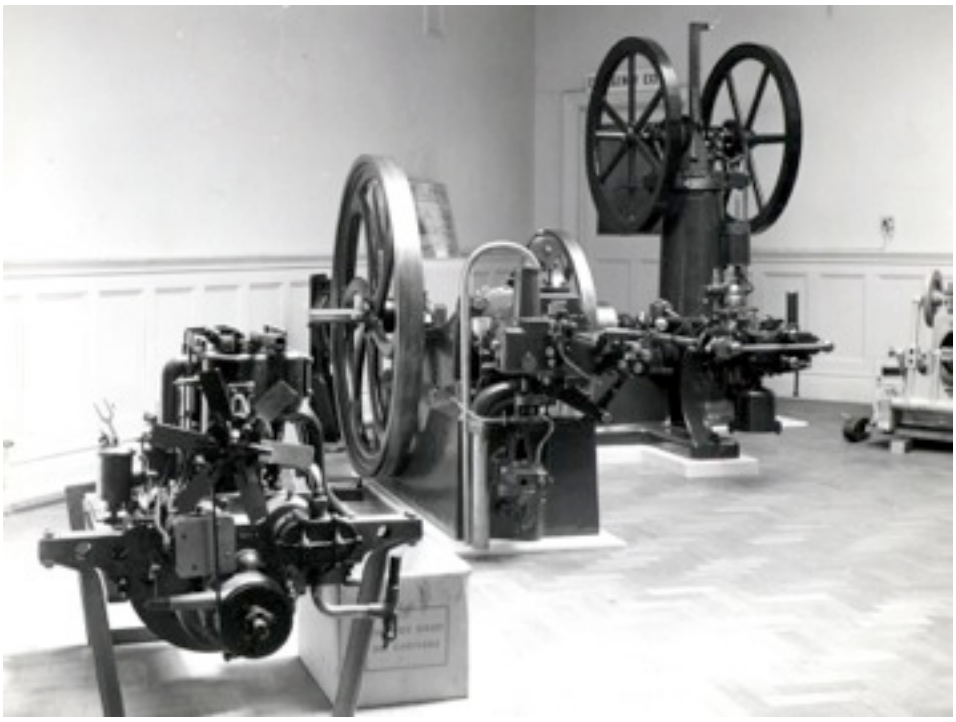
> "Another significant opening was of the new Greater Manchester Museum of Science and Industry at Liverpool Road Manchester, although not initially in steam. This was one of the best museums of its type for a generation and in my opinion still remains in the top echelon."

Later that year, the Editor wrote 'The Greater Manchester Museum of Science and Industry started steaming their impressive collection of mill engines.'

In *Professional Engineering* for March 2011, there was an article about the new displays at MOSI.

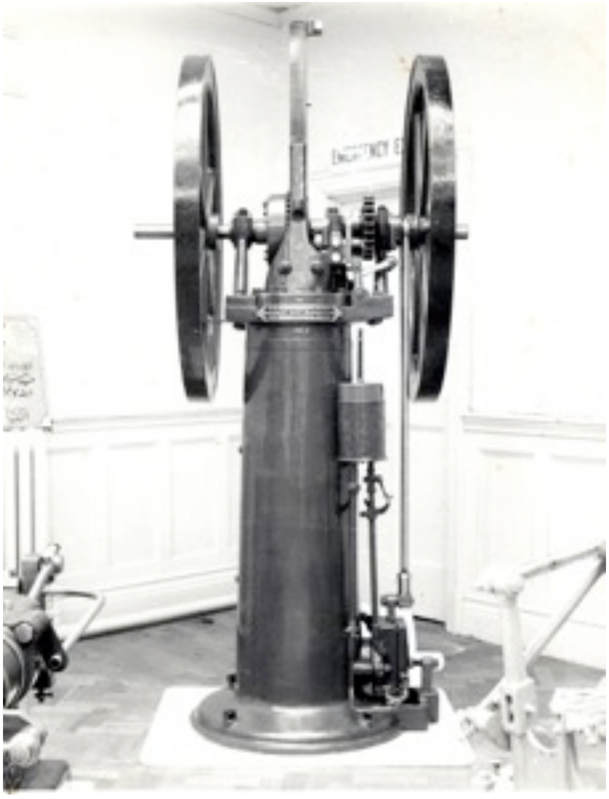
> "The impressive nature of the new gallery means it would be easy to overlook some of the existing displays… The power hall is particularly impressive, offering a gamut of beam engines, pumps, water turbines, oil and gas engines – you name it, it's there.
>
> Two displays really took the eye – a gigantic Firgrove mill engine made by McNaught of Rochdale in 1907. And a Ferranti Cross-compound inverted engine made in 1900. Both are fine pieces of craftsmanship."

Internal Combustion Engines

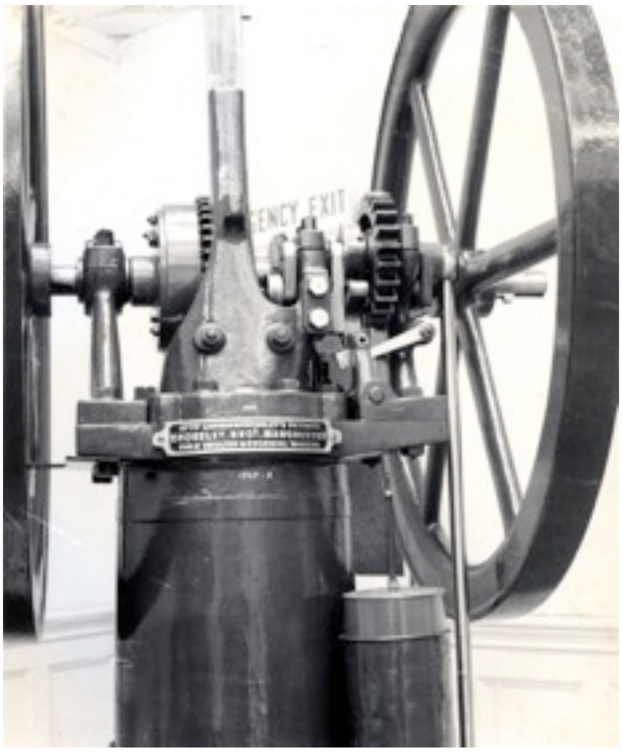


The initial display at Grosvenor Street of the Crossley engines with the Royce car engine in the foreground.

We were very fortunate with the internal combustion engine collection in securing some very early examples through Crossley Ltd. The Crossley brothers had formed an association with the pioneer inventor Nicklaus Otto of Germany and secured the rights to build two types of his engine in Britain and the Colonies. Crossley Ltd. had preserved some of their early engines in their Power House. When they decided to cease having stand-by generators, they were about to offer these engines to the Birmingham Science Museum. Luckily plans for the Grosvenor Street Museum had progressed far enough and had come to the notice of Frank Beard, their service manager, who approached me to see if we could take any of them. Frank showed me round Crossley's works in Grey Mare Lane where I saw some photographic albums and ledgers of engine sales. Later Ken Barlow made use of some of these archives for his PhD thesis but I fear they were not preserved. Likewise, I was asked what could happen to a large religious oil painting in what once had been a chapel for the workers there. I referred this to the Art Gallery but suspect it was not considered to be of sufficient artistic merit to be worth preservation.



Crossley atmospheric gas engine, front view, with gas slide valve for inlet and ignition bottom right.

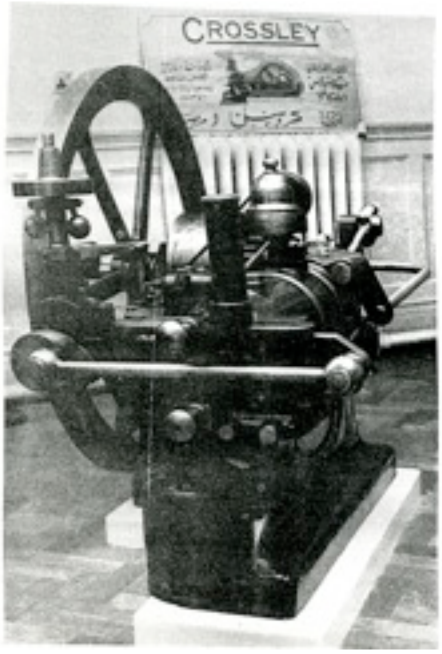


Details of the Crossley atmospheric gas engine with gearwheels and ratchet mechanism to operate the valve gear. Bottom right is the gas anti-fluctuation float and water chamber.

Of the Crossley internal combustion engines, we had space to display only three so at least one went to Birmingham. We never did acquire an example of what must be considered the first working type of internal combustion engine, the Lenoir, but this was not very successful with a high gas consumption. The Crossley collection in three engines took the story from the atmospheric gas engine, through an early four stroke gas engine to an early liquid fuel oil engine. At Grosvenor Street, these were displayed initially static opposite the Newcomen engine. The atmospheric gas engine is a rather top heavy beast with its twin flywheels. We were glad we could use part of the iron framing of the skylight to attach a hoist. The engines were painted by a man from Crossley's in the correct shade of green.

When the time came to expand into the Methodist part of Grosvenor Street, we decided to make the two early engines run again. One problem was that the gas supply was being changed from town to North Sea gas which had different burning characteristics. The atmospheric gas engine had a free piston. An explosive mixture was drawn into the cylinder and fired by a permanently burning flame through a movement of the slide valve. The piston with its rack shot up rather like a canon ball, creating a partial vacuum below in the cylinder. The pressure of the atmosphere forced the piston down, the rack engaged, turning the flywheels. We certainly had no idea that it would work so spectacularly and noisily. But we realised that it might be difficult to control the explosion and so decided not to try to convert this beast to North Sea gas. Accordingly it was run off bottled simulated town gas which had a high hydrogen content. When reassembling the engine in its new position, we found that the driving shaft had become twisted. We jokingly complained to Frank Beard that this was very poor workmanship by Crossleys in a machine merely an hundred years old and they duly replaced it. As well as being noisy, mechanically very complicated, such engines were limited to a maximum size of 3 h.p. due to shock forces. The one we had produced perhaps 1 h.p. for all its massive bulk.

Otto's four stroke engine, often called the silent engine, provided a dramatic contrast. To run it on North Sea gas required modification of the porting to give the right proportions of gas and air mixture. Ignition was again by a flame but, due to the way this was carried across by the slide valve to ignite the main charge, we decided it was safer to retain the simulated town gas for the ignition flame while it would be more economical to use North Sea gas for the main charge in the cylinder. When running, the engine performed so quietly compared with the atmospheric gas one and produced much more power, probably a possible 3.5 h.p. from its much smaller size.



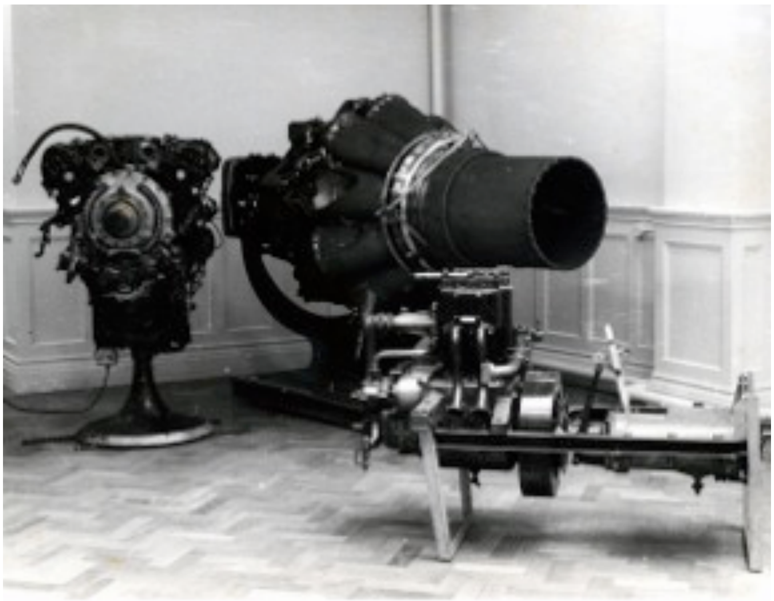
Crossley horizontal four stroke gas engine showing gas inlet and combustion slide valve, centrifugal governor and domed belt-driven oiler.

Another gas engine on display was a little Robinson four stroke type with inclined cylinder. Here a gas flame heated part of an enclosed tube which opened at its lower end into the cylinder. As the gas/air mixture in the cylinder was compressed, some was forced up the tube till it reached a part hot enough to ignite it. There was doubt whether this arrangement could be converted to North Sea gas but Ken Barlow achieved this successfully as he had done with the Crossley four stroke. The tube had to be the correct length. This little engine was useful for demonstrations as was a single cylinder Petter petrol/paraffin engine lent by myself to show yet another principle. In the enlarged display, there were a single cylinder Crossley semi-diesel and a model of a Crossley multi-cylinder engine. Gardiners of Patricroft donated an early example of their four cylinder 4LD diesel engine. This was a very important design because it was adapted for use in buses, ships and even in lifeboats.

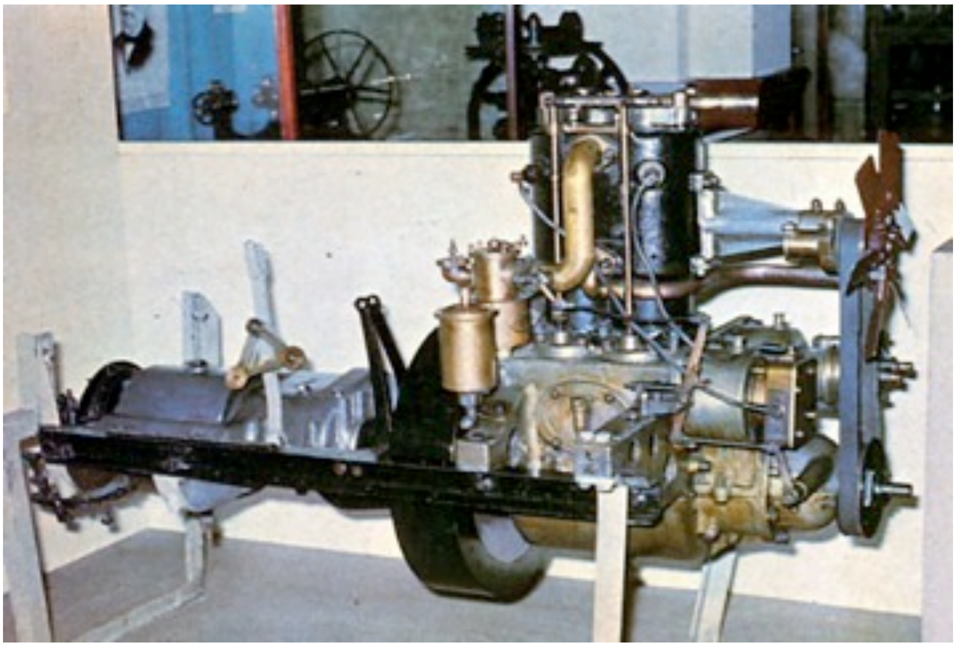
Harry Applebee, technician, starting the Robinson gas engine.

The Petter engine in the new internal combustion
engine display at Grosvenor Street.

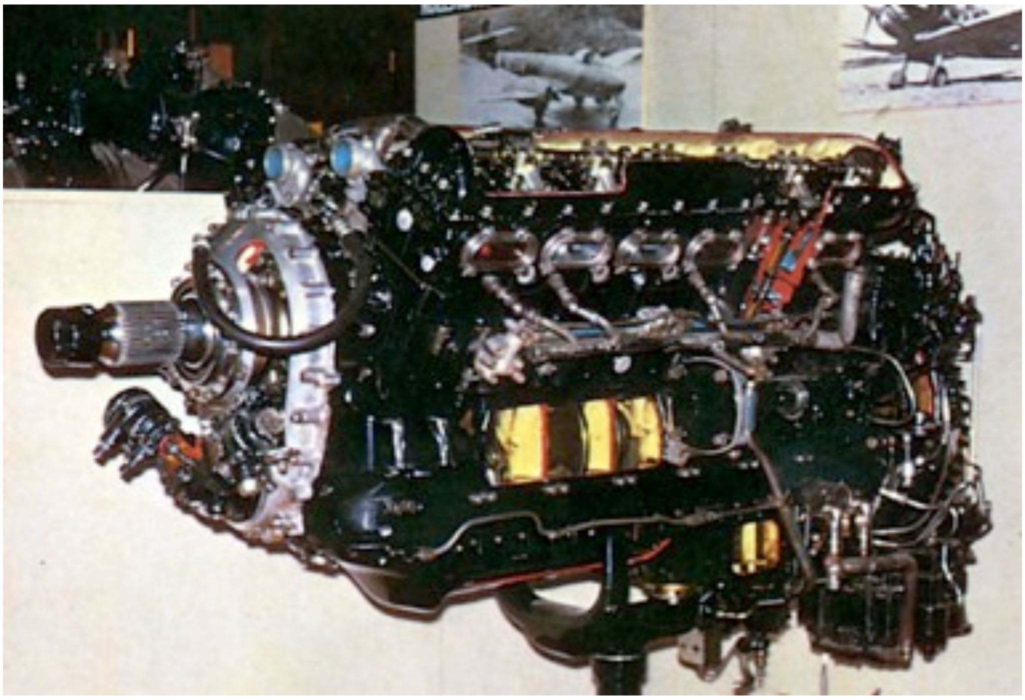
From the beginning at Grosvenor Street, UMIST Mechanical Engineering Department presented three engines associated with Royce/Rolls Royce. The oldest was the two cylinder engine and gearbox from one of the three motor cars built by Henry Royce before he formed the partnership with Rolls. We never tried to see if we could get this running owing to its immense value. When putting this on display in the enlarged part of Grosvenor Street, the sign writer called it a Rolls Royce – the Rolls had to be quickly blanked out! The Rolls Royce Merlin had been sectioned for instruction purposes and mounted on a small stand so that it could be rotated. It had been lent to Marple Grammar School from where we had to collect it. It had to be manoeuvred up a long sloping path with a step at intervals. This proved to be a major problem as the incline made the top heavy engine nearly overbalance on its small stand. The Rolls Royce Derwent jet engine was much easier to move, having wheels under its much broader stand. This had also been sectioned and showed on early type of jet engine with a centrifugal compressor instead of the later straight through types. So at Grosvenor Street we were able to show a brief history of the internal combustion engine with the exception of the diesel engine. This was to be remedied with the move to Liverpool Road.



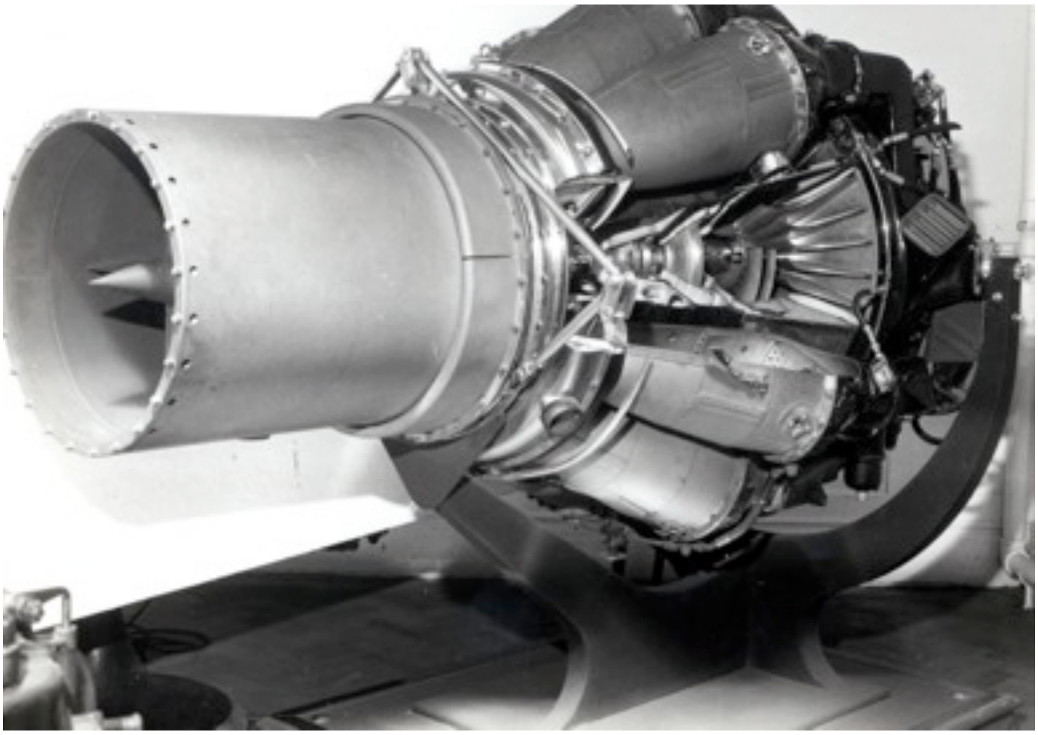
The initial display at Grosvenor Street of the Rolls Royce Merlin on the left, the Derwent centre and the Royce car engine right, presented by the Mechanical Engineering Department, U.M.I.S.T.



The Royce two cylinder four stroke engine and gear box displayed at Grosvenor Street.



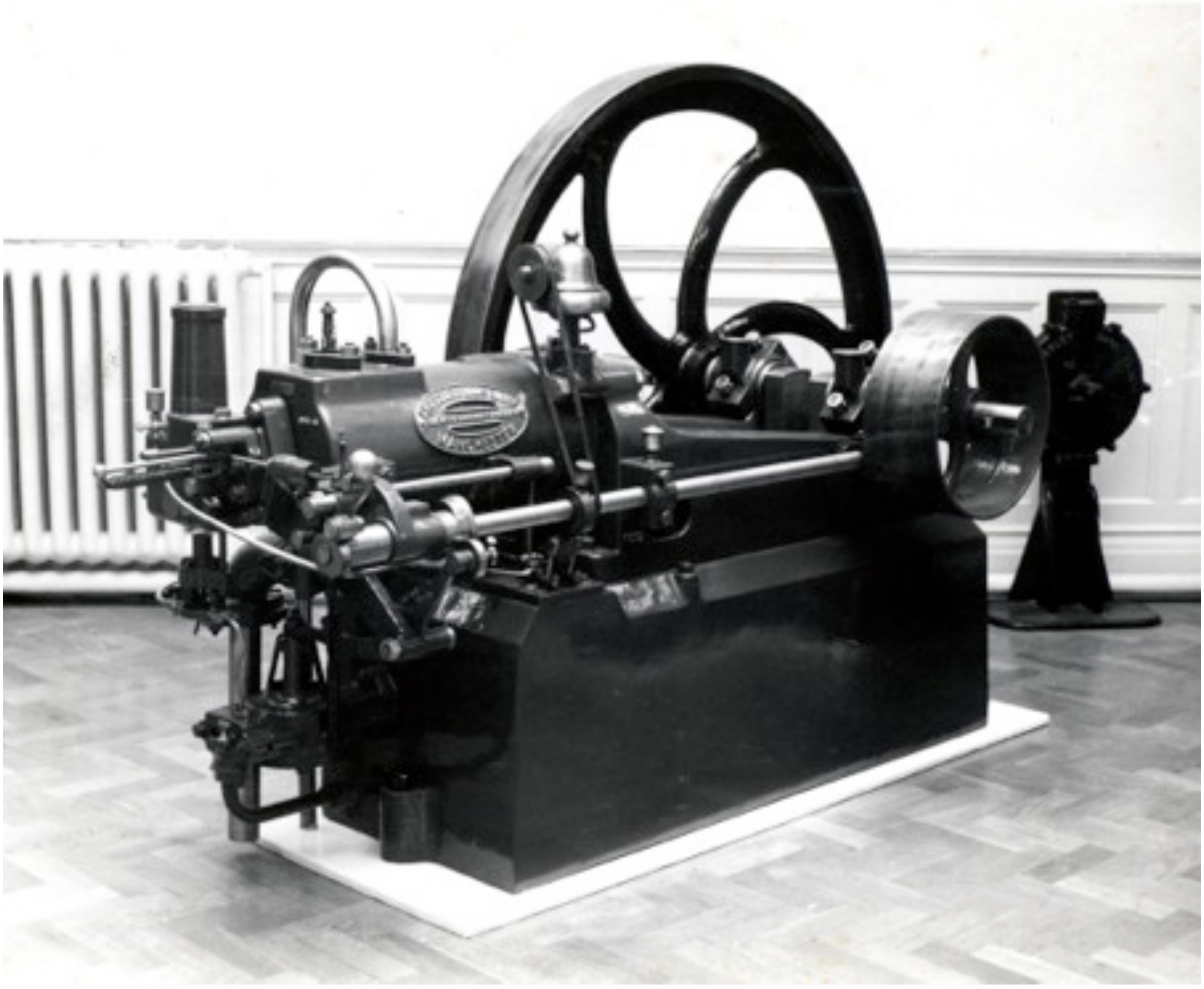
A sectioned Rolls Royce Merlin engine.



Rolls Royce Derwent jet engine, a very early type of jet engine with centrifugal compressor.

At the Power Hall, we decided to split the atmospheric gas engines from the four stroke to give the latter more display space. The Crossley atmospheric gas engine was displayed with a much smaller Bischopp engine in which the piston was not free but was linked to the crank. The four stroke display started with a replica made by

Ken Barlow of Otto's original engine in full working order. Next came the Crossley silent four stroke gas engine from Grosvenor Street. We found the diagram for how the slide valves should be scraped to give slightly higher faces in some parts to ensure gas seals and reduce friction. Jack Taylor, Museum technician, was an expert at scraping so the engine worked much better after his ministrations. Another smaller engine was rigged up with overhead line shafting to drive a small lathe for demonstration purposes. Then came the third of our original Crossley engines, an 'M' type heavy oil engine. Ignition was by a flame heating a hot bulb. Once hot enough, the subsequent explosions would keep it up to temperature. The Royce two cylinder, Merlin and Derwent engines originally were displayed here as well.



Crossley 'M' type horizontal four stroke heavy oil engine with a form of hot tube ignition.

Diesel Engines

On the opposite side of the walking route two large diesel engines were positioned. Diesel's original idea was to inject the fuel with a blast of air which would help it atomise for better combustion. Permission to build these engines in Britain was gained by Mirrlees Watson of Glasgow. One of their original engines is preserved in the Science Museum, London. Then a partnership was formed with Bickerton of the National Gas Engine Company, Ashton-under-Lyne, and the decision was taken to manufacture these engines in the Manchester region with its great range of engineering skills. But where to found the works? The story is that Bickerton realised that if he were to go and search for somewhere, the price would rise because he was too well known. So Day, the National Works Manager, was sent out and found a vacant site at Hazel Grove. With such local connections as well as the historic importance, a Mirrlees Bickerton and Day air blast diesel engine would be a very appropriate exhibit.

Discreet enquiries about the possibility of having the very early single cylinder one displayed in the open at Hazel Grove assured us it was not for the taking. The Manchester Ship Canal had used these engines for pumping water back up at Mode Wheel Locks but their fate was unknown. The site was difficult to access and they had been out of use for many years. The news came that the Mid-Kent Water Board was in the process of electrifying their Trottersclife Pumping Station near West Malling and the mid 1920s three cylinder Mirrlees air blast diesels would be scrapped. Yes; we could have one provided we removed it. This meant Museum staff going down to Kent. Mirrlees agreed to store the parts while the foundations in the Power Hall were being prepared.

Our engine was at the end of a line of five. The pump house was fitted with a ten ton overhead crane and there was good access for vehicles. What we did not realise at the time was that the ends of the pump house had sunk due to water extraction from underneath so that gaps opened up between the crane rails. The crane wheels would stick in the gaps. The parts had to be moved to the centre of the pump house for loading. We developed a technique of swinging a heavy part on the end of the crane hoist chains and pulling on the traversing chain just at the right moment to use the momentum of the swinging part to make the wheels jump the gap. Health and safety were not watching! Pickfords' men were quite surprised at this technique when they came to take the parts away.

Most parts were dismantled with no problem and marked for reassembly until we came to the main bedplate. This was a single casting for all three cylinder pedestals, air pump, flywheel bearing and sump. It was grouted into concrete made with flint nodules. Even attacking the concrete with quango hammers made virtually no impression. After chopping away some of the grout with hammer and chisel, we decided to try lifting the bedplate. I insisted on replacing the nuts loosely on the holding down bolts to give about a quarter inch gap. Then, with the ten ton block on the crane, supplemented with our own five ton block and a couple of five ton hydraulic jacks inserted where we could underneath, we sweated up all the lifting tackle. Suddenly there was a large bang which shook the whole building. The bedplate was free and in one piece. Luckily it had not broken and luckily the grout had not run far underneath. As well as the complete engine, we were able to stock up with a wide range of spares. The engine has been run successfully in the Power Hall.

Next to the Mirrlees is displayed a single cylinder horizontal National diesel engine. This has the next stage in development, solid fuel injection, so it does not need the complications of an air pump capable of compressing air up to 1,000 p.s.i. with its associated storage cylinders as can be seen on the Mirrlees. The National drives its original generator and lighting set so is also displayed fully operational, completing the internal combustion engine display.

National diesel engine and generator being erected in the Power Hall with Mirrlees 3 cylinder diesel engine under wraps in the background.

What Had Been Achieved

Perhaps the internal combustion engine display has been overshadowed by the much larger steam engine exhibits but in the history of civilization they were extremely important because they were a more compact form of power that could be left to run themselves without the need for an attendant such a stoker for the boiler. Maybe today many once used in industrial concerns have been replaced by electric motors so we forget how once they were widespread in so many factories and elsewhere. We were able to display most of our engines actually working with their original source of energy, gas, petrol or diesel. The Mirrlees diesel engine is an impressive machine, and takes the story into the modern era.

Chapter 5, The Railway Collection.

The Background

The formation of the Greater Manchester Council and its participation in the Museum changed its future prospects because here was a scheme that had potential for benefiting the whole region. Then British Rail wished to dispose of their goods depot at Liverpool Road Station, a prime site near the city centre which had two later warehouses, the single storey Goods Shed but also the Grade 1 listed original 1830 Liverpool & Manchester Railway station with its associated warehouse. Proposals for this to become some form of transport museum had been circulated for a long time. However the state of the 1830 warehouse with its wooden floors and closely spaced wooden columns meant that it was barely suited for a museum of technology. Added to which the structure had deteriorated through neglect over many years.

Therefore it was with some apprehension that I heard that the Greater Manchester Council had agreed to purchase the 1830 buildings from British Rail for the enormous sum of one pound. Romance had prevailed over reason. The original plans for the Museum would have covered the rail tracks in the 1830 area to house railway exhibits. However the GMC wanted to hold a celebration to mark the 150 anniversary of the world's first Inter-City Railway opened on 15 September 1830. Acquisition of the Goods Shed would not only provide accommodation for the celebrations in 1980 but would also provide a much better display area for the proposed Museum of Science and Industry. While most of the buildings on the site were multi-storey and the rail tracks were supported on brick arches, one end of the Goods Shed covered solid ground where it would at last be possible to erect the mill engines. Having been instrumental in persuading the GMC to purchase the Goods Shed, I left it to the architect, Arthur Little, to persuade them to acquire the 1870 warehouse which by this time had been purchased by the City of Manchester. We knew that this structure was by far the best on the site for museum purposes even though it too was in a semi-derelict condition. This transfer occurred after the 1980 exhibition had closed so our initial planning could not take it into account.

The decision to turn Liverpool Road Station into the permanent home for the Museum meant that there would have to be some display of railway locomotives. But which? By 1979, most preserved steam railway locomotives in Britain had permanent homes. While some might be borrowed, for example from the National Railway Museum, this would not form the nucleus of a permanent collection. However there were certain themes that merited pursuit. The first was that the Museum would be situated in the world's oldest passenger railway station so that the history of railways had to be included. The North West Region had been a centre for locomotive construction with firms such as Beyer, Peacock, William Fairbairn, Benjamin Hick, Nasmyth Wilson, the Vulcan Foundry at Newton Le Willows as well as more recently Metropolitan-Vickers. One feature which could be represented was that all these manufacturers exported some of their products. Repatriation of locomotives from abroad would add another picture to the preservation scene in Britain. Finally, with so many other exhibits able to be demonstrated, it seemed appropriate that there should be a working railway on the site.

A Working Railway

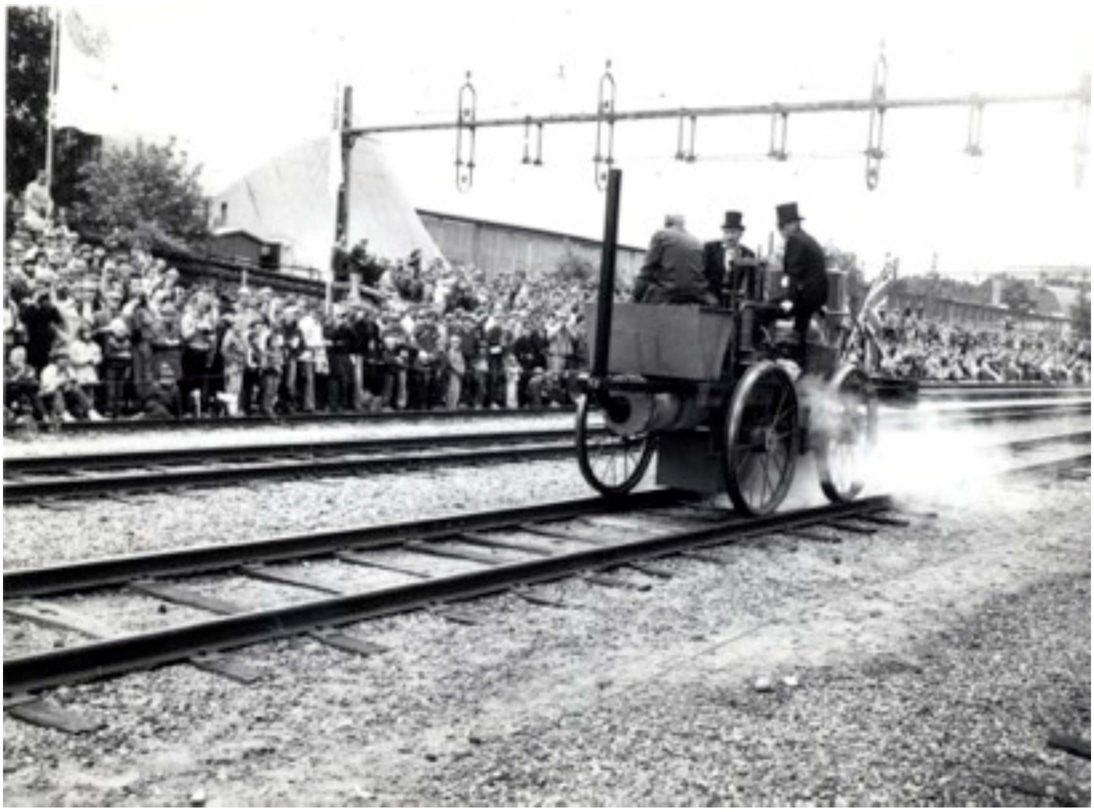
The length of line within the immediate Museum gave some scope for running a small train, especially if it could be extended over the River Irwell towards the main lines. The architect designed a platform with modern style canopy close to the Byrom Street entrance. But when Joe Taylor, the Railway Inspector, saw it, he condemned it immediately because the stanchions supporting the roof were too close to the running line. Luckily there was just enough room to move the canopy back. There were no run-round facilities at either end so the locomotive was placed at the Liverpool end of the carriages and pushed them into the platform. This was alright until Granada held its New Year festivities at the Museum. To give the best effect for viewers, our replica train had to draw into Liverpool Road as if coming from Liverpool. So our train had been previously taken on the main line through Victoria Station and turned on the Miles Platting triangle. But it was not turned again once the festivities had finished. However luckily the platform was just long enough to accommodate the four-coupled tank engine from Agecroft and our two carriages.

The engine from Agecroft built by Stephenson & Hawthorn hauling the replica carriages.

The loan of the No. 3 shunting locomotive from the C.E.G.B. Agecroft Power Station was the end of a long quest for a suitable demonstration steam locomotive. It was built by R. Stephenson & Hawthorn in 1954 but it and the carriages had to be fitted with equipment to work vacuum brakes which was generously supplied by Davies & Metcalf of Romiley. Much earlier when we were preserving the archives from Beyer, Peacock, I had looked longingly at their works shunter puffing around the yard at Gorton. It was a four-coupled saddle tank engine built in 1878. Although in poor condition, it would have been an appropriate engine but we had no money to buy it and nowhere to store it. It has since been restored and came to Liverpool Road in August 2009 to help celebrate the steaming of the first Garratt.

While dismantling the Haydock beam engine, we looked at the 0-6-0 saddle tank engine 'Bellerophon' in the maintenance workshop there. It had been built at Haydock so, with its local connections, it would have been another appropriate locomotive. But again there was nowhere to store it. When it became apparent that the Museum would be established at Liverpool Road, Donald Anderson, a colliery owner in the Wigan area, offered us the 0-6-0 tank engine 'Lindsay' which he had restored. It had been built locally so would have been appropriate but once again no purchase funds were forthcoming and no temporary storage place.

Another line of investigation was to build a replica locomotive based on an engine of the 1830s. The replica 'Novelty' built by Locomotion Enterprises of the Rainhill Trials re-enactment in 1979 was a possibility. After those trials, it come to Liverpool Road and trials with it soon showed that the design of boiler would not generate enough steam to haul a couple of carriages regularly. However we did fit it with a parking brake and made its air blower work sufficiently for it to be taken to Sweden to celebrate the 125th. Anniversary of their railways. While it ran smoothly, the rims of the wheels had been made too narrow so it was liable to fall between the rails. It worked well enough to convince the Mayor of Gavle and the Swedish Railway authorities to buy it for their museum since it had been designed by Ericsson the Swede. I was relieved to see it find a good home in Sweden for it would have been a liability in Manchester. I did investigate the possibility of building a replica of one of Benjamin Hick's 2-2-0 tender locomotives, some of which were exported to America. However the boiler design and size, while better then Novelty's, would probably have been too small for reliable demonstrations hauling replica carriages.



Novelty at the celebrations in Stockholm to celebrate the 125th anniversary of the Swedish Railways, June 1981.

Another small locomotive that might have been able to haul the replica carriages was a J. Fowler 0-4-0 diesel with mechanical transmission of 1957 vintage. It was presented by the Clayton Aniline Ltd., having been used at their Clayton factory. Before it could be fitted with an exhauster for vacuum brakes, it was left out in the open one winter with the cooling system filled with water but no anti-freeze. The cylinder block was cracked. There was also on site for a while a fireless locomotive which could be filled with steam from the boiler supplying the mill engines. This also seems to have languished unloved. Taken together with the steam locomotives, the railway collection covered a wide variety of motive power.

Front view of the 0-4-0 Fowler diesel locomotive.

As well as a working locomotive, we needed carriages. I scaled up the drawings in Nicholas Wood's book, *A Practical Treatise on Railroads*, 1838, and found that the carriages were almost exactly the same size as the four-wheeled coal wagons then still common on British Railways. These replica carriages would be very useful for the Great Railway Exposition in 1980. We wanted two goods wagon underframes fitted with vacuum brakes and screw couplings. We had good contacts with British Railways and the rail unions at the time. A meeting was held in Horwich Works. Coal wagons were not available because the Government had decreed that as many as possible were to be stocked with coal in case of a miners' strike. But some covered wagons were being scrapped – would a couple of these chassis be suitable since they were the same size and had vacuum brakes? Soon a couple of these minus their bodies somehow failed to reach the scrap yards and fell off in Liverpool Road.

A local timber merchant supplied the wood for the bodies and roofs. A Community Industry scheme was established which completed the carriages just in time for the Exposition. I drew out the stanchions supporting the roofs to the same size as depicted by Nicholas Wood but there were so many complaints from people hitting their heads due to the low roof height that we had to lengthen the stanchions. I am pleased to note that these carriages are still being enjoyed by passengers today.

Second class replica carriage.

The Liverpool Road Station Society members manned the replica train. They hoped that Liverpool Road itself might become a maintenance depot for any locomotives for steam-hauled excursions visiting the area. Consequently an ash pit was dug between one set of rails alongside the Power Hall. For refreshing our visitors, I went to Micheldever near Winchester to view a Pullman car. I had hopes that this could be turned into a sort of executive meeting and dining suite but funds were not forthcoming. In the end, an ordinary restaurant car was adapted as a café called 'Chuffers' which filled this role until larger facilities could be opened in the 1870 warehouse.

Historic Locomotives

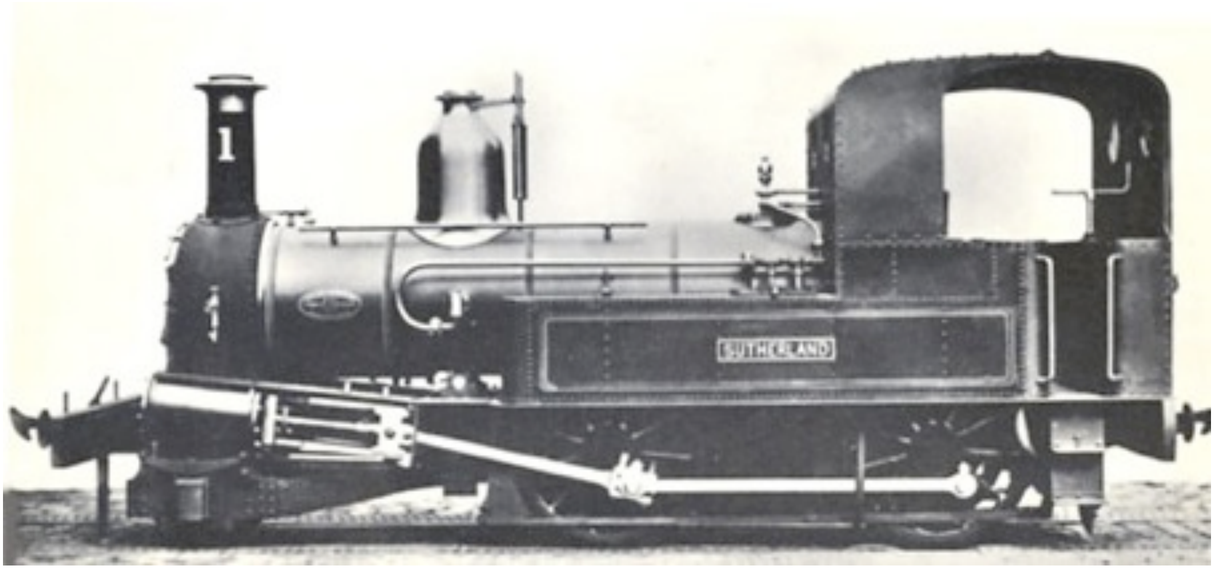
To make the transition from the mill engines to the railway collection, I had hoped to have an introductory display of model locomotives to show the development leading up to the first ones for the Liverpool & Manchester Railway. These might have included a Blenkinsop rack type used on the Orrell Railway near Wigan. There might have been space here for the 1929 replica of 'Novelty' lent by the Science Museum. This has a cylinder and four wheels off the original. Had Locomotion Enterprises known about this and measured the correct width of the wheel rims, it would have saved a lot of problems later. Another original cylinder was displayed at Rainhill Station which I think was moved to the Liverpool Museum. We had another Community Industry scheme rebuild the 1929 replica so that its wheels and motion could be turned by a concealed electric motor.

With Novelty representing the dawn of locomotive technology, we needed something to show the initial flowering of the pioneers. This exhibit might show as well the basic features of a steam railway locomotive. How an engine works might be explained by sectioning one. The sectioned Merchant Navy class at York Railway Museum is an impressive exhibit but almost too large for the average visitor to understand. The Lucerne Transport Museum had sectioned a narrow gauge tank locomotive. Visitors could stand on steps beside it while a member of staff pointed out the various parts following a recorded commentary. Could we do something similar in Manchester, and, if so, what locomotive might be available?

Pender

Thoughts turned to the Isle of Man where the railway network had been drastically reduced, leaving many of their locomotives redundant. Most had been purchased from Beyer, Peacock and so fitted two of our criteria, local and overseas connections. Might one be available? But how could it be brought back to Manchester because it would have to be dismantled and craned onto a boat at the small wharf in Castletown. For this, we had neither men nor money. Yet the project was worth pursuing.

My cousin, Elspeth Quayle, was a member of the House of Keys. I had been able to visit some of the railway workshops and she arranged for me to have lunch with the Minister of Transport. This coincided with the debate about inaugurating a roll-on-roll-off ferry service to the Island. It was decided to have this type of ferry which incidentally was to solve our transport problems. At lunch, we agreed that, in return for my suggesting what historic items the Isle of Man Railways had in their workshops, the Manx Government would sell one of their locomotives to the Museum provided it would not be steamed again and would advertise the Manx railways. Here was an engine that could be sectioned. The locomotive offered was No. 3 ‘Pender’, the last of the first batch built by Beyer, Peacock in 1873 to a design that originated in 1865 for the Norwegian Railways.



Beyer, Peacock's official photograph of the first batch of locomotives purchased by the Isle of Man Railways.

'Pender' in position at Douglas ready to be pushed onto Pickfords low-loader by the County Donegal railcar, September 1979.

By the time all the details had been settled, the Ro-Ro ferry was running. 'Pender' would fit onto one of Pickfords' low loaders so we decided the bring 'Pender' back in time to take part in the procession on 15 September 1979 to celebrate the 149th Anniversary of the opening of the Liverpool & Manchester Railway. I returned to the Isle of Man to check all was ready for loading and clean 'Pender' up a bit. It had been intended to load 'Pender' on the same afternoon as Pickfords arrived and return on the ferry the following day. This plan was foiled by the late arrival of the ferry. It was dark by the time we were able to push 'Pender' up the ramp onto the low loader with the ex-County Donegal railcar. There was also a hand-operated winch on the low loader to assist hauling 'Pender' up. There was nearly a disaster as the railcar pushed 'Pender' up quicker than we could take in the wire rope on the winch so the wire went slack. 'Pender' slid back and the tow bar nearly went through the radiator of the railcar. All was eventually secured safely but it was too late to arrange for 'Pender' to catch the ferry the following morning so the crossing was made the day after. Luckily 'Pender' was low enough to fit under the ferry door.

Still on the same low loader, 'Pender' joined in the anniversary procession through Manchester in 1979. Pickfords took her back to their depot at Farnworth where she was stored in a container because we had nowhere else to put her. We were arranging for another Community Industry scheme to carry out the sectioning and restoration. The City of Manchester came to the rescue by offering us part of Beyer, Peacock's boiler shop at Gorton which had been taken over by their Refuse Department. The team worked under the supervision of Sid Barnes, my Chief Technician, and an ex-Beyer, Peacock fitter, Jack Starkie. 'Pender' herself had been rebuilt over the years with new cab, side tanks, boiler, etc., so the sectioning left the original remaining parts unaffected. It was a great help to have the boiler shop overhead cranes still operable. An electric motor and chain drive were concealed under the cab floor so the driving wheels, valve gear and pistons could be turned round to explain how an engine functions. The boiler was also sectioned to show its interior.

The sectioning and repainting were finished in time for the Great Railway Exposition in September 1980. 'Pender' was displayed in the undercroft at Liverpool Road and connected to an electricity supply. One visitor asked why, if the wheels were turning, was the engine not moving. The driving wheels had been supported on rollers and the engine jacked up. At the end of the Exposition, an extra rail to give 3 ft. gauge was laid in the Goods Shed where the Liverpool Road Station Society continued to have Open Days and a special Father Christmas Weekend. But then the contractors wanted vacant possession and the question arose what to do with 'Pender'. This time she was rescued by being taken to the Queen's Road Depot to join the collection of historic buses on display there where she remained until her permanent place in the Power Hall was ready. There she has become a very popular exhibit, once more mounted on the rollers so the wheels and motion can be turned round.

‘Pender’ in the Power Hall ready for display after sectioning by a Community Industry team.

Pakistan Locomotive No. 3157

We have jumped roughly forty years from ‘Novelty’ to ‘Pender’ and roughly forty years on again to the next exhibit, Pakistan Railway No. 3157. No. 3157 is a typical 4-4-0 tender locomotive that was working express trains in Britain at the end of the Victorian and early Edwardian eras. However the wheel gauge is 5 ft. 6 ins., the widest in regular commercial use today. The overall width is 9 ft., only 3 ins. wider than the British standard loading gauge so the locomotive was able to fit into the Power Hall. 3157 with inside cylinders was an enlarged type of the broad gauge locomotives for mail trains running with satisfactory results on all the principal lines of the Indian subcontinent. The earlier ones had slide valves with boiler pressure 180 p.s.i. and one batch was built by Beyer, Peacock for the North Western Division of the Indian Railways in 1904. Three similar ones were built by Nasmyth Wilson of Patricroft in 1911 but this time for the Eastern Bengal Railway. It had been hoped that we could have had one of these but they were scrapped during our enquiries. In the same year, the Vulcan Foundry of Newton le Willows built four more for the North Western Railway of India, fitted with Phoenix superheaters in the smokebox and piston valves. To compensate for the lower pressure of 160 p.s.i., the cylinder diameter was increased from 18 ½ ins. to 20 ins. The same makers in the same year built 3157, works No. 3064, but with a Robinson or Schmidt superheater so she must be one of the oldest locomotives designed originally for superheating. This was a very popular type, for possibly around 300 were made with the last being constructed by Armstrong Whitworth at Newcastle upon Tyne in 1922.

Negotiations for 3157 started in September 1979 through the British Overseas Railways Historical Society and Mr. John Scott Morgan’s contacts at the Pakistan Embassy in London via the British Council. Enquiries were made to see if we could purchase one of the Nasmyth Wilson locomotives and the Pakistan Minister for Information at the time, Mr. Jameel uz Zaman, took up the proposal enthusiastically.

The Anchor Shipping Line agreed to carry one at a very reduced rate so it seemed that it might be possible to bring back one of these locomotives in time for the 150 Anniversary celebrations in 1980. However, unknown to us in Manchester, fate intervened, for Mr. Zaman died suddenly after a short illness. When we discovered this, we raised the matter with his successor, Mr. Qutubuddin Aziz, who was equally enthusiastic, but by then the celebrations were over.

Fate struck again, for the Anchor Line sold its ships which would have brought the locomotive back to Manchester Docks where the unloading charges would have been reduced to a minimum. In the meantime, through the endeavours of Mr. Aziz, the President of Pakistan most generously agreed to present one of these locomotives to the Museum as a gesture of thanks for help and support over the Afghan refugee problem. Then the Pakistan National Shipping Corporation also most generously agreed to honour the commitment of the Anchor Line and ship the locomotive. Their boats, however, would not fit up the Manchester Ship Canal, but the Mersey Docks and Harbour Company lowered its dues and so the financial problem of bringing the locomotive back was greatly reduced and we could accept the gift.

The staff of the Pakistan Railway locomotive works at Lahore did a first rate job of restoring the engine, replacing the brass numerals, repainting and putting her back into full running order. We were unaware that she ran the 600 miles from Lahore to the docks at Karachi where she was loaded onto the M.V. Makran, flagship of the Pakistan fleet, which sailed on 7 April 1982. When we heard that 3157 was at sea, we had to make hurried arrangements to move her from Liverpool and place her in the Goods Shed. Eighteen days later, she was off the Mersey Bar. After docking on 26 April, the 250 ton mammoth crane was alongside early that afternoon to start unloading engine and tender. 3157 had returned to Liverpool 71 years after leaving in 1911.

The Pakistan locomotive being unloaded at Liverpool showing the damage to the running plate caused by the sling.

Before 3157 could be unloaded, sniffer dogs went all over her to ensure that no drugs were being smuggled. I wondered what they thought of the thick black fuel oil. The tender came off first and was lowered straight onto the waiting low loader. Unfortunately the engine of the tractor of Pickfords' low loader for the locomotive blew up on the way to Liverpool so the crane had to place 3157 herself on the quayside where she sat until Wednesday morning when she was pulled onto the low loader. I had moved onto the quayside to photograph her coming out of the ship and was unaware that the riggers had not placed a spreading beam to separate the lifting wires at the front end of 3157. Because these wires were not vertical, slight damage was caused to the running plates above the front bogie.

The tender was delivered to Liverpool Road on Tuesday afternoon and run off onto the special track prepared by the Liverpool Road Station Society members. 3157 followed on Wednesday afternoon and looked magnificent as she was driven past the various warehouses on the site. As she was being run off the low loader towards the Power Hall entrance, I suddenly realised that I had not checked the heights of engine chimney and doorframe. All was well. One week later, after much polishing to remove the dirt and dust of all her travels, 3157 was admired by Her Majesty the Queen who visited Liverpool Road before going to see (appropriately perhaps) the 'Rovers Return' in the newly built Coronation Street studio set of Granada Television. I had hoped that 3157 might be linked to the Museum's steam supply so that her driving wheels, suitably mounted on rollers, could be turned round. Also there would be a film of her being unloaded at Liverpool but this has been lost subsequently. Special features that might be included in any display could be superheating and vacuum brakes.

Black Five Locomotive

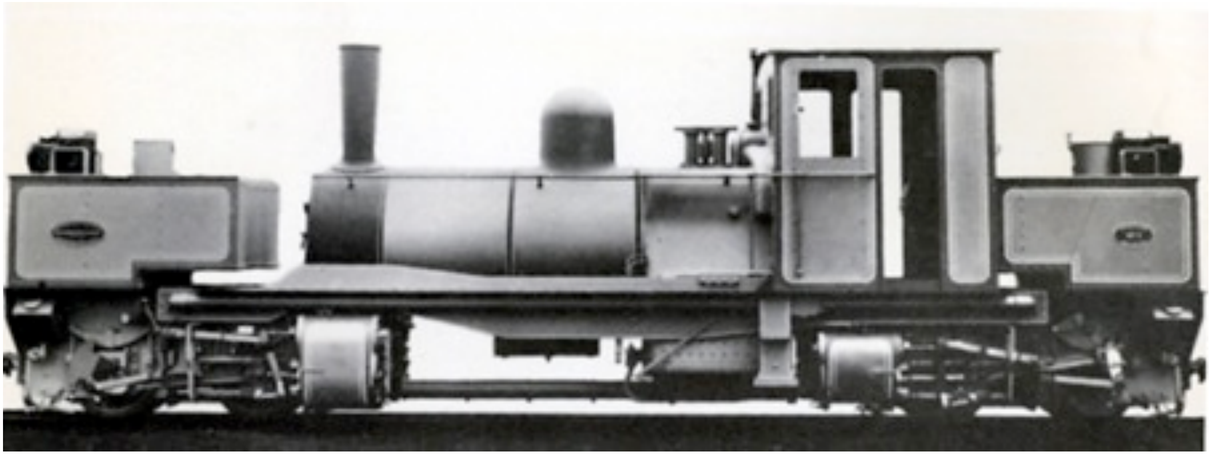
Black Five locomotive at Liverpool Road Station.

When the Museum at Liverpool Road was first opened in 1985, a 4-6-0 L.M.S. Black Five tender locomotive of the 1930s was lent. So we have moved on another thirty years or so. It showed the later developments of outside cylinders with outside valve gear. It was hoped that this engine could be restored to full working order so that it could be used through the Liverpool Road Station Society to run special excursions. Through a change in Museum policy, this was never achieved and the Black Five was removed. In these four locomotives, we had a microcosm of the historic development of the steam railway locomotive.

The Garratt Locomotive

While the history of the ordinary steam railway locomotive had been covered briefly, there remained one important type missing, the Garratt articulated locomotive. Herbert William Garratt had taken his idea to Beyer, Peacock for a locomotive with an ordinary boiler mounted on a frame slung between two power bogies on which were placed the water tanks and fuel bunker. Beyer, Peacock saw the potential and pioneered the design. With such local connections, a Garratt was a must for any industrial museum in Manchester.

When Beyer, Peacock closed their Gorton Works early in 1966 and we were negotiating to save their archives, I was taken round the workshops and looked longingly at the first Garratt they built in 1909, the 2 ft. gauge K1 which had been brought back from Tasmania as an historic exhibit. But at this time the Museum was still only a dream with no finance and no space for storing anything as large as K1. I was relieved when K1 was purchased by the Festiniog Railway Company even though there were rumours that the engine would have to be drastically modified to fit their loading gauge. Otherwise K1 might have gone abroad. What other Garrats might be available? Those supplied to the L.M.S. Railway had all been scrapped, as had the single one for the L.N.E.R. One of the four four-coupled shunting locomotives was still in possession of the National Coal Board. But, once again, with no storage, the Baddesley Colliery locomotive went to Bressingham Museum. So we had to look overseas.



Beyer, Peacock's photograph of the first Garratt locomotive sent to Tasmania.

Beyer, Peacock had built some of the largest and most modern steam locomotives when construction ended in 1956. One of these would be a fine tribute to the British locomotive building industry and Beyer, Peacock in particular. Africa became the home of the Garratt with important types supplied to Kenya, Rhodesia and South Africa. Perhaps the most impressive was the 59 Class for the East African Railways. Massive power was packed into these metre gauge engines. Through the British Overseas Railway Historical Society, contact was made with the authorities in Kenya and one was provisionally reserved for repatriation. But a quote of £150,000 for shipping alone put paid to that.

South African Railways No. 2352

A series of remarkable coincidences enabled us to bring back one of the most powerful Garratts built in 1929 – 1930, the GL Class for the South African Railways with 89,130 lb. tractive effort. When it had been agreed in 1978 that Liverpool Road would become the site for the Museum, I approached the South African Railways to see if one of their 2 ft. gauge Beyer-Garratts might be available, particularly one of the 1958 batch which were the last steam locomotives built at Gorton. The reply was that all of them were in active service with no withdrawal date in sight. Then Mr. Pratt of the Plym Valley Railway offered on temporary loan the 3 ft. 6 ins. gauge GMAM Class Beyer-Garratt which he had been given to run on a line he proposed to build at Plymouth. His was one of the very few built by the North British Company in Glasgow under contract from Beyer, Peacock. Subsequently this locomotive has found a home in Glasgow. The fact that it was not locally made was at variance with the Museum's collecting policy so it was decided to approach South African Railways again to see if a 3 ft. 6 ins. example built by Beyer, Peacock might be available.

The reply from South Africa contained a list of mouth-watering types of important Garratt designs, including GEA, GM and most surprising of all a GL. Many steam locomotives had been retained as a strategic reserve in case supplies of oil were cut off. But through the spread of electrification and advances in producing oil from

South Africa's own coal, these locomotives were finally declared redundant. GL No. 2351, 'Princes Alice', was earmarked for South Africa's own museum. No. 2352 was the first of the second batch of six ordered after the first two had been working for only seven weeks, such was the excellence of their performance. These GL Class completed in 1929 may been seen as the culmination of twenty years of design and experimentation with this type of articulated locomotive. 2352 was a massive machine with a wheelbase of 83 ft. 7 ins. and a total length of just under 90 ft. Its weight empty was 160 tons. With a fire grate of 74.5 sq. ft., it needed a mechanical stoker. It was the most powerful steam locomotive ever built in Europe and the most powerful ever to work in the Southern hemisphere. Even at this size, it could be fitted into the Power Hall where it would be a very impressive exhibit. However, the condition of 2352 was unknown after twelve years in store and she was at Germiston near Johannesburg, nearly 500 miles from the sea and a port for shipping.

The problems of physically moving the engine from Germiston to a port, shipping it and then bringing it to Manchester were going to be immense, besides the difficulty of finding the funding. Overseas Containers Limited gave a very generous quotation of £30,000 for actually shipping the engine which made the whole project at least seem possible. So the approval of the Museum Trust was sought and extra finance granted by the Greater Manchester Council. With these hurdles crossed, a letter was sent in August 1983 to the railway headquarters in Johannesburg requesting No. 2352. At that time, Michael Bailey was working for the Manchester Ship Canal and in early October told us that the General Electric Company would be moving some heavy pieces of electricity generating turbines to the Transvaal on three heavy lift road trailers at the end of the month. The trailers, each capable of carrying more than 100 tons, would be returning to Britain in the middle of December. Now a GL Garratt, split into three basic parts, would easily fit onto these trailers. GEC was willing to allow them to be used, and Wynns, the Stafford haulier, was willing to load and deliver to Manchester. This meant that the locomotive could be loaded onto a road trailer in South Africa, loaded onto a roll-on-roll-off ship, unloaded in England and delivered direct to Manchester without intermediate handling or exposure to the sea as deck cargo. No response had come from South Africa because my August letter had gone astray. As soon as this was discovered, a second letter was sent, pointing out the possibilities of the GEC and Wynns operation. The ship carrying the electrical equipment out to South Africa had already left when on November 18 the telex was received saying that the South African Minister of Transport had agreed to the donation of 2352 for display in Manchester.

It is greatly to the credit of everyone concerned with the project that it was less than one month later that the engine was on board ship and had left South Africa because an unforeseen snag arose. South African regulations for moving heavy items on its roads are different from those in England. It transpired that the Wynns' trailers had to be unloaded at the port of Richards Bay where they would be put straight on board ship again. Luckily, instead of dismantling and loading the engine at Germiston, the South African authorities agreed to deliver it to Richards Bay. This involved checking and greasing the fourteen axles, all the coupling rods and other parts which had not moved for twelve years. No. 2352 left Germiston on Tuesday December 6 and had to be sent on the old, longer route through Pietermaritzburg and Durban because it had only steam and vacuum brakes whereas all the trains on the new direct line to Richards Bay are hauled by electric locomotives with air brakes. Vacuum brakes were being phased out rapidly on the South African Railways so it might not have been possible to move 2352 a little later. No. 2352 was permitted to travel only in the hours of daylight at a maximum speed of 30 k.p.h. (20 m.p.h.). The heavy rains which broke the three year drought were very welcome but caused dislocation on the railway lines through washouts and other problems. Then it was the period just at the peak rush hour for Christmas so 2352 could not be hauled over the weekend and was stabled at Durban Bayhead. It was a considerable operational achievement to get it to Richards Bay in only a week by 10.30 on Tuesday morning December 13.

In the meantime, I had flown to Johannesburg. It was not only a physical shock leaving the cold damp grey of a Manchester winter but a cultural shock leaving the airport into a strict apartheid regime where everything was still segregated, buses, trains, stations, restaurants. I called on the railway authorities to thank them for all their efforts on our behalf. I was able to present a small token of thanks in the form of two copies of my book, *Beyer, Peacock, Locomotive Builders to the World* and a commemorative glass goblet, which were greatly appreciated. After discussing various problems about the locomotive and its loading, I left by plane for Durban where I finally caught up with 2352. A dull rainy day doesn't make anything look at its best and particularly 2352 which had spent twelve years in the grime and soot of Germiston steam locomotive depot. A closer look was more reassuring. Paint was peeling off the tanks but the rusting was not deep. Only in two places on the boiler cladding were there some holes. The connecting rods had been taken off and put in the coal bunker which was half full; an unexpected bonus of five or six tons of coal which later found its way into Agecroft No. 3's firebox. What was missing, however, were many of the brass boiler fittings and oilers.

Dr. Hills in Johannesburg presenting a copy of his book Beyer, Peacock, Locomotive Builders to the World and a 'Rocket' goblet to the Director of the South African Railways as token of appreciation for the S.A.R. GL Beyer-Garratt.

Richards Bay

Richards Bay was South Africa's newest harbour, opened only in 1976 for handling bulk cargoes such as 30 million tons of coal a year. The 'ro-ro' ships with their own stern discharge ramps were an exception. To travel there, and indeed throughout South Africa, I received great help from both the railway authorities and O.C.L. officials. Wynns had agreed to send out their team of men a couple of days early to separate 2352 so that they were waiting on the 'Square' by the side of the harbour for 2352 to arrive, probably the first and perhaps the only steam engine ever to go to that port.

Working on any machine is the best way to appreciate its qualities. The superlative design of the Garratts soon became apparent as we struggled in the confined spaces of the 3 ft. 6 ins. gauge to free the parts which had to be massive to withstand the enormous power of this engine. I had studied such drawings as we had in the Beyer, Peacock archives so had been able to prepare myself a little. The engine units have to be linked to the boiler not only by the pivots themselves but by the reversing gear, steam and exhaust pipes, water pipes, vacuum and steam brake pipes, connections to the cylinder drain cocks, electric wires to the lights and, on the rear unit, the mechanical stoker. Some of these had been disconnected at Germiston to allow the engine to be moved more easily. But the retaining clips on the pivots were well and truly buried inaccessibly in the centre of the engine beneath layers of dirt and coal. The hemi-spherical shape of the front bearing meant that only one clip at this end had to be freed to enable the front unit to be drawn out.

The rear unit gave more trouble. No drawings of the mechanical stoker had survived in Manchester so its construction was a mystery. Had we but known it, one of the railway officers had copied the stoker manual which was sitting in a locker in the cab beside us as we struggled to open up various parts. I think years of neglect, rain, rust and coal dust had jammed the way it ought to have been separated. In the end, a universal joint on the Archimedes feed screw had to be cut. The harbour authorities lent an oxy-acetylene set. The gas bottles were dragged over on a trolley by an African who handed the torch to a white man. The bracket carrying the shaft that drove the main feed screw had been welded on. To free the rear unit, the bolts that secured the water tank and coalbunker to the frames had to be cut. At last one end of the stoker could be lifted to clear the boiler unit as it was jacked up. Then the rear engine unit could be dragged away.

The rear unit being lifted by the crane and forklift truck.

The front unit being lowered onto the trailer for towing off to the ship.

Wynns' men had hydraulic jacks operated by a small motor-driven pump. Two lifting beams were placed under the boiler on four of these jacks. By simply turning a valve, the boiler was raised. By 2 o'clock on the Wednesday, the engine units had been separated and left ready for loading. The boiler unit was left on its lifting beams ready to have a trailer pushed underneath it. A van had appeared full of most of the missing brass parts. A railway official had been detailed to look at 2352 passing through Pietermaritzburg, see what was missing and take replacements off other stored locomotives. For safety, we put them inside the front water tank. I jumped to the ground, forgetting the strength of the sun near the Tropics at mid-day. The pain was agonising as the heat of the ground nearly scorched my feet even through leather shoes.

The 'ro-ro' ship, the 'Elgaren' from Gotenburg, reached Richards Bay ten hours late at 4 o'clock on the Friday afternoon and was due to sail twenty-four hours later. That

Friday was a public holiday and normally the port would have been closed. Permission was given to work late and by 2 a.m. on the Saturday morning eight pieces of electrical equipment weighing over 100 tons each had been off-loaded, leaving three trailers empty. Work started again at 8 a.m. on the Saturday morning and soon one of the trailers was being pushed under the boiler. A motor-driven hydraulic pump on each trailer powered jacks and the steering on each set of wheels. With the trailer in position and packing pieces placed on it, the whole trailer frame was raised on its own jacks so that it lifted the boiler, freeing the lifting beams. The beams were pulled out with the help of a small fork-lift truck; the boiler secured and then towed off to the ship, where it was pushed up the ramp and into the hold; a simple operation with power steering.

It was hoped to move the engine units in the same way but there were two snags. I had not seen the trailers before they left England but knew they consisted of an open grid of steel girders with no decking. Looking at them at Richards Bay, it was obvious that timber packing would be necessary to prevent the wheels falling into the gaps. How could we find and purchase this? Then a thought struck me. Wouldn't it be nice if 2352 could be displayed on genuine South African Railway rails. Rails appeared and spanned the gaps on the trailers. But then the second snag. The engine units are so packed with parts such as pipes and brake gear that it was impossible to run lifting beams underneath. The tanks on top meant that, if only one crane were used, a spreading beam would have been necessary so that the slings would hang vertically and clear the tanks. No such beam was available. The solution was to use one of the ship's 35 ton fork-lift trucks at the inner end and at the outer a 200 ton mobile crane which the harbour authorities made available. Such lifting power was not really necessary as the units weighed between 45 and 50 tons. This allowed the trailers to be pushed under the engine units at the end the crane was supporting. The units were gently lowered onto the rails and towed off to the 'Elgaren'.

By 2 o'clock on the afternoon of Saturday 17 December, Wynns' men were washing their hands. Our three trailers with the engine together with some empty ones were on board being chained down. Soon the massive ramp was being raised. The 'Elgaren' sailed on schedule at 4 o'clock. She had recovered her schedule and left in time to catch the tide at her next port of call. If this move had taken place a few weeks later, the ship would have been full of oranges, leaving no space for our locomotive. I made my way back to Johannesburg to thank the South African Railway authorities for all their help. It was the busy Christmas season so I was lucky to get a flight home because I needed to make arrangements at the Museum for our present which was due to be delivered in about a month.

Arrival of 2352 in England

Blizzards were sweeping across Scotland and a bitter cold wind was blowing up the Thames when the 'Elgaren' docked at Tilbury early in the morning of Thursday 19 January 1984. She had been delayed by a strike at Le Havre but caught up on schedule again because she could not call at Antwerp where the lock gates had been damaged by a storm. Her next port of call would normally have been Rotterdam where 2352 would have had to be transferred to a smaller vessel bound for Manchester. Luckily there was a cargo of copper as well as 2352 so she was diverted to Tilbury. The bureaucratic problems of Her Majesty's Customs and Excise had been sorted out after frantic telephone calls by paying over £2,000 Value Added

Tax (value added to what?). Unloading all went smoothly and the three units were rolled off, with the boiler proudly displaying the Overseas Containers Ltd. banner who had made it all possible. Customs clearance was given the same afternoon. At that point, plans went awry because the blizzards had totally disrupted the electrical apparatus of the Central Electricity Generating Board. Most of Wynns' men were engaged moving vital transformers and other parts to keep the supply going and could not be spared immediately to unload the engine. 2352 was therefore taken up the motorway as far as Stafford and left sitting on the trailers until further arrangements could be made.

The boiler on the quayside at Tilbury ready for despatch to Manchester.

The snow had disappeared from Liverpool Road Station when the rear engine unit arrived during the afternoon of Tuesday 31 January. It was essential that all parts came in the right order for unloading and were the right way round. It had been decided to run the engine units off their trailers by railed ramps onto short lengths of special track and that they would be replaced under the boiler unit only after some initial cleaning had been carried out. The space at the Station seemed vast until the parts began to arrive when it became apparent how vital was the steering gear on the trailers. The trailer with the rear unit was delivered from the Liverpool Road side along Byrom Street. It had seven rows of wheels, some of which mounted the kerb at the entrance to the Station yard, so tight was the corner. This tractor and its load were parked overnight since the lorry with the ramps and the mobile crane were not due till the next day. Wednesday was, of course, typical weather for Manchester, wet and windy. This, together with the restricted site, delayed running off the rear unit until 5 o'clock in the evening, by which time the front unit had appeared. The front unit had been placed on a smaller trailer at Tilbury so there was no difficulty getting into the Station and, because this part was placed by the Power Hall, access was easier and the ramps positioned more quickly.

Running the engine units off was simple because one end of the trailers could be raised on the internal jacks. The tractor had a winch so a wire rope was attached to check the unit when it was running down by gravity. When the track became too flat, a special jacking lever moved the wheels quite easily. The first unit was off the ramps soon after 2 o'clock on Thursday when the boiler unit arrived outside. This was a ten row trailer with a total of eighty wheels. To get the boiler facing the right way, it had to be backed in, which was in fact lucky because access was slightly easier coming along Byrom Street from the Granada end. Even so, it took three attempts to manoeuvre the trailer through the gate. This was the only occasion in the whole movement of 2352 when a trailer was not positioned correctly the first time. What would George Stephenson have thought if he could have watched this monster arrive at his station for 'Rocket' would have almost fitted inside its fire box.

Friday morning was occupied with placing lifting beams under the boiler and putting in position four stillages to support their ends. The trailer with boiler still on it was backed in between the stillages after lunch and left for the weekend. Oil had leaked out of the hydraulic system during the South African trip so the jacks gave barely half an inch clearance. The oil was topped up and the job finished on Monday 6 February. There was only just enough space to pull the trailer clear of the boiler. Wynns' equipment was taken away and the boiler left on the Museum's own stands ready for cleaning. While this unloading was in progress, news came through of a hurricane devastating the area around Richards Bay in South Africa. Most of the bridges on the coal line to the port were broken down while nearly fifteen miles of track were swept away. The line between Durban and Richards Bay was also damaged. Had such a tragedy occurred earlier, there would have been no possibility of moving 2352. Our thanks must go to all those who helped bring back such an impressive and historic exhibit to Manchester, the place where she was born.

Electric Traction

Manchester had pioneered electric traction in Britain in many ways starting with Mather & Platt in the 1890s with D.C. systems. Then there was the 1,500 volt D.C. overhead system for the Altrincham line in the 1930s which the L.N.E.R. intended to develop for its high-speed main line over Woodhead up to London. This was overtaken by the 25 Kva A.C. system which was tried on the Styal line before becoming the standard for the rest of the country. On the two rail tracks inside the Power Hall, that adjacent to the platform was set aside for electric traction with suitable displays on the platform itself. The historical sequence started on the platform with one of Mather & Platt's Gramme ring motors of 1895. This had a very early type of armature and until 1979 was used on the Snaefell Railway on the Isle of Man. We remounted it on part of a bogie framing so it could be demonstrated driving a set of wheels through its original control gear. Although a very appropriate exhibit for Manchester, it was later returned to the Isle of Man. Next came an early pantograph and overhead wire from the Altrincham line. It was possible to raise and lower this pantograph. Further along was the bank of switchgear and the cab off one of the Woodhead EM1 locomotives, No. 26039, 'Hector'. The controls in the cab were linked to the switchgear to demonstrate how to drive the locomotive. It was intended to have a film of the Woodhead route shown at the same time as the demonstration.

Meanwhile on the track alongside the platform, we had been able to display some electric locomotives. Two were lent by the C.E.G.B. One was a Bo-Bo type built by Hawthorn Leslie in 1924 which spent all its life at Kearsley Power Station. It drew power from overhead wires. The other was a four-wheeled battery electric locomotive once used at Bolton Power Station. It was built by the General Electric

Company at Preston in 1944. This proved to be very practical for moving stock and locomotives around the site since it was kept fully charged and so ready for instant use. With these electrical exhibits, we received a great deal of help such as installing the charger for the battery locomotive from Derek Shepherd, one time manager of Bolton Power Station.

Battery electric locomotive and replica carriage.

During the Great Railway Exposition in 1980, the EM1 Bo-Bo locomotive from the National Railway Collection had been displayed in the Goods Shed. After the Exposition had closed, it remained on site until it had to be returned to York since the contractors needed possession to convert the Goods Shed into the Power Hall. These locomotives had been constructed at the L.N.E.R. works at Gorton Tank with electrical equipment from Metropolitan-Vickers of Trafford Park. So this EM1 would have been a very appropriate exhibit, built and used locally. However in April 1980, David Ward, an Englishman working for the Dutch Railways, wrote to the *Railway Magazine* pointing out that six of the original seven Co-Co EM2 class were still on active service in the Netherlands and would continue to be used until 1984 or 1985. Was there any possibility of one being preserved in Britain? Like the EM1s, they also had been built at Gorton with Metropolitan-Vickers electrical equipment in 1954. At this time, it was expected that the 1,500 volts D.C. Manchester to Sheffield line would be extended for 300 miles to eventually reach London for which high-speed passenger locomotives would be required. 1,500 volts was too high to be used in the traction motors so all these locomotives carried rotary converters to reduce it, an advance on the Snaefell and Kearsley systems. But even as the EM2s were being built, development of solid-state rectifiers for use with high-voltage A.C. made the Woodhead line obsolete before it was completed. Instead of becoming a major class, the seven EM2s remained prototypes, shuttling their passengers between Manchester and Sheffield. They were in fact the first high-speed electric locomotives to work on regular passenger services in this country. While their permitted maximum was 90 m.p.h., there is a story of one reaching the 'ton' on the descent towards Manchester by Crowden.

Passenger services ceased in 1968 and the EM2s languished for a couple of years at Bury. Now the Dutch Railways had been electrified at 1,500 volts D.C. with overhead equipment and needed more motive power. They purchased six of the seven EM2s which were refurbished for a second career on the Continent as the Netherlands 1500 Class. They proved to be outstandingly successful in the country of their adoption, covering many more miles in revenue service there than they ever did in England. In fact, the Netherlands Railways (N.S.) are reported as saying that these engines were the most reliable they ever had. Unfortunately, obtaining spares for such a small class became prohibitive and was the final reason for their withdrawal.

As the National Railway Museum had preserved an EM1, it was not interested in the passenger type. Here was an opportunity for Manchester to save an important contribution to locomotive design with overseas connections. Moreover we found that space could be allocated to house an EM2 undercover in the Power Hall. Through correspondence with David Ward, it emerged that the Netherlands Railways would be sympathetic towards saving one of these locomotives. At a small ceremony in Utrecht on 3 February 1981, the N.S. agreed to present EM2 No. 1506/27002, 'Aurora' which would be restored to first-class condition in Holland and would retain its Dutch colours at the Museum in recognition of its time overseas.

Dr. Hills presenting a ‘Rocket’ goblet to a representative of the Dutch State Railways as a token of appreciation for the gift of ‘Ariadne’.

All seemed fair when disaster struck in the middle of 1983. David Ward telephoned early one morning to say that ‘Aurora’ had been badly damaged by fire through being towed with a brake block stuck on and would probably be beyond restoration. A few days later, the N.S. confirmed that it would have to be scrapped and agreed to replace it with No. 1505/27001, ‘Ariadne’, so the project could continue. In the meantime, a society had been formed to help raise funds towards the cost of repatriating ‘Ariadne’ and to help maintain and demonstrate the locomotive back in Manchester. When the Museum undertook the funding itself, the EM2 Society decided to see if a second locomotive could be purchased which would be restored to its original British Railways condition for preservation at the other end of the line.

Once again, the Dutch authorities were exceedingly co-operative and hence the scheme for the preservation of N.S. 1502/2700, ‘Electra’, emerged. By this time interest was growing in England and enthusiasts were crossing to the Netherlands to see the EM2s in service. A party visited Tilburg Works and permission was given to replace the nameplates on ‘Ariadne’ and ‘Electra’ at a ceremony in the summer of 1985 (*Railway Mag*. Oct. 1985, p. 482). This was a very great honour since it was not customary to name other Dutch locomotives at that time. When the EM2 Class was finally withdrawn in June 1986, David Ward organised a farewell tour. A handing-over ceremony at Tilburg Works on July 10 initiated the start of the journey for two of them through Belgium to England.

The 'Cambridge Ferry' – the same boat that had taken them to the Continent – brought them back to Harwich by courtesy of Sealink. This was just in time because the Harwich train ferry was scheduled for closure shortly after due to the opening of the Channel Tunnel. To have organised hauling these locomotives through Belgium, France as well as the Tunnel itself would have been exceedingly difficult. It would have necessitated obtaining special permission in each country, finding suitable locomotives to haul them as well as paths in the busy rail networks. So it was on a beautiful sunny afternoon of Tuesday 15 July 1986 that a group of railway enthusiasts, cordoned off by a rope barrier, watched as the rail ramp was lowered to the 'Cambridge Ferry' dead on time at 14.35. A couple of tanker wagons were drawn off first and then used to couple onto 'Ariadne' because the weight of the hauling locomotive as well as an EM2 would have been too great on the ramp. As it emerged into the sunshine with gleaming new paintwork, we could see that the men at Tilburg had done a magnificent restoration job. It was placed in a siding and then 'Electra' was pulled off in the same way. That night, the two locomotives were separated with 'Ariadne' going to Willesden and then along the West Coast line to Manchester where it was delivered to the Museum on the Thursday. Representatives of the Dutch Railways officially handed it over on the following day (*Railway Mag*, Sept. p. 585). In the meantime, 'Electra' had been towed up the east side of England to Toton and delivered to the Midland Railway Centre at Butterley, also on the Thursday. Another handing-over ceremony was held that Saturday.

'Ariadne' at Liverpool Road.

Railway Rail and Track Collection

The 'so called' permanent way on which trains run is generally forgotten in displays about railways. It is of course essential for the smooth running and safety of trains. The history of rails is a story of the struggle to find an economical material with good wearing characteristics and sufficient strength to carry the weight of both locomotives and rolling stock. Our collection started with an example of wooden rail, the earliest type. To give a longer life, such rails might have metal strips nailed along their tops. We had an example from the light railways used to harvest peat from Chat Moss. Cast iron seemed to be an ideal material, strong in compression, hard wearing and possible to produce in quantity. The Peak Forest Tramway was laid with 'L' shaped plates on which the wheels without flanges ran on the bottom web and were kept on course by the vertical part. The plates were mounted on stone blocks and the space between the rails filled in to provide a track for the horses. We had various examples of this type of rail.

Cromford and High Peak rails.

The Cromford & High Peak Railway characterised the next development where the wheels were flanged and ran on the top of the rails. The rails were iron, cast in the form of a fish-belly to give greater strength to bridge the gap between the supporting stone blocks or sleepers. We had a broken example of this rail. But owing to its brittleness, cast iron proved to be too weak to carry steam locomotives. Also as each rail was only about a yard long, there were innumerable joints. In the meantime, attention had switched to wrought iron. This could be rolled in longer lengths with different cross-sections. An early form of rolled fish-belly wrought iron rail was soon replaced by ones with stronger 'T' or 'I' sections as well as 'bridge' rails. We had examples of all these. The history of rails continues with the introduction of steel and 'bull-head' rails supported on chairs or 'flat-bottom' rails mounted on plates on top of the cross-sleepers.

To show modern types, we had a couple of models of wooden and concrete sleepers with short sections of rails. There was also a complete standard gauge wooden sleeper with cast iron chairs and short section of rail. This was complemented by a concrete sleeper and flat-bottom rail. To carry these upstairs at Grosvenor Street for display on the first floor was exceedingly difficult. That display also had a small section on rails for street tramways. These exhibits had been collected by Stanley Swift, mostly from road repair sites around Manchester. They showed how much stronger rails were necessary to take the weight of the electric cars which replaced horse-drawn ones. A pair of these rails was displayed with granite sets. At Liverpool Road for the Great Railway Exposition, some examples of rail track were displayed on the bridge over Water Street. They consisted of a couple of yards each of wooden sleeper, concrete sleeper and continuous concrete panel track. Robert Manders drew up a list of rail track exhibits in 1979 which is appended hereto.

Railway Signalling

At the end of the Power Hall nearest to Liverpool, I had intended to display our railway signalling collection to show not only the development of mechanical signalling but, more important, explain safety features on our lines. The collection had been assembled through the guidance and help of a very knowledgeable enthusiast, Dr. Paul Spriggs, lecturer in the Metallurgy Department. He had been able to visit most of the signalling installations in the region so could recognise what historic equipment might be worth saving. The appended list was prepared by Robert Manders. It shows both what we had actually collected as well as others which would fill gaps. The list covers only lever frames and does not include any instruments such as block token instruments. The following notes concentrate on the removal of some of the frames and the reason for their acquisition.

No. 4 Mackenzie & Holland, No. 11 Soldier Locking: Conceptually, this frame was probably the oldest in the collection. The locking mechanism stretched under the floor on which the signalman stood. The mechanism consisted of rods parallel to the row of levers. Iron bars connected the lever to a lug secured on an appropriate rod. Pull the lever and the rod rotated, twisting further lugs which locked the bars on other levers to prevent them being moved (putting it simply). The box was in Macclesfield Goods Yard and once controlled the line branching off towards Bollington. We wanted only eight levers to show the principle but, to make a neat job of its restoration, we needed to take the outer frame ends. This meant taking up the floor at both ends of the box. We also needed sufficient rods which meant hacksawing through 2 ins. diam. iron. Other bits and pieces were stripped out so we could construct a working frame. All these parts had to be lugged down the steps of the box, across a number of lines to where we could bring transport. It all weighed quite a lot. It was partially reassembled and put in the Power Hall.

No. 1 Midland Railway, rocker and tappet locking: This mechanical locking mechanism was particularly neat, being contained in a tray behind the levers. The box where it came from was situated on the Hayfield branch at the end of the New Mills tunnel. Parts were carried up the cutting slope to where they could be loaded onto a lorry. When the signalman grasped and moved the catch on the lever, this also moved a flat horizontal bar with notches on it. That moved pegs in the notches which were fixed on bars running parallel to the levers, preventing any other lever being pulled until the first lever had been pulled over completely and the catch released. That reset the locking. This frame was erected at the top of the stairs leading to the basement of Grosvenor Street where it could be demonstrated. It was taken to the Power Hall.

No. 7 Saxby & Farmer Tappet Locking: Brooklands Road Station signal box on the Manchester, South Junction & Altrincham Railway was situated conveniently on the other side of the railway lines to the station car park. I had hoped to build a replica signal box at Liverpool Road just outside the end of the Power Hall through which visitors could exit towards the 1830 station. The interior fittings of frame and instruments were taken from Brooklands Road to fit this out. The frame itself would be set at such a level that would enable visitors to see the locking, etc. underneath.

The dozen or so levers could be linked to signals and points in the station yard. We took out point rods, signal wire pulleys, etc. I inspected the frame at Brooklands Road and thought it would be easy to remove. The bearing blocks for the levers were mounted on a single long fish-belly cast iron beam. In the darkness in the bottom of the box, I thought that the blocks were individual castings, so the weight of each part would be easy to carry away. In fact, the beam and bottom halves of the blocks were a single very complex casting. We nearly caused chaos on the Altrincham line, struggling to get this casting across the railway lines to the car park. Luckily the trains were not much delayed. The project for a signal box at Liverpool Road never materialised.

No. 15 General Railway Signalling Co. Slide Frame: When Central Station closed, I remember staggering back to Grosvenor Street with the track diagram panel. The box had been modernised with a form of what might be called electro-mechanical locking. To operate it, a catch on the back of the small horizontal lever was grasped. If the lever (and hence signal) could be moved, another catch controlled by an electric magnet was raised allowing the lever to be pulled. A crank on the end rotated a barrel with electric contacts round it. The current from these locked or freed appropriate levers through their electro-magnetic catches. The example we preserved came from one of the signal boxes at Bolton. A section of sixteen levers was displayed at the top of the basement stairs at Grosvenor Street where its small levers contrasted with the length of those on the Midland frame adjacent.

Brunswick Junction 'In-Out' Panel: 'Electronics can now almost completely replace the human operator', so wrote Bob Manders. This panel is an early example designed by Metropolitan-Vickers and installed at Brunswick Junction near Liverpool. The signalman turned a switch at the point where the train was due to enter the section and another at the place where it was due to leave. The electronics set the signals and points along the route. This panel was last seen in the National Railway Museum at York, having been disposed of by the Museum in Manchester in spite of its local Manchester connections.

Other Equipment at Grosvenor Street: On the stairs leading to the basement were mounted signal arms showing their size when close up. In the Education Department Laboratory was arranged a short length of track and block instruments to demonstrate bell codes when passing trains from one box to another. There was also a pair of tablet instruments to explain safety on single line railways. Much of this equipment was presented by British Rail to the Museum through Paul Spriggs. Also as has been shown, much more was moved by Museum technicians. In the pressure to develop Liverpool Road, accessioning and restoring most of this collection had to be delayed. I had hoped to do this with Paul. However I had to leave and then Paul died suddenly with the result that this very fine collection was disbanded, probably a lot going to scrap.

Chapter 6, The Textile Collection.

Manchester became synonymous with cotton textiles so cotton, its manufacture through all its stages from the import of the raw material to the finished dyed and printed fabric had to be covered in a Museum of Science and Industry. One objective was to explain the basic principles of spinning and weaving. Another was to show the history of the technical development of the machinery. Therefore I decided to concentrate on three eras of the industry; first the domestic hand industry, then the crucial inventions of James Hargreaves, Richard Arkwright, Samuel Crompton and Edmund Cartwright and finally the heyday of the industry around 1900. Obviously not all aspects of such a diverse industry could be covered so the emphasis lay on the basic principles of medium counts spinning and weaving. This would enable other museums in the region to preserve exhibits appertaining to the specialisations of their area, for example Bolton fine spinning and weaving, Rochdale condenser spinning for flannelette cloth. At Grosvenor Street, we did not have the space to display all the different types of machines to set up a small production line but we collected those that we knew would be needed later in a permanent home.

The Early Period

At least in Grosvenor Street we could cover the early period. Dr. David Owen, Director of the Manchester Museum at the University, had accepted a few industrial exhibits which he willingly passed over to us because he had realised that, if he started to collect in that field, the tail would soon be wagging the dog. Among these exhibits were two types of spinning wheels. One was a very rare original Great Spinning Wheel. It was the type associated with cotton spinning before the Industrial Revolution and had the simple plain spindle. To spin on it required three stages. First the spinning sequence; then reversing the wheel and spindle to 'back off' to unwind the coils of spun thread from the tip of the spindle back to the cop ready for the third stage of 'winding on'. The right hand controlled the Great Wheel, turning it in one direction for spinning while the left hand paid out the fibres. In backing off, the wheel was turned the other way. Then the wheel would be rotated in the original direction with the right hand while the left hand guided the spun yarn to build up the cop on the spindle. These stages of spinning were adopted on both Hargeaves' Jenny and Crompton's Mule. We learnt a lot about various ways of manipulating the fibres held in the left hand and the need for winding the yarn onto the cop so it could be pulled off again either for rewinding or being placed in the shuttle for weaving. The seemingly crude construction of the Great Wheel masked its effectiveness and appropriate design. There is no method for keeping the driving band round the rim other than accurate manufacture. We also had a similar type of wheel that was used for winding the pirns to be placed in shuttles. On this, the plain rimmed large wheel drove a countershaft that had a pulley wheel with a second band driving the spindle on which the pirns were placed, giving an increase in speed for the latter. This was probably used in a silk mill at Macclesfield.

From the Manchester Museum also came the other type of spinning wheel operated by a foot pedal. It had a flyer fitted onto the spindle that guided the yarn so it was wound onto a bobbin free to revolve on the spindle. A double band round the large driving wheel operated by the foot pedal drove the spindle and flyer through one size of pulley while the bobbin was made with a pulley of a different size. This arrangement gave different speeds to bobbin and flyer so that twisting and winding on occurred simultaneously and continuously. This principle was developed by Arkwright in his spinning machine. It allowed both hands of the spinner to manipulate the fibres and control the twist in the drafting zone. While this type of wheel is more usually associated with spinning the longer fibres of wool or flax, we found it was possible to spin cotton on these flyer wheels, even the very short waste cotton fibres from condenser spinning.

These flyer wheels were called by various names like Jersey or Norse. The one from the Manchester Museum was a fine example of the Norse type with the spindle above the wheel constructed from mahogany with a few ivory or bone details. It had probably been used for spinning linen. Since it was too fine for giving general demonstrations, we purchased a heavier example of the Jersey type where the spindle and flyer are set to the left of the driving wheel. This was demonstrated to school parties and on our special 'Working Saturdays' and proved to be a popular attraction. To prepare the fibres for spinning, we had a pair of simple hand cards for teasing out the fibres into rollags. We never tried combing wool because we were concentrating on cotton and generally used cotton on both types of wheel. Combing may have preceded carding. The type of wheel probably helped determine the quality of the yarn, a more highly twisted one being produced on flyer wheels, hence more suited for warp, while the plain spindle Great Wheel gave a softer, lighter twisted yarn better for weft in fustians.

For weaving, we had several Dryad horizontal table looms, warped up simply to show the basics of weaving to school parties. There was also a model of a vertical loom. One of the very early exhibits was a wooden framed silk Jacquard handloom from Macclesfield. To warp it would have required silk and a new Jacquard harness so its Jacquard mechanism was retained and mounted on a small frame to show how it worked while the slay with its flying shuttle drop boxes was kept to show the final development of handloom mechanisms.

Various pieces of textile exhibits, with two shuttles and yarn twist tester in foreground, model Jacquard loom on left and sample book of patterned textiles.

Bury Museum gave a large handloom for weaving wide cloth. It had been stored in a library basement close to the heating boiler but luckily none of its wooden parts had been used as fuel. It was a type that must have been the mainstay of the textile industry in the 1830s. It had eight foot pedals so could have woven cloth such as a twill or a sateen or perhaps a small pattern. We set it up to weave plain cloth with warp threads of alternate colours, yellow and blue, to show the basic weave of over one and under one. This loom had the capacity for four flying shuttles and drop boxes but we only ever used one shuttle for plain weaving. There was a knack in weaving properly with the flying shuttle, to flick it across by a jerk of the picking stick and then to use the picking stick and picker to catch the shuttle as it entered the box on the further side to prevent the shuttle either sticking fast in the box or bouncing out again. This loom had a ratchet take up mechanism which moved the cloth on when beating up the weft with the slay but we did not connect this up due to the heavier nature of the woollen yarns we were using. There were also adjustable temples either side of the cloth to keep it at the right width. At first we had to prepare the warp in a chain and tie it onto the previous one, a slow job. Then we fitted a later warp beam at the back on which a much longer warp could be wound at a mill in Saddleworth, saving an immense amount of time.

Robert Manders demonstrating the hand loom from Bury.

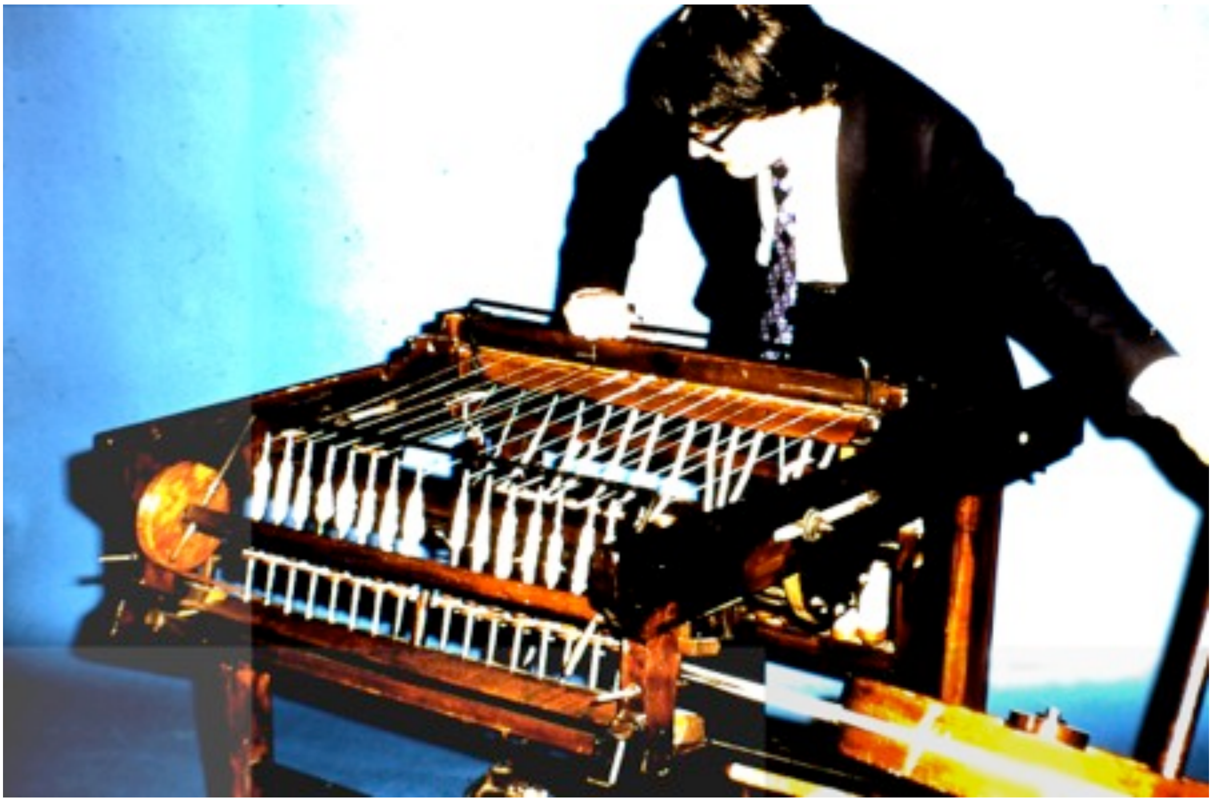
The other working handloom came from UMIST Textile Technology Department. It had drop boxes for two shuttles so could show the effects of different wefts. It had a Jacquard harness and head with, I think, 250 needles. Warping it up was a quick learning process of how a pattern could be built up across the width of the loom with repeats and reverse repeats to give different effects. Not understanding about reverse repeats, it was necessary to re-enter half the warp when first setting it up. It showed how, with only 250 needles, a cloth could be woven of much greater width and complex patterns. Both looms were warped up with yarns that did not need sizing to prevent deterioration of the dressing. This applied also to the power loom installed later with a two-fold 32s cotton yarn. When demonstrating the hand Jacquard loom, the correct sequence of the shuttles had to be followed to ensure the selvages were woven correctly. We were presented with a Devoge piano card cutting machine to show the process of card cutting from the 'cartoon' or pattern drawn on blue thin card printed with squares. For demonstration at Grosvenor Street, the board on which the 'cartoon' was mounted was reduced in width. This machine was used to re-cut damaged cards in the pattern chain.

Another hand-operated machine was the extra-ordinarily complex knitting machine invented by the Rev. William Lee in 1589. Our machine came from Carrington-Viyella. It had some later developments so it could produce finer stitches but otherwise was based on Lee's original ideas. We had some success in knitting on it but it really needed a skilled operative as well as some new needles before it could be demonstrated regularly. While these machines were rarely used in the Manchester area, we thought it worthy of display because Jedediah Strutt invented an attachment for producing ribbed knitting through which he made the fortune that enabled him to support the development of Richard Arkwright's 'water frame' for spinning cotton so it was important for the development of the Industrial Revolution.

In the pre-industrial era, cotton cloth might be coloured with patterns. We assembled a range of hand printing blocks to show various types. Some were for stamping a mark on a bale to identify the merchant. We used these for school demonstrations. The pattern might be carved out of wood, mostly the oldest. The finest had copper or brass shapes driven into the wooden surface to form the raised pattern. People later hung these on their walls as decorations. For small pattern repeats on something like silk ties, the wooden surface of the block was covered with plates cast from type metal. The pattern was cut or burnt with special tools in the end of a lime wood block to form the casting mould. Then the plates cast from this were nailed onto the printing block.

Each colour needed its own block that had to fit in with its neighbours. I wanted to be able to display a simple set to show the range needed for even a few colours. I heard that it might be possible to buy a set from a person who lived at Gretton, near Winchcombe, Gloucestershire. I arranged to stay with Mrs. Sonia Rolt who lived near-by at the hamlet of Stanley Pontlarge and solved a mystery for her. On some recent Saturday nights, a large furniture van had driven up the lane past her house and returned a little later. It transpired that the person selling the blocks was known to her. He had decided to invest his redundancy money in purchasing the collection of blocks from the Langley print works. He reckoned that, if he could not sell the blocks for re-use to firms like Liberties for high quality silks, he could sell the metal patterns for scrap. He had arranged to store the blocks in a barn on the farm at Stanley Pontlarge. To move the collection cheaply, he hired a furniture van for the weekend, drove it to Langley on the Friday evening, loaded up on the Saturday, drove back to Stanley Pontlarge and unloaded it that night. Sonia was delighted that the mystery of the van was solved and we were happy to purchase a set.

The Industrial Revolution
The Spinning Jenny



The Spinning Jenny being demonstrated, showing how difficult it was to operate.

While occasionally a spinning wheel might have a couple of flyers and bobbins, these may have been used for plying or doubling yarns rather than spinning. The first successful spinning machine for cotton with multiple spindles was the Spinning Jenny of James Hargreaves. It is said that the idea came from seeing a Great Wheel knocked over and continuing to rotate. His first Jenny of 1763 is reputed to have had eight spindles but this had increased to sixteen by the time he took out a patent in 1770. Since no early Jennies have survived, we constructed one based on the patent drawing and on a replica made by Higher Mill, Helmshore. It taught us how difficult and back-breaking a machine it was to operate. The spinner's fingers were replaced by a clove which should have clamped the rovings but we found the wood twisted through climatic changes so not all the sixteen rovings were pulled through the same distance with the result that the thickness of the final yarns would vary. Then it was difficult to keep the eight driving bands to the sixteen spindles at the same tension so spindle speeds, and hence twist, would be uneven. To wind on the spun yarn required the foot to raise the bar working the faller wire, an action more difficult to control than pushing down. But the real fault with the Jenny lay in the length of spun yarn that had to be left between the tips of the spindles and the rovings being drawn through the clove. If the yarn had a hard twist, some of these turns would run into the roving and prevent that being drawn out. Therefore only a lightly twisted yarn could be spun on the Jenny, suitable for weft but not strong enough for warp. However, even with all its problems, our Jenny was very useful for demonstrating to school parties and on Working Days. Alas, it was thought to be inappropriate for Liverpool Road and ended up in the 1804 North Mill at Belper.

The Waterframe

Perhaps the earliest surviving industrial example of Arkwright's waterframe.

In contrast to the Jenny, many early Waterframes have survived. The Science Museum in London has what must be the original that Richard Arkwright submitted with his patent application in 1769. We were proud to be lent by Tootals what must be the earliest surviving example of a production machine with the grouping of four vertical flyers and bobbins. It has the roller drafting mechanism which formed the core of Arkwright's invention. The spacing between the rollers is fixed so this machine could cope with only one staple length of cotton. The gearing too appears to be set to give only one drafting ratio. Only the flyer is driven. The weight of the bobbin gives sufficient drag to wind on the yarn. Owing to this drag, Arkwright's machine had to be set to insert a much greater twist than the Jenny; hence it produced a hard strong yarn, suitable for warp. It spun continuously so it was better suited than the Jenny to be driven by power in mills, either by horses or waterwheels. We had a special opening ceremony for the new spinning gallery at Grosvenor Street when we drove this machine with an electric motor. Once we had increased the weights on the front roller, it spun perfectly. Because it was inappropriate to demonstrate it regularly, I had a replica made which could be turned by hand for general use. It showed that similar machines could have been sold to the domestic industry. However Arkwright chose not to go down that route but to restrict it to mills. Hence, through Arkwright's acumen, it became the iconic machine of the early Industrial Revolution.

The Spinning Mule

Samuel Crompton's Spinning Mule was arguably perhaps the most important of the three great spinning inventions that helped to launch the classic period of the Industrial Revolution. While Hargreaves' Jenny showed the possibility of a multiple spindle machine and Arkwright's waterframe the potential of spinning machines driven by power, Crompton's Mule proved to be the most versatile through the wide range of yarns that could be spun on it, from the coarsest to the finest, hard or soft. It would eventually form the basis of Lancashire's dominance in cotton textiles by being developed into a machine containing a thousand spindles worked by power.

The mule had to be included in the Museum, but, of early machines, there was only the remnant of one of Crompton's mules, probably of 1810, in the collections of Bolton Museum. The earliest pictures of a mule may be those in Rees's *Cyclopaedia* of around 1810. This contrasts with the Jenny and waterframe. Some form of hand-worked mule would be desirable to explain the basic principles of this intermittent type of spinning because it was not easy to stop one of the later self-actors at appropriate moments. I had accepted a shortened fine spinning Platts mule from Bolton Technical College that was in first class condition mechanically but contained all the extra complex motions for fine spinning. It was stored in a house in Rosamund Street but a break-in occurred when some parts were stolen. However enough were left to construct a demonstration hand-operated mule with about twenty spindles. It contained a creel for the roving bobbins feeding into a set of properly weighted drafting rollers mounted on their original stands. The long carriage was shortened and mounted on wheels which ran on the original rails. A wooden framed headstock was designed on which was a crankshaft that could be turned with the right hand. On this was fixed a large cast iron wheel round which ran a band to turn the spindles on the carriage via appropriate guide pulleys. The crankshaft also had a bevel gear to drive a shaft leading to the drafting rollers. This shaft could be disengaged at the appropriate stage in the spinning sequence.

The left hand drew out the carriage while the right turned the crank to work the spindles and drafting rollers. The drafting rollers were disengaged while the spindles continued to be turned to put in more twist if necessary before being reversed to back off the yarn. To wind on, the crankshaft was turned in the original way while the left hand operated the faller wire to guide the yarn onto the cop. The counter faller wire was retained which made winding on much easier through helping to maintain the tension in the yarn, thus preventing snarls. This showed the importance of the counter faller wire. The carriage almost drew itself in as the spindles rotated. It was much easier to spin on this mule than on the Jenny and to control the various stages. Perhaps this pointed to the success of the mule compared with the Jenny. But it is dangerous to make such a comparison because we were using rovings prepared on modern machines and modern drafting rollers and spindles. It was sad to learn that such a demonstration exhibit was deemed to be unnecessary at Liverpool Road but luckily it found a home at Belper North Mill. For this early period we were lent a carding machine by Tathams of Rochdale. This came originally from one of

Arkwright's mills at Cromford. With its iron frame, it probably dated to around 1800. It had flat cards round the upper periphery of the main cylinder and Arkwright's important crank and comb for doffing. The web was drawn off into single sliver. Our collection in Manchester could never rival those at Bolton or Helmshore for early machines but we could demonstrate the principles.

The early carding engine showing the end where the cotton was fed in.

The Heyday
Preparatory Machines
The period either side of the First World War must be considered as the peak of the Lancashire textile industry. Our intention was to set up a small production unit, starting with a bale of cotton and following the processes through to a piece of woven cloth. It was hoped to do this with examples of machines representing some of the major textile machinery manufacturers to preserve their names. Also machines might be acquired from different spinning companies to preserve their names as well. But herein lay some of the difficulties. Mills tended to specialise in the yarns they spun so that their machines needed a particular blend of cotton which might not be suitable for machines from a different mill. Then the lap formed on one type of opening machine might not fit a carding engine from a different mill. A mill might have only two or three opening machines supplying perhaps forty carding engines but we needed only one of each so running one opening machine continuously would produce far too many laps for a single carding engine. Auxiliary equipment was necessary, such as cans for slivers, bobbins, tubes, etc., all suitable for their particular machines.

One of the first machines we took out was a Tatham's carding engine from Lodge Mill at Turn above Edenfield. In 1966, it was about one hundred years old and continued in use until we removed it. The main cylinder was wooden lagged so an archaic construction. Another unusual feature for condenser spinning was the doffing arrangement in which the web was split into only four sections instead of many more. It was eventually passed over to Rochdale Museum since it had more local connections there and was unsuitable for medium count spinning.

Grosvenor Street could not accommodate the range of machines necessary but, in anticipation, we accepted a Creighton vertical porcupine opening machine made by Lord Bros., Todmorden. Eventually this was replaced by the present Platts line because the lap produced on it was too narrow for the carding machine we had. The 1896 Asa Lees carding machine from Moorfield Mill, Shaw, now on display was re-erected first in Grosvenor Street although never demonstrated there in order to preserve the card clothing. The card clothing on the Tatham's machine suffered from damp in the Charles Street railway arch store. The carding engine fed the sliver into a can which had to be the right diameter and height to fit. A supply of cans had to be collected to provide enough for the drawing and slubbing frames.

For drawing out the slivers from the carding engine, we had two draw frames. From Brooklands Mill, Leigh, we accepted a single head 1901 Platts machine with mechanical knock off or stop motion. It was part of their set for spinning samples. A twin head Howard & Bullough draw frame was presented by the Textile Department, UMIST, which had electric stop motion. Both these were already shortened since most draw frames would have had at least four heads.

From the draw frames, the slivers might proceed by two routes, either through combing machines for fine spinning and then to the roving frames, or straight to the slubbing and roving frames for medium counts. We never intended to demonstrate combing. This would have needed a machine to turn the slivers into laps to supply the combing machines but we did put into store examples of a Heilman and a Nasmyth machine. What state they were in when removed from the dampness of the store at Constantine Lloyds is not known.

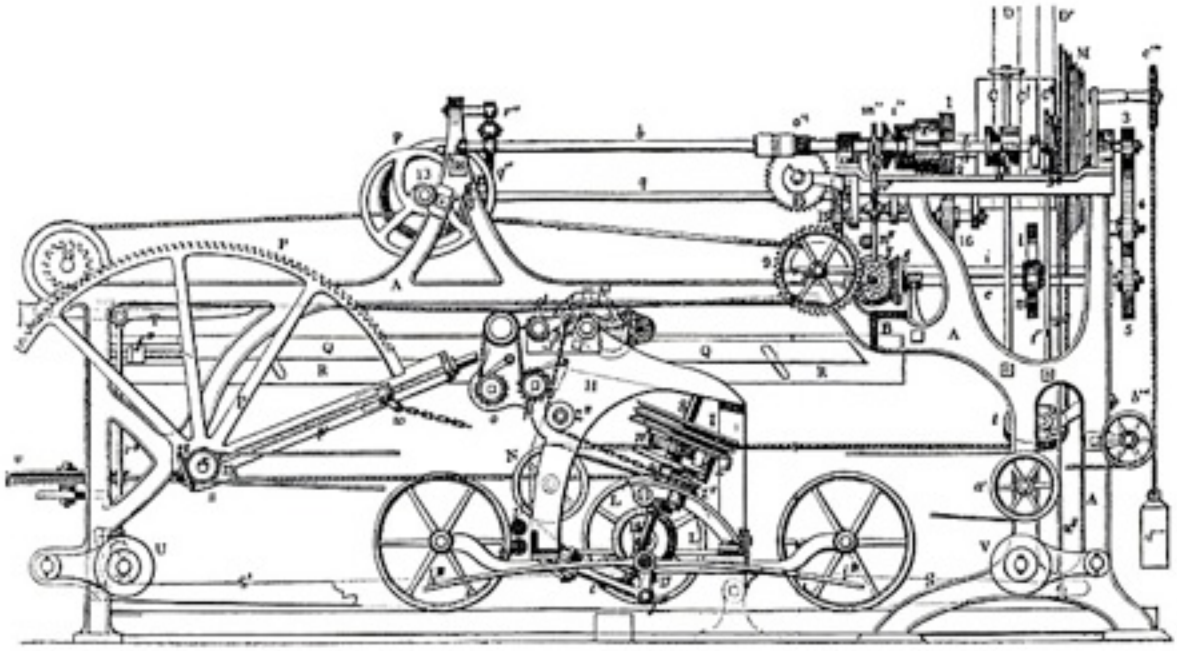
For medium counts, the slivers might be processed into rovings through three similar machines, a slubber, an intermediate and a roving frame. The final bobbins on the roving frame had to fit the creel of the spinning mule we eventually acquired. Because we were not producing yarn commercially, we decided to omit the intermediate stage. In moving a Howard and Bullough roving frame from UMIST, the cast iron part of the carriage holding the spindles broke so this frame was scrapped. However Shiloh Spinners presented us with a Platts slubbing and a roving frame from Royton Mill. These were shortened to reduce the amount of cotton we were using. The roving frame was re-erected in Grosvenor Street so that we could have a supply of the right size bobbins for our spinning mule. It was driven by an electric motor at a slower speed than in the mill. Even so, the noise it made when started would surprise a school class of youngsters. In its re-erection, we were helped by a fitter from Platts because such textile machines were not built in groups of spindles that could be assembled in easy sections. Parts had to be cut to appropriate lengths. In the case of the roving frame, the final length was determined by the need to accommodate the pair of opposing cone pulleys which altered the speed of the bobbin so the peripheral speed remained constant as the diameter increased. We mounted both our slubbing and roving frames on steel girder sub-frames to avoid the need for dismantling these delicate cast iron parts when moving the frames in the future.

The Self-acting Spinning Mule

The self-acting spinning mule, based on the inventions by Richard Roberts in 1825 and 1830, must be considered as one of the most complex machines worked mechanically. The objective was to wind the spun yarn onto a tapering plain spindle in the form of a cop which could be removed and placed directly into a shuttle ready for weaving. Roberts developed a mechanism that would adjust itself to take into account variations in spindle diameter and other parameters so that the mule spinner needed to make remarkably few adjustments. The sight of the mule spinner himself with only a couple of assistants in the mule gate attending to a pair of mules as the carriages moved in and out, each having over a thousand spindles stretching across the full width of a textile mill, was a sight never to be forgotten.

I felt that somewhere a full length mule should be preserved, even though the likely hood of running it with a full compliment of cotton was remote. Accordingly we took out from Bowker & Ball's mill in Dukinfield an Asa Lees mule, also to preserve an exhibit of that famous machinery maker. It was on one of the upper floors of the mill which presented difficulties in getting it out of the building. The lengths of some of the shafts and wooden creel would fit down neither the stairs nor in the lift. The exterior bale hoist was designed to be quick acting both in stopping and starting so tended to jerk any parts of machinery suspended from it. Yet this mule was removed successfully and stored at Constantine Lloyds. It was a lengthy operation in more ways than one both in time and fitting it onto Buckley's lorry. It was taken to Higher Mill, Helmshore, where it was re-erected but a few parts had been stolen in the meantime.

The Spinning Gallery at Grosvenor Street



Drawing of a self-acting mule headstock showing the complexity of the mechanisms.

When it became possible to expand into the rest of the Grosvenor Street building in 1972, a better spinning gallery became a reality. This coincided with Shiloh Spinners deciding to stop using their medium count Platts mule at Elk Mill. Because the fine spinning mule from Bolton had had parts stolen which could not be replaced and it was still hoped to be able to re-erect the one from Bowker and Ball in its full length, we decided to accept the offer of a mule from Elk Mill and shorten it. At the time, most people thought that building such a mill in 1927 and equipping it with mules was foolhardy owing to the decline of the textile industry and the introduction of the ring frame. But these mules continued to be used until 1974, then being the last of the Oldham system.

Originally these mules had 1,200 spindles and were 120 ft. long. We decided to cut one down to only 135 spindles, roughly balanced on each side of the headstock. This would give an impression of a proper mule but would require only a fraction of the cotton needed to demonstrate it. Knowing that it would have to be moved out of Grosvenor Street and to save dismantling the complex mechanisms of the headstock again, we decided to mount the headstock on one steel sub-frame and the roller drafting apparatus on separate sub-frames on either side. This foresight proved to be well justified because the mule has been moved twice since.

Lord Mayor with Dr. Hills in front of the creel of the Spinning Mule.

However shortening a mule is a complex exercise. Even in the 1920's there was no attempt to build a mule with units of say twenty spindles which could be joined together to give the correct number of spindles needed. The joints of the drafting rollers did not correspond with those of the supporting plates on which they were mounted. In the carriages, the lengths of the tin rollers driving the spindles did not correspond with the joints of the drafting rollers and so on. To make it look authentic, the end frames and ends of the rollers, carriage and so on were taken and needed re-fitting. Luckily Platts came to the rescue and provided the assistance of a fitter who was about to retire but who had helped to erect these mules as an apprentice. Platts engineers also machined some of the parts to re-fit them. The headstock had to be dismantled to get it out of Elk Mill. This time it was easier to move with shortened parts while most of the creels and carriages were left behind. A major part supporting the main driving pulley, the rim shaft, was found to be cracked. The obvious thing was to replace it with one from another mule. When it came to re-assembling the headstock in Grosvenor Street, it was discovered that the locating pins on the replacement part would not fit. Even as late as 1927, each headstock was fitted up at Platts individually with no standardisation even though this would have been an order for a large number of mules.

The mule at Grosvenor Street was driven by its own electric motor suspended from the ceiling. Getting the heavy cast iron bedplate up there was difficult. As with the roving frame, we decided to lessen the speed but this could not be reduced too low because the last part of the travel of the carriage in either direction relied on the momentum to fully complete it and effect the changes in the mechanism for the next stage in spinning. If the mule were going too slowly, the changes would not happen so the mule would stop. We were given a series of gauges for setting up the various parts, such as seeing the angle of the spindles was correct, the drafting rollers were horizontal and so on. Platts fitter reassembled the mule so it would go through the motions of spinning but this was different from actually spinning cotton. Luckily the person who had operated the mule at Elk Mill, Fred Hilditch, decided to see what had happened to his mule and one day strode into the Museum. He soon had the various parts set correctly and agreed to come and demonstrate his mule a couple of afternoons a week to rectify the faults we caused when we operated it ourselves. Running the mule had become second nature to him so he found it very difficult to explain the reasons for making his alterations or minor adjustments while it was running. We never did receive a bill from Platts for the services of their fitter. We were also lucky that Shiloh Spinners generously supplied us with the intermediate bobbins of cotton with which we filled the creel on our roving frame to make the correct thickness of roving for both our mule and ring frame. The cops on the mule fitted into the shuttle of our Lancashire power loom. Those that were not used for weaving were sold in the Museum shop at a price, we were told, below the value of the cotton they contained. Running the mule was very popular with school parties as well as other visitors especially on our Working Saturdays.

The Ring Frame

The ring frame began to be introduced from America around the 1870s. It was more compact, simpler to operate but produced a harder twisted yarn than the mule. Also the cotton was wound onto a tube from which it had to be rewound into a different package for further use. While visiting Brooklands Mill, Leigh, to photograph the J. & E. Woods cross compound steam engine, the opportunity was taken to look round the rest of that mill and its neighbour. A unit for spinning test samples was seen consisting of a single-head draw frame, a shortened roving frame and a shortened ring frame, all built by Platts in 1901. When these mills closed in 1967, the opportunity was taken to preserve the draw and ring frames as there was the chance of a shortened roving frame from UMIST.

The 1901 Platts ring frame was the oldest seen in the course of collecting exhibits. It was reduced in length to about twelve spindles on either side. Because it was being used to spin samples, only one side was used. The drafting rollers and stands were missing on the other. A possibility of replacing part of these presented itself when Oldham Tech. closed its Textile Department where there was a demonstration set of gearing and short length of rollers but these went to Oldham Museum. The ring frame was short and light enough to move in a single piece. It was on the ground floor of the mill and was taken into our store in the basement of the Rosamund Street chapel. From here it was moved into the new spinning gallery at Grosvenor Street to be driven by an electric motor. This was fitted with a push-button time switch so visitors could operate it themselves. The creel was modified to take the same roving bobbins as the mule and the gearing of the drafting rollers set to spin the same count of yarn. A new set of the correct size of rings was fitted which considerably reduced the number of breakages. This little ring frame has proved to be a most useful demonstration machine and completed the spinning section of the heyday of the Lancashire industry.

Processes After Spinning

The spun yarn might have to go through various processes to prepare it for the next stage of production such as knitting or weaving. From a mule cop or ring frame tube, it might be rewound onto a cone when thin parts or thicker slubs might be removed. It might be doubled to give a heavier thread which was more stable as it did not twist itself into snarls. The yarn might be wound into hanks for dyeing or onto bobbins for placing in a creel to make a warp for a loom. All these processes needed different machines. We did take an early horizontal gassing frame from Bolton Tech. A very early chemical treatment of cotton yarn was 'Mercerization', a treatment I think with sulphuric acid pioneered by John Mercer of Great Harwood around 1844. The cotton swelled up and became more glossy, giving a smoother finish on say shirting. The yarn was passed through a gas flame to remove its fluffiness, otherwise the protruding fibres would have swelled up in the acid and given a harsh feel.

Probably an early gassing frame in which cotton yarn was passed through a gas flame to burn off any protruding fibres before the yarn was treated in the Mercerization process.

The Leesona Pirn Winder

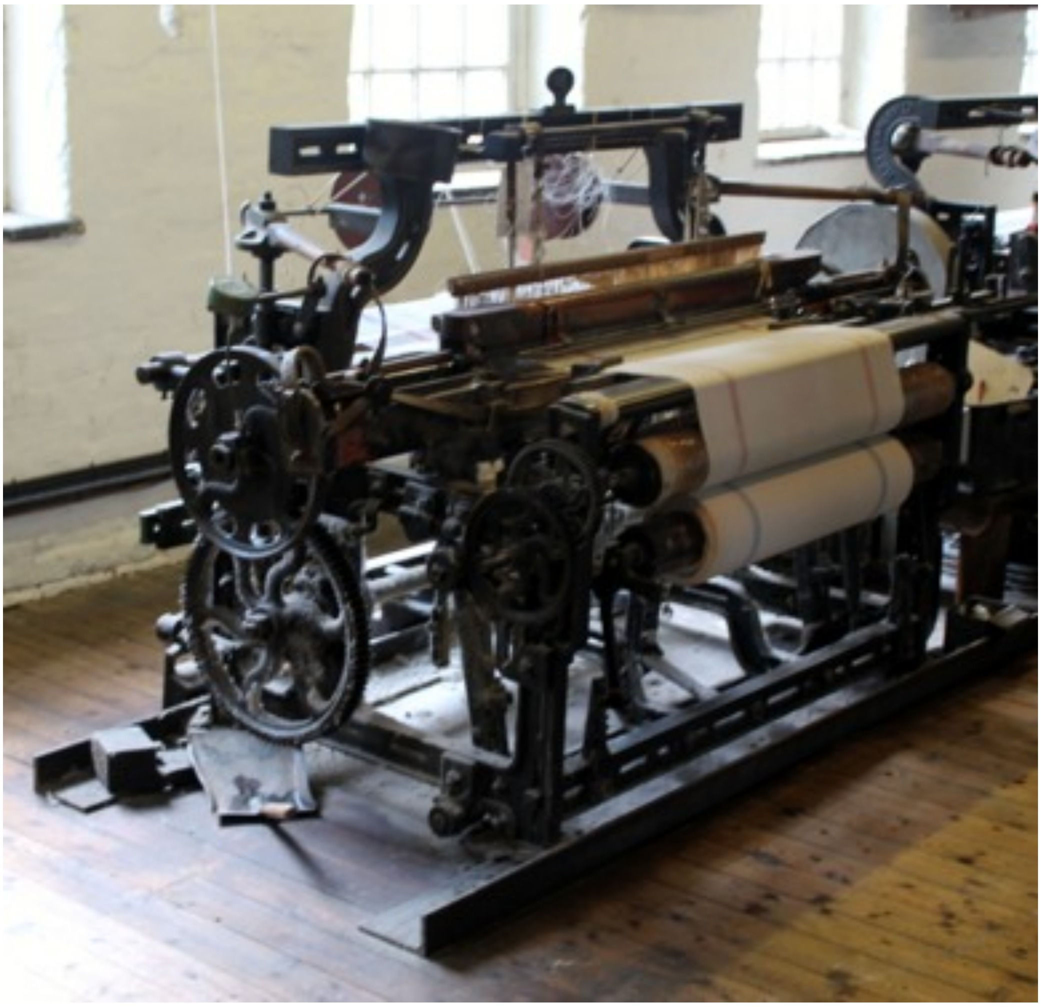
To demonstrate our various looms, the shuttles had to be filled with appropriate yarns. There was the shuttle for the large handloom, smaller ones for the Jacquard loom, others for the Lancashire loom, the bobbins to go in the ribbon loom as well as later the terry towelling loom at Liverpool Road. The Leesona pirn winder had three or four heads which could be set to wind yarn onto appropriate quills or pirns and was adapted to take yarns from the tubes off the ring frame or other packages that we acquired. It was a great asset because we could not have given some of our weaving demonstrations without it.

The Section Warper

One of the impressive sights in a weaving shed was the beaming machine for preparing warps for the looms. It consisted of a 'V' shaped creel to hold the bobbins or other packages, one for each warp thread, from where the threads would be drawn off horizontally to pass through a reed to give the correct spacing before being wound onto a beam. It might be a few feet between the creel and the beaming machine with the threads suspended in mid-air, funnelling down from the width and height of the creel to that of the reed. Should a thread break, a knock-off mechanism would stop the beamer.

Although impressive, because the number of bobbins necessary for a full-width warp would have been enormous and the whole ensemble taken up a great deal of valuable space, we compromised at Liverpool Road with a section warper. This needed far fewer bobbins. One section would be wound onto a large circular open frame, then the creel would be moved sideways the appropriate amount so that the second section could be wound on and so on to fill the frame. Finally all the sections would be wound off together onto the beam for the loom. While it was more difficult to keep the tension even throughout, it could be more easily adapted to suit the varying widths of the different looms we had on display. It was re-erected in the original textile display at Liverpool Road but presumably stored subsequently. It was decided not to attempt to preserve a sizing or slashing machine through the complexities of making the hot size, applying it and drying the warps around a steam-heated cylinder.

The Lancashire Loom



A Lancashire Loom.

The typical product of the Lancashire cotton industry was plain calico cloth. The typical power loom on which it was woven was the over-pick Lancashire loom dating back to the 1820s. To save on material costs, we needed to find one weaving cloth only about 30 ins. wide. Pennington Mill, Leigh, wove some of the finest quality cloth used at one time for typewriter ribbons. This might have presented problems because we wanted to weave with yarns spun on our mule and ring frame. This yarn was much thicker than that used at Pennington Mill. We were able to wind bobbins for the shuttles on the Leesona pirn winder and adjust the take-up for the cloth as it was woven. Because we were not in production and wanted to use it only for demonstrations, we decided to slow the loom down. But it needed enough speed for the pickers to send the shuttle across. To set up the loom at Grosvenor Street, we had the assistance of UMIST Textile Department who prepared the warp while the President of the Weavers' Union came to demonstrate it. Even when running comparatively slowly, it still made a great noise. To preserve an example of another type, we took out a wider under-pick loom from Hannah Lees, Oldham, but this was never put on display. This was later represented by a terry-towelling loom which needed two beams, one for the warp and the other for the pile.

The Ribbon Loom

The Jacquard Ribbon Loom showing how high it is.

The other power loom displayed at Grosvenor Street was a narrow fabric or ribbon loom which could weave four ribbons. It had a Jacquard attachment and two shuttles to each ribbon. It had been taken from Cash's nametapes mill to Courtauld's Museum in Coventry from where we removed it to Manchester. Its height could be accommodated in the Board Room on the first floor at Grosvenor Street and the parts were light enough to be carried upstairs although the Jacquard head was difficult to re-erect on top. This head had sufficient needles to weave quite an extensive pattern. Devogue fitted a new Jacquard harness designed for only a single repeat on each of the four ribbons. Warp and weft came from a Macclesfield mill. A pattern showing the name of the Museum and the flywheel of the Durn Mill engine was designed by someone in the Polytechnic Textile Department. On early ribbon looms, the shuttles were knocked through the warps by little picking sticks, a possible inspiration for Kay's flying shuttle. We shortened one of these ribbon looms from a North Manchester mill which is displayed at Liverpool Road. But on the big ribbon loom, the shuttles are drawn across by a rack and pinion system. With a pair of shuttles for each ribbon, we chose one to weave the white background and the other to weave the coloured pattern. To prevent the ribbon curling, the tensions on the bobbins had to be just right, that for the coloured weft being much less. The finished ribbon was wound onto a drum with a friction clamp. To get all four ribbons being taken up at the same speed was difficult to avoid the round flywheel becoming oval or egg-shaped. One advantage was that this loom could be run at slow speed since the shuttles were driven positively. For visitors, it was a fascinating machine to watch while the finished ribbons could be sold in our shop. The woven pattern had to be changed for Liverpool Road when a picture of the front of the 1830 building was chosen.

Calico Printing

To show the industrialisation of calico printing, UMIST Textile Department presented a model of a printing machine for three colours with copper engraved cylinders. On these, the pattern was cut into the surface to hold the ink. In addition, we had a complete set of rollers for printing fine silk cloth with the pattern formed from raised brass strips with felt inserts similar to hand block printing technique. There was also a section of the frame holding rollers for printing wallpaper which used a similar technique.

Braiding Machines

We received three or four early type braiding machines from a firm in Broadheath. The bobbins proceeded round circular tracks to pass each other so deflectors were necessary to send them in the right direction. The framing was wood. Later machines had lozenge shaped tracks which needed no deflectors since the bobbin carriers had slipper-shaped feet to follow the tracks. There were two layouts on our early machines. One produced tubular braid where the bobbins went round and round. The other produced flat braid where the bobbins reversed at the end of the track. We motorised one of the tubular braiders with a time switch so people could watch it work and be fascinated with its operation as the bobbins danced in and out of each other. These machines are a very early overlooked instance of textile mechanisation, for they were developed certainly by 1800 and possibly by 1750. The tensioning system for the yarn and its release mechanism were quite intricate so were remarkable achievements if the earlier date is correct.

Harrison Knitting Machines

William Lee's knitting machines had many small delicate parts which needed a frame-smith to keep them in order. Somewhere around a dozen movements by the knitter had to be performed to produce one row of stitches. Such machines remained in use at least until the 1970s due to the fine stitches that could be knitted on them with their bearded needles. Courtaulds gave us a later double headed circular machine with bearded needles. In the 1850s, another type of needle was invented, the latch needle, possibly by Harrisons of Manchester. This greatly simplified making the loops and passing them over the ends of the needles but these needles could not be made to the finer gauges of the bearded needle. Soon both flatbed and circular types of knitting machines were developed which became very popular in people's homes and there were larger industrial ones. We were given examples of both domestic types. We replaced the hand drive on a Harrison circular machine with a pulley connected to a small motor controlled by a push-button timer so it could be operated by a visitor. It produced a long tubular length but had to be watched to see all the needles were working properly otherwise the knitting would fall off.

What Had Been Achieved

Within the confined space available at Grosvenor Street, it had proved possible to collect a wide variety of textile machines that outlined both the basic processes of spinning and weaving as well as showing the change from hand production to the machines of the Industrial Revolution and the important Lancashire cotton industry of the late eighteenth century. Most of these machines could be demonstrated which proved to be a great attraction for school parties and general visitors.

Chapter 7, The Machine Tool Collection.

Introduction

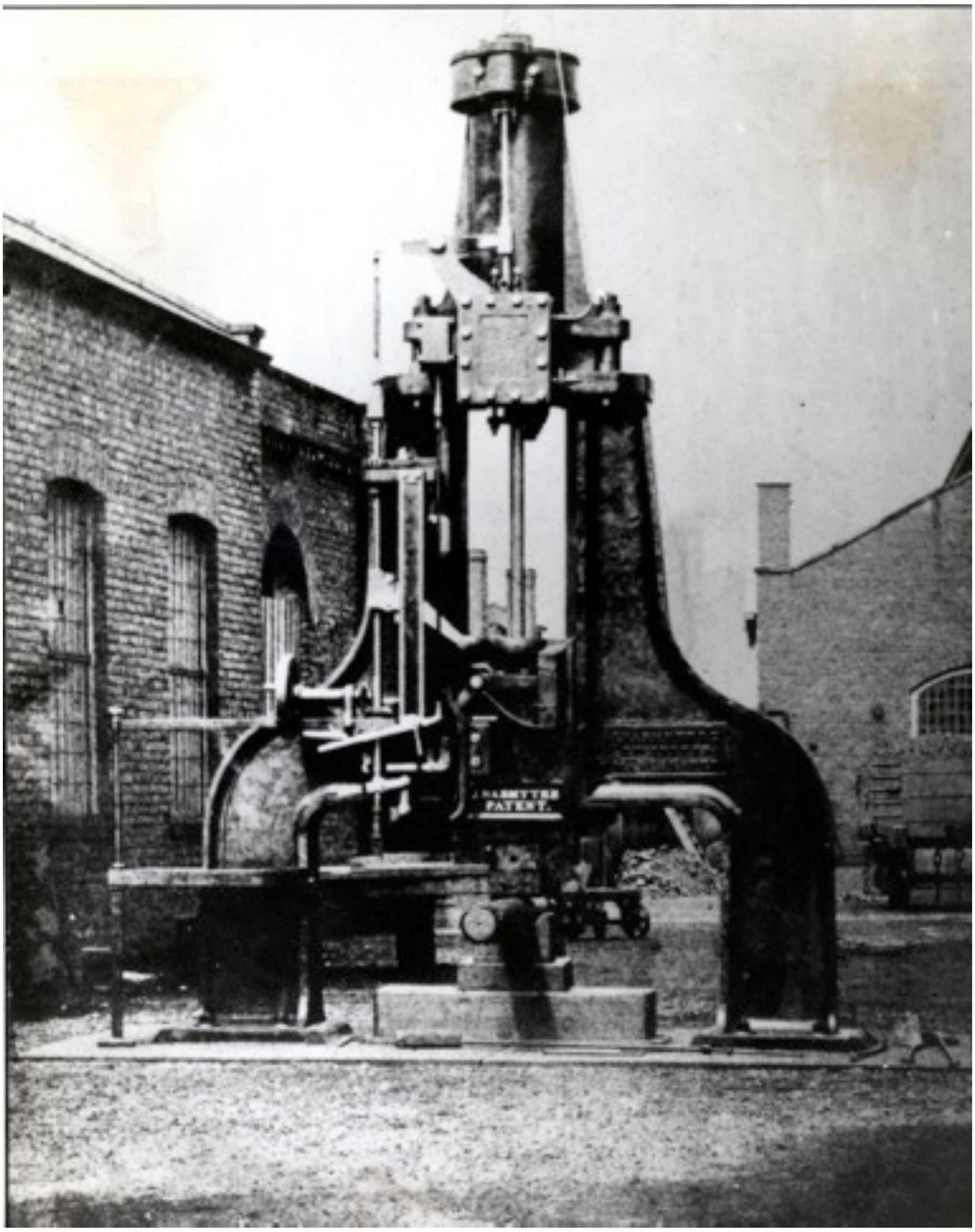
Of all exhibits in a technical museum, perhaps machine tools are the most difficult to display and explain. Mostly they are totally unknown to the ordinary public so there is little understanding of their function. Yet they are the basis of industrialisation since no machinery can be constructed without tools. In its position as the world's first industrial city, it was only to be expected that Manchester would become a centre for manufacture of machine tools. It has been suggested that there were somewhere around an hundred firms in and around the city that produced machine tools over the years. So one of the objectives of the Museum was to perpetuate the names of some of these firms by collecting appropriate exhibits as well as ones that showed basic principles of machining. Small ones would be collected wherever possible.

Perhaps Joseph Whitworth is the most famous of Manchester machine tool makers and we were able to assemble a significant range of his products. He was well known for his introduction of accurate measuring devices. We were presented with various examples of his 'micrometers' or comparators, one of which was said to be able to detect the difference of a millionth of an inch. We were also able to assemble examples of his slip gauges, plug and ring gauges and taps and dies. The collection of Whitworth machine tools included a small and a large lathe, a planning machine, a gear cutting machine, a pillar drill and a single head shaping machine. These will be covered in detail later.

In the following account, the exhibits have been grouped together according to some of the basic principles in which they remove metal. First an appropriate lump of metal had to be obtained. Reducing the ore into a piece of iron, copper, or whatever, was not generally carried out in Manchester except perhaps the Bessemer converters tried at Gorton Foundry or the last place in Britain to make wrought iron at Messrs. Walmsleys, Bolton. We made no attempt to cover this in the Museum. Neither did we try to cover foundry work in spite of the importance of cast iron as the basis for most machine tools. Forming the metal by hammering or squeezing forms one section. Most of the other machine tools had either a cutting tool held against a moving work piece or a stationary work piece acted upon by moving tools. It was intended to be able to demonstrate some of these in a workshop where other exhibits could be restored and maintained.

Metal Forming Tools

Most workshops would have had a smithy in which little parts could be made and tools sharpened. Accordingly we accepted some blacksmithing tools such as swages and hammers as well as an anvil. Larger blacksmiths shops might have a foot-operated Blacker hammer, claimed to be a local invention. From Brooks Ironmongers in Hyde we took out another foot-operated hammer, a spring-pole Oliver. The wooden spring pole was fixed in the roof above the hammer.



An early photograph of Nasmyth's original steam hammer.

For hammers operated by power, from Stockton Heath Shovel Forge we removed a tilt hammer with a wooden shaft and wooden baulks forming the base. This forge made shovels for the navys digging the Bridgewater Canal in the 1760's so this could be the oldest machine tool in the collection. We made no attempt to locate a steam hammer because one by the original inventor, James Nasmyth, was preserved in Eccles Museum. When a B. & S. Massey pneumatic hammer was offered by the South East Lancashire and North East Cheshire bus operator, we accepted it but we did not remove the wooden base for the anvil which stretched quite a few feet below ground level. This was quite a large example. For cutting iron bars to length ready for working in these hammers, we preserved a punching and shearing machine. It was surprising the ease with which it could slice through a bar or punch holes in sheet ready for the next operation.

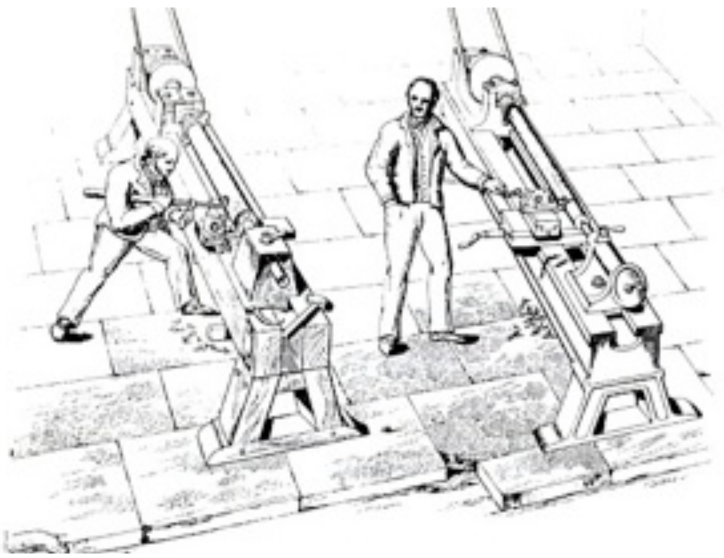
When B. & S. Massey closed, we were able to preserve many of their drawings showing steam hammers like this one in South Africa.

Bedson Rolling Mill

Rod was rolled, wire was drawn through a dye. Richard Johnson & Nephew produced rod. Early rolling mills tended to create oval shapes of round rod with a rib down either side. The red-hot billet was fed between a pair of horizontal rolls with matching grooves across them getting progressively smaller. After passing through the first pair of grooves, the billet had to be returned over the top of the rolls to be passed through the next set of smaller grooves. When the billet had been reduced to the final size of the rod, the penultimate set gave an oval shape. By turning the rod through 90^{o}, it would be passed again through the last set with the same cross-section to give a round rod. Attempts to roll rod by passing it through a series of rolls with progressively reduced grooves ran into the problem of the final cross-section shape. It was solved by Richard Johnson & Nephew placing every other set of rolls vertically instead of horizontally. In this way the billet was squeezed sideways in alternate directions, obviating the need to turn the rod at the final pass through 90^{o}. One problem to be solved was connecting the gearing driving the rolls because, due to the increasing length of the billet as it became smaller in cross-section, the rolls had to increase proportionately in speed. Another problem was that the front end of the billet cooled quicker as it entered the rolls. On later sets, there was a device to automatically cut this end off on what was now rod as it passed through. This important invention was made at the Bradford Works in Manchester. It was soon copied worldwide. A section of three rolls was preserved in the entrance hall of Richard Johnson & Nephew. This was presented to the Museum and found a new home in the entrance hall at Grosvenor Street. As it was quite heavy, an Acrow prop gave support from the basement below.

Lathes

Arguably the lathe was the first machine tool and its importance has remained right up to the present. We were able to assemble a small selection which covered many crucial developments except turret and capstan lathes. One source of machine tools was the maintenance workshops in mills. Machine tools were essential for keeping the steam engine, line shafting and production machines running. As most of these machine tools were used irregularly for one-off repairs, there was little incentive to replace old ones with modern ones designed for batch or mass-production. So older machine tools remained in use until the closure of the mill, providing the Museum with historic exhibits. One such mill was Derker Mill, Oldham, founded in 1813. When being shown round the mill, I noticed a complete box of Whitworth male and female plug and ring gauges but these had disappeared by the time I returned. I never saw such a fine set subsequently. Also there was a pair of bulks of timber which could have formed the bed of a long lathe. My deduction was correct but alas the stone block forming the headstock bearings had been thrown away.



James Nasmyth's drawing of an old-fashioned wooden bed lathe with hand-held tools on the left and his improved lathe on the right with tools mounted in a cross-slide.

After seeing in the Deutsches Museum a facing lathe mounted on a wooden bed, I desperately hoped to find one for Manchester but had to wait some years until visiting Pennington Mill, Leigh, looking for a Lancashire loom. I went into the maintenance workshop and there, lo and behold, was a long lathe with a pair of wooden timber baulks forming the bed. It probably had been used for truing the bearings at either end of sections of line shafting. It was complete with headstock, tool holder and tailstock. The headstock and tool post were mounted on metal strips let into the upper surfaces of the timber but these strips extended for only a short distance of the full fifteen feet or so of the bed. As this full length was greater than we could accommodate, I decided to saw the lathe in half to preserve the more significant parts. I suppose I must be one of the few persons to have sawn a lathe in two. It shows how wood could be used as a structural member. The bulks were mounted on wooden blocks and retained at the correct distance apart by wooden spacers, tied together with bolts. The mandrel in the headstock had parallel bearings with the horizontal thrust taken up by an adjustable pressure bolt system. I think the driving pulley was stepped to give three or four changes of speed. I doubt if it had back gearing. The turning tool would have been hand-held resting on a steady. The cutting tool itself was fixed in the end of a long wooden handle which could be tucked under the operator's armpit to steady it. The date of construction of Pennington Mill is unknown but is most likely to have been in the middle of the nineteenth century. If that guess is correct, then this wooden bed lathe must have been archaic but probably much cheaper than an equivalent iron one. It must have done the job intended for it to have survived a century or so.

Holtzapffel Lathes

From the ridiculous to the sublime. G. Cussons, makers of educational equipment, presented two ornamental turning lathes made by the famous London firm, Holtzapffel. Both were treadle operated. One was all iron framed but the other was mounted in a wooden framing complete with box of parts for oval turning and other ornamental work. An overhead frame supported shafting and pulleys for driving rotary cutters for cutting fine patterns. The mandrel in the headstock could more horizontally. On the rear end could be fixed collars with external threads of different pitches cut into them. To cut a thread, a pivoted clamp like a knife blade was lowered into the thread so the mandrel was moved horizontally as it revolved. Less than an inch of thread could be cut at one go. To cut a long thread must have needed great skill. It is feared that some of the ornamental turning equipment was stolen in the move from Grosvenor Street to Liverpool Road because the lathes were dumped at first in the then unprotected Byrom Street warehouse. We used one of these lathes for demonstrations at Grosvenor Street.

Whitworth Small Lathe

This simple lathe with cast iron bed had no screw-cutting facility and may have been treadle operated. It came to the Museum through Prof. Jack Diamond and the University of Manchester Engineering Department. It was found in the former London & North Western Railway engine shed workshop at Oxford, where presumably it had been used for light maintenance. It had one design advance for the mandrel had a taper front bearing to take the cutting forces. To remove it from the engine shed involved filling in the railway tracks with ash to form a pathway over which the lathe could be moved to a loading position. The lathe could have been contemporary with the engine shed so possibly dated to around 1850.

Whitworth Large Lathe
The large green Whitworth lathe came through Prof. Koenigsburger of the Machine Tool Department, UMIST. Its origin is unknown but it showed most of Whitworth's major developments such as taper headstock bearing, lead screw concealed inside the cast iron bed where it would be kept away from swarf, back-gearing for a greater range of speeds. It came with a complete stack of gearwheels for cutting threads of different pitches. It was a very solid piece of work, with stout supporting legs and heavy other castings, showing why Whitworth's tools were noted for their accuracy and longevity.

Gap Bed Lathe
This lathe about eight feet long had several interesting features. A section of the bed by the headstock could be removed to fit a large diameter workpiece onto the faceplate or chuck. At the front was a normal leadscrew for screw cutting while at the back was a second drive shaft with a slot cut along its length. In this fitted a gearwheel which, when engaged, drove the traversing mechanism on the saddle for facing a piece of work. The screw threads for moving the saddle were well worn, showing the lathe had had a great deal of use.

Typical large gap bed lathe.

Carver Lathe
In the workshop at Derker Mill was an unusual lathe by Carver of Manchester. It had a double set of slideways. On the rear pair were mounted the headstock and the tailstock. Both overhung towards the front so that the saddle could pass below them on its own set of slides. The saddle was very broad, covering a long length of the slides, perhaps to prevent sparks from a grinding wheel falling onto them. It is suspected that this lathe was an early form of grinding machine, possibly for truing the spindles on roving frames. A grinding wheel could have been mounted on the saddle driven by a belt from an overhead pulley.

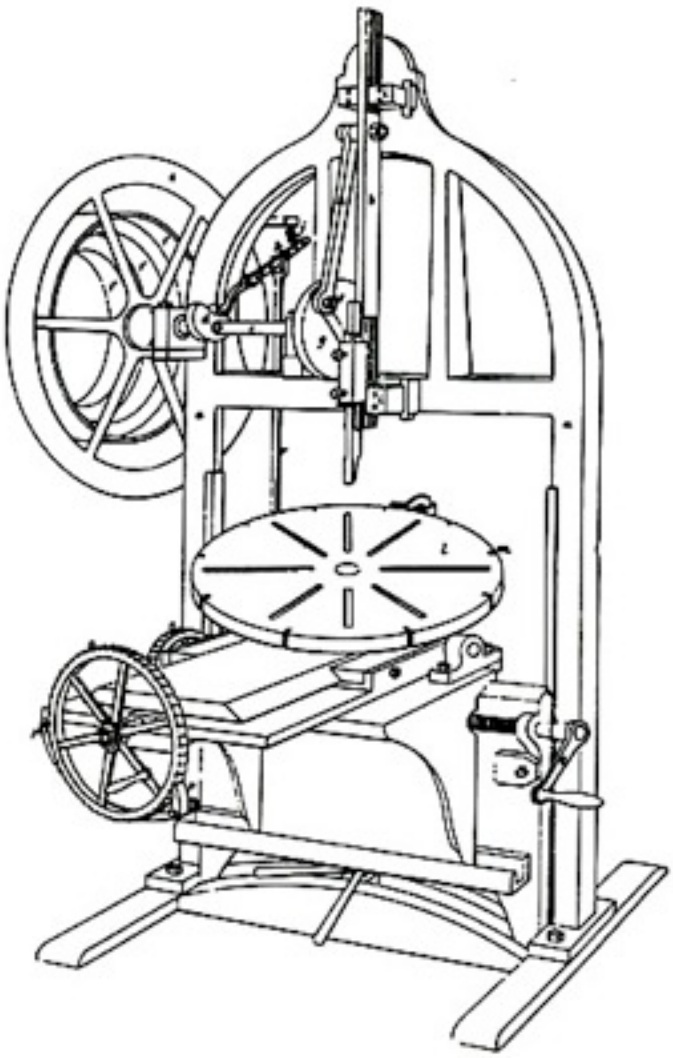
Browne and Sharpe Automatic Lathe
I think this came from the Machine Tool Department, UMIST. It was an early American example of a lathe that could be programmed to repeat the manufacture of a small part from a bar by using a set of tools consecutively. Each tool was advanced and retracted automatically. When the sequence had finished, the part

was cut off and the bar advanced ready for the next machining sequence. The Americans were in advance of the British in the development of such machines.

Other Tools

Once the idea of mounting a cutting tool rigidly on a saddle and moving the saddle on slides had been introduced, development of specialised machine tools proceeded apace so a second phase of the Industrial Revolution started in the 1820s. A textile mill had numerous pulleys and gearwheels on the line shafting and machines themselves. One way of securing these was by cutting keyways in the bosses and securing them with keys. To cut the keyways, slotting machines were invented.

1835 Sharp Roberts Slotting Machine



A contemporary drawing of the 1835 slotting machine of Sharp Roberts.

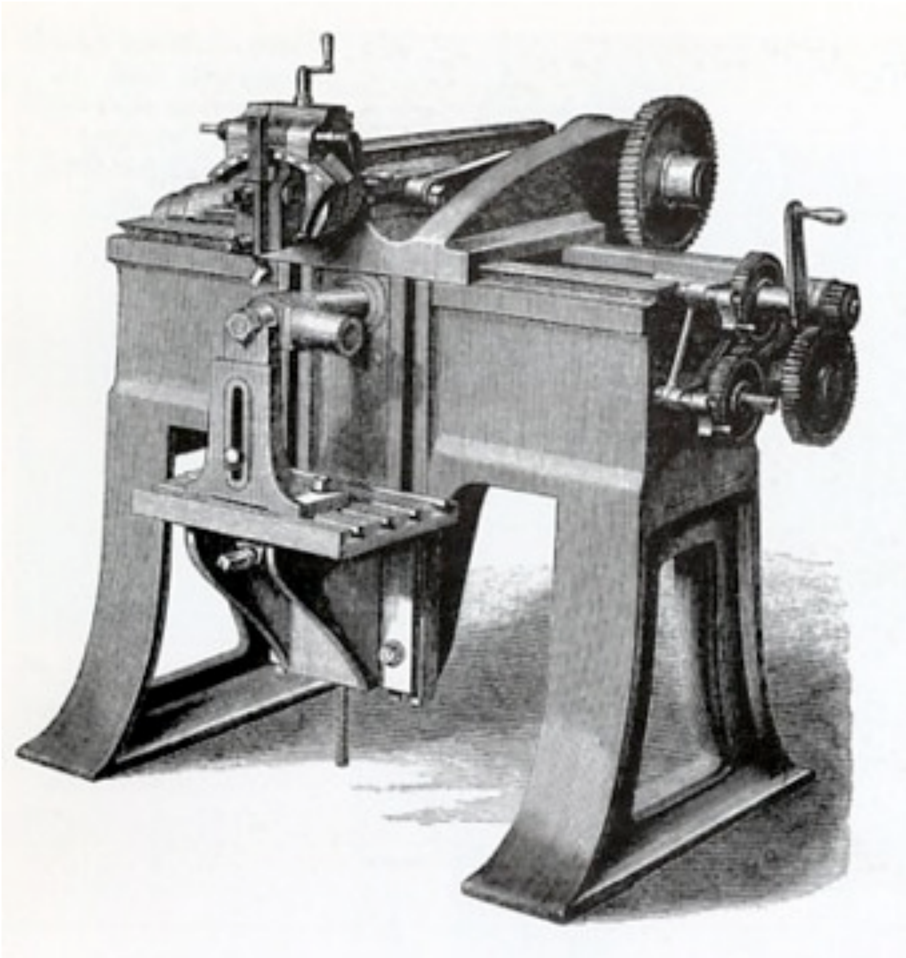
This impressive machine had the sliding toolholder mounted vertically suspended from the top of an arch. The wheel in which the keyway was to be cut was secured to a table that could be tilted for tapered holes. The table could be moved sideways and a little front to back. The diameter of the wheel to be machined was limited by the distance between the vertical legs supporting the arch. The toolholder ran in multiple ‘V’ grooves so should have been very accurate. It was driven by a connecting rod moved by a crank with a multiple-step pulley on the end of the shaft. For display in Grosvenor Street, the pulley had to be removed and the shaft shortened. The length of the stroke could be adjusted through a moveable crankpin. A study of the threads of some of the bolts on this machine and a similar one in the Science Museum collection was undertaken to see how standard they might be. The results were published in R.L. Hills, *Life and Inventions of Richard Roberts*. The Sharp Roberts slotter was presented by Sam Sutcliffe, a scrap dealer in Oldham. He had it in his yard for a number of years. By the time I was introduced to him by Frank Wightman, he was very elderly and not really capable of keeping an eye on his yard so we were lucky that the slotter was not vandalised.

Pillar Slotting Machine

This slotting machine, formed out of a fluted pillar, was one of the first exhibits obtained for the Museum. It was collected by Donald Cardwell who found unloading it in the railway arch Charles Street store posed considerable problems through its size and weight. It consisted of a single pillar with a plate at the top for securing it to a crossbeam. The driving pulley and gearing were mounted at the back with their shafts passing through the pillar. The crankshaft for driving the slotting toolholder was mounted in a similar way. Some teeth on the meshing gearwheels had been broken and replaced with pegs. There was a table with vertical slides situated at the bottom. The diameter of any workpiece was limited by the distance of the cutting tool from the pillar. Limitations on the size of the workpiece were later overcome through the ‘horse head’ type of slotter, where the supporting frame for the cutting tool could overhang much further from the base. Another type was developed by James Nasmyth in which the cutting tool was driven from below in the centre of a large table.

Shaping Machines

A more common variant on the single point cutting tool moving across the workpiece was the shaping machine. One of the fixed head type was purchased from Sam Sutcliffe together with the Sharp Roberts slotter. Its origins are unknown but Sam thought it was very early. A multi-stepped pulley at the rear on a horizontal shaft drove a bevel wheel meshing with a larger horizontal one on which was the crank arm for operating the cutting tool. The slides for the tool holder were situated at the top. In front was a table that could be moved up or down or sideways. It came with no outer bearing for the main drive shaft nor any matching stepped pulley.



An example of a travelling head shaping machine.

Whitworth Travelling Head Shaping Machine

This was a more versatile machine since the cutting head could traverse from side to side across the whole width of the machine. Along the back was a slotted drive shaft on which ran a gearwheel meshing into a gearwheel on the crank and connecting arms for operating the shaping arm. It came from the workshop of one of the masonry quarries in Darley Dale. It added to the variety of Whitworth machine tool we were able to collect.

Shaping Machine With Two Heads

This was a much larger, heavier machine that came from Avon Moseley's rubber works near Piccadilly Station. It was more versatile than either of the others. This was the site of a very early rubber works and also had an early Crossley calendar dating back to the 1860/70s which was too large for us to preserve.

Planing Machines

Another variant on the single point cutting tool was the planning machine where the tool was held stationary and the work piece moved under it. The work piece had to be returned to the starting position which meant a dead pass so various ways were tried to lessen this time when no work was being performed.

1842 Whitworth Planing Machine

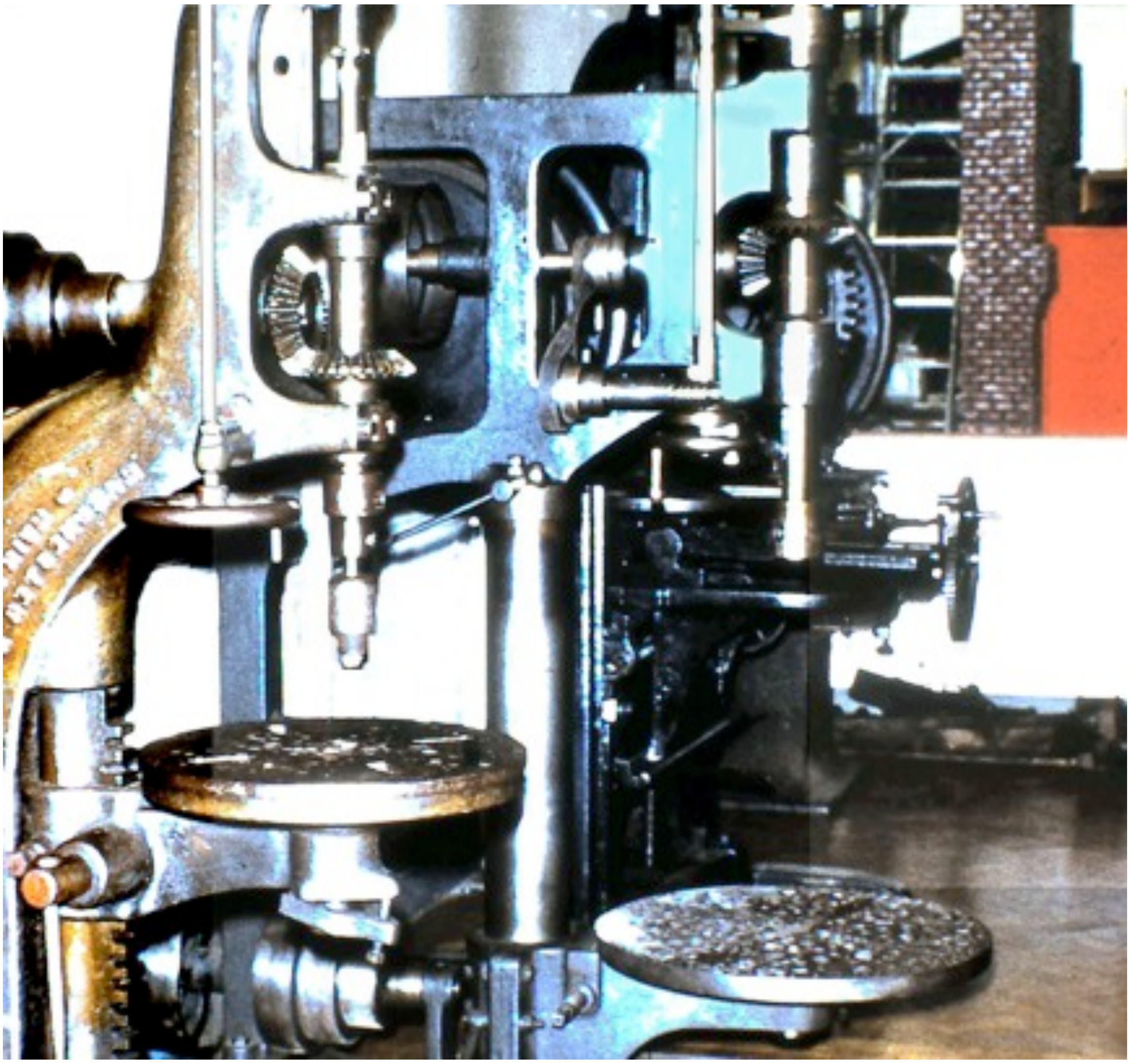
The 1842 Whitworth Planing Machine.

The prize exhibit among our planing machines must be the Whitworth one dated 1842. It was presented by Arthur Bebbington who had a heating engineering business at Crewe. He said it came from the London North Western Railway workshops at Crewe where it had been used to plane the sides of axle boxes, one at a time. It was replaced with a larger one that could plane four at once. Arthur's father obtained it from the Railway. The table was moved by Whitworth's favourite screw and worm mechanism, claimed to give a steadier motion than rack and pinion. There were two drive shafts, one inside the other with opposing bevels, to give the reversing motion with three pulleys (one loose) across which the flat belt was moved. Whitworth developed a tool holder that turned through 180^{o} so the tool would cut as the table returned to its starting position. This planing machine showed signs of having been fitted with such a tool holder but this had been replaced with the ordinary clapper box type because wear in the bearings caused the cut to be uneven in either direction. This machine was transported back to Manchester in one of UMIST's vans. The framing above the bed was dismantled and light enough to load easily. The bed was another problem. Luckily, the van floor was just the same height as the bottom of the bed. By unbolting the leg casting at one end, the bed could be slid a little into the van and then the other leg casting removed and the bed slid right in. It was unloaded the reverse way at the Charles Street railway arch store. The planing machine was not weighed before it went into the 15 cwt. van! We mounted it on a frame and drove it by a geared motor.

Other Planing Machines

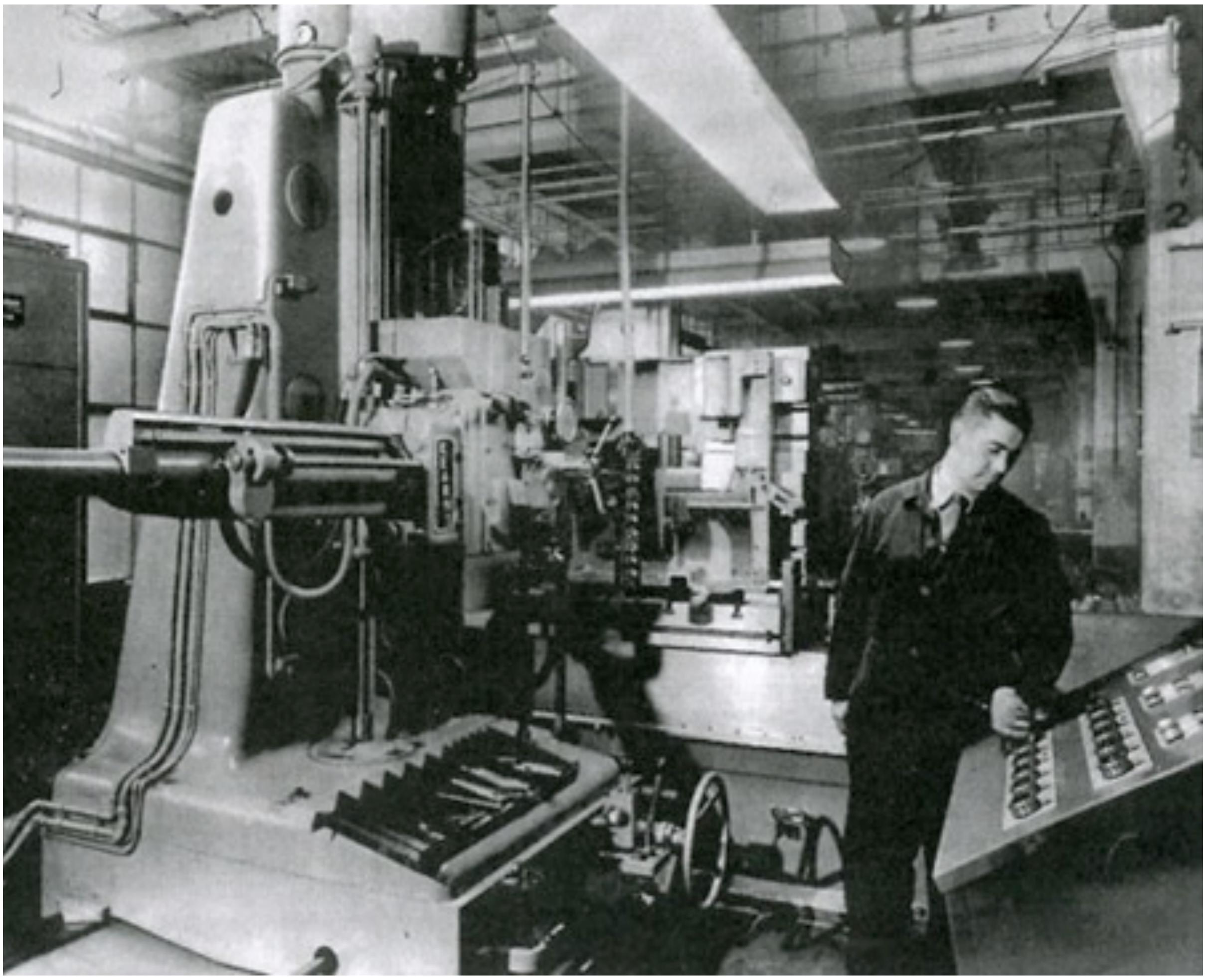
We acquired another unnamed planing machine that had a rack under the table into which the driving pinion fitted. It was similar to a smaller one by Cunliffe & Croome. This had special gearing for speeding up the return of the table. The outer end of the pinion shaft had a double bevel wheel with two rings of teeth with different diameters, one to give the fast return and the other a slower cutting speed. There was also a small 'table top' size planning machine that had been used by a millwright to take on site and cut keyways. This was thought to be useful for giving demonstrations. After I left the Museum a roller fluting machine with four single point cutting heads was acquired, but I know nothing about its origin. It followed the same principle as a planning machine, with the rollers being moved under the cutting tools. The rollers could be indexed round to form the next flute.

Rotary Tools With More Then One Cutting Edge



A picture of some of the drilling machines in Grosvenor Street.

Material could be removed more quickly by tools with more than one cutting edge. They would normally rotate. Such tools included drills, hobbing and milling machines. The drilling machines we acquired in particular covered a number of local makers not represented elsewhere. They had probably survived because they were not used as extensively as say a lathe. The normal drill, such as the twist drill, presented two cutting faces. For display purposes, most were relatively compact such as the Whitworth pillar drill that came from the Mechanical Engineering Department at the University. Probably when he was closing down his workshop in 1971, Arthur Bebbington presented an example by William Muir. Later one by Pollock & McNab came from a different source. A larger example was the Yorkshire pillar drill with its open sturdier framing. A much larger machine was a radial arm drill which found good use in the workshop at Grosvenor Street.



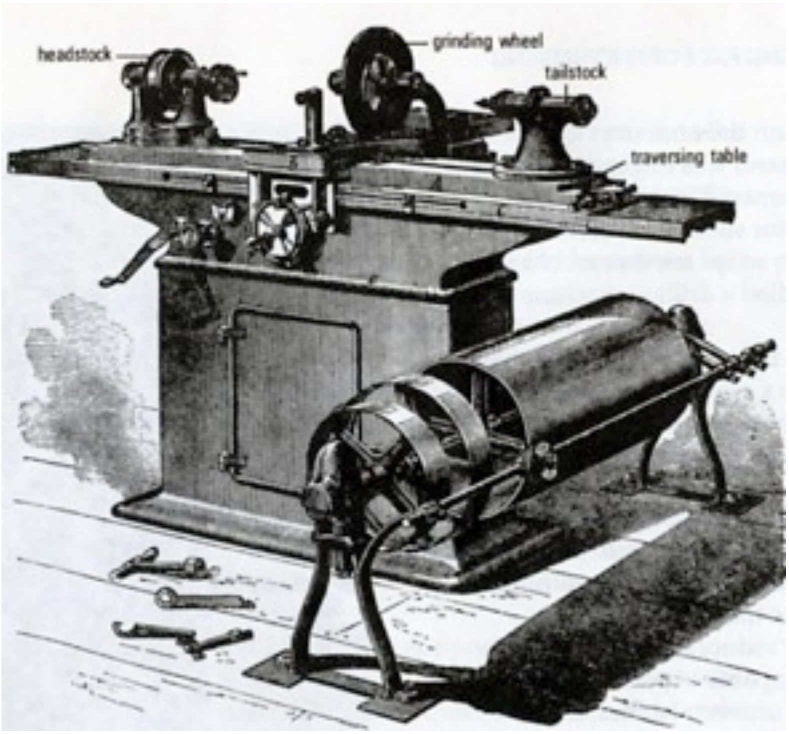
The 1954 horizontal boring machine by Kearns-Richards, the first numerically controlled machine tool.

A modern example of a tool with a rotary cutter was the horizontal boring machine by Kearns Richards of Broadheath. It was developed by Curtis Sparkes as the first numerically controlled machine tool in the world. Compared with most of the other machine tools in our collection, it was massive. A smaller example of a horizontal boring machine also by Kearns was acquired later.

Whitworth Gear Cutting Machine

The prize exhibit with a rotary cutter must be the Whitworth gear cutting machine. The Beyer, Peacock archives show that it was purchased new from Whitworth's in 1854 and the cost is given. It had the set of gearwheels for changing the size of wheel to be cut and also one or two of the hobs for cutting the teeth. It came to us through Edgar Allens of Openshaw. They had taken over one of Whitworth's old works from British Steel so presumably someone had acquired this tool from Beyer, Peacock when it became redundant there.

Milling machines with their multi-toothed cutters were poorly represented but we did acquire an early horizontal one of the over-arm type. The same was true of grinding machines. An early one by Muir came from Arthur Bebbington. It had a long table which could be moved along in front of the single grinding wheel. Arthur made it earn its keep by sharpening the rotary cylinder cutting blades on lawn mowing machines.



An example of a grinding machine by Browne & Sharpe to show the layout of the one by Muir.

Overhead Crane

Perhaps not really a machine tool, but no reasonable sized engineering workshop would have been equipped without an overhead travelling crane. Before the introduction of electricity and electric motors, most overhead cranes, above for example mill engines, were operated manually by pulling on three chains, one to raise and lower the load, one to move the crab or carriage across the width of the crane and the last to move the whole crane along the length of the shop. This was heavy work on the hands. We were lucky to obtain a crane by Cravens of Reddish from a firm near Guide Bridge worked by rope drive. A continuous rope, in this case driven by an electric motor, ran the full length of the shop above the crane rails and doubled back to the motor pulley. The rope was supported on pulleys. One set had an ingenious tilting arrangement to allow the crane to pass. There was also a jockey pulley to keep the rope taught. On the crane carriage was a headstock with three large pulleys. One could be clutched in so the crane could travel the length of the shop, another to drive the crab across the width of the crane and the third to work the lifting mechanism. The carriage had parallel girders, not fish-belly, to allow for reducing its width if necessary. It was stored by Ferranti's at Hollinwood until the time came for its re-erection over the large steam turbine in the electricity generating gallery at Liverpool Road.

What Was Achieved

We were lucky to acquire some historic machine tools showing early types. We were also able to preserve others made by once famous manufacturers in the region. Our first keeper of industry, Graham Catterall, installed girders in the machine tool section at Grosvenor Street so that countershafts could be mounted above appropriate machines to demonstrate them. With the range and variety we assembled, we had the possibility of setting up a typical engineering workshop that might have serviced a cotton mill or small engineering works.

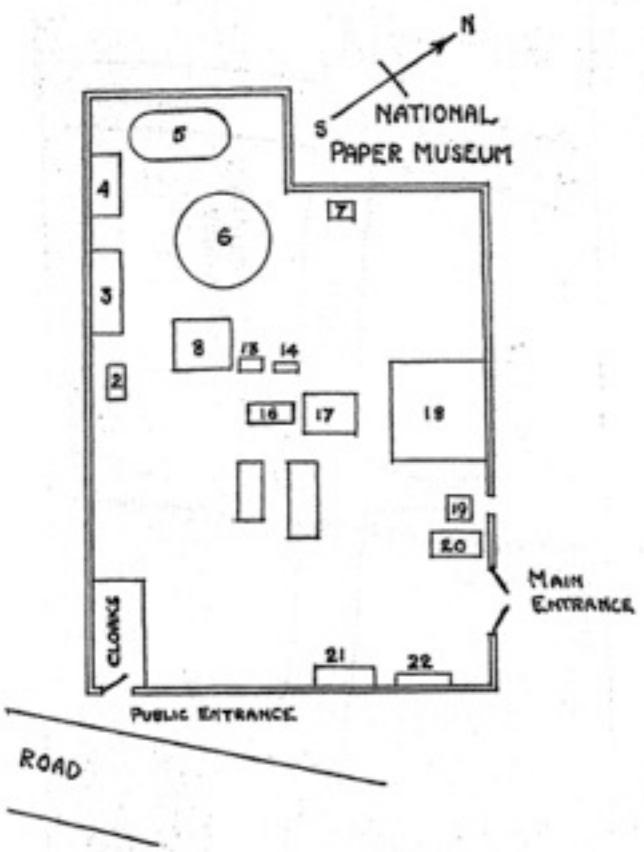
The intention was to use them in the restoration of other exhibits in a permanent museum.

Chapter 8, Paper Related Exhibits.

The National Paper Museum

On 24 April, 1963, the official opening ceremony of the National Paper Museum was held at the Vegetable Parchment Mill at St. Mary Cray at premises provided by Messrs. Wiggins Teape Ltd. The story starts much earlier for, in 1958, Jack Barcham Green, former Liveryman of the Stationers' Company, had instigated the formation of a committee under the Technical Section of the British Paper and Board Makers' Association because he had realised that the mills where paper was being made by hand were closing down one after another and that, if exhibits were not preserved quickly, there would be nothing left to show an important part of our cultural heritage. By the time of the opening, an excellent collection of exhibits had been assembled which showed all the stages of papermaking by hand from the raw material, rags, to the finished sheet.

St. Mary Cray



Plan of the Paper Museum at St. Mary Cray.

Key: -

2, Rag Hurdle; 3, Rag Duster; 4, Rag Boiler; 5, Hollander Beater; 6, Pulp Storage Chest; 7, Stamper Trough; 8, Papermaking Vat; 13; Couching Frame; 14, Hydraulic Press; 16, Evans Adlard Press; 17, Balston Press; 18, Drying Loft; 19 Size Press; 20, Size Tank; 21, Drying Cylinder; 22, Plate Glazing Rolls.

Briefly the story started with a rag hurdle (2) or cutting table where women cut up cloth made from cellulose fibres such as linen or cotton. These pieces of cloth were taken to the rag boiler (4), in this case a rectangular box type. To show how rags were pulped, there was a Hollander beater (5), made with cast iron plates for its sides and a wooden base. It almost certainly came from Balston's Springfield Mill in Maidstone and probably dated from the opening of the mill in 1807. This beater was complete with cover, strainers, drum washer, etc. The pulp in the beater would have been emptied into a circular storage chest (6) with an agitator to keep it in suspension.

The centrepiece of the display was a wooden sided, lead lined vat (8) complete with all appurtenances such as agitator and steam heater inside, and across the top the bridge or draining board with Ass against which the mould was left to drain. To one side was the framing (9) against which the coucher lent while couching the sheet of paper from the mould and on part of which the layer placed the felts. There were also the mould tub in which the mould was rinsed as well as the hand box in which the vatman could rinse his hand. The pulp was passed through a knotter to remove any lumps before emptying into the vat. There were also pulp or stuff pumps and a collection of hand moulds.

The pile or post of alternate layers of felt and paper was dragged over to the hydraulic press (14) to have as much water as possible squeezed out. Then the post was returned close to the vat where the layer separated the paper from the felts, putting the paper on a lay stool and the felts where the coucher could reach them. The paper was taken to the drying loft (18). In the Museum, the loft was represented by four vertical posts with rows of holes drilled along them. Pegs were inserted into the holes to support moveable crossbeams. Between a pair of crossbeams were stretched ropes traditionally made of cow hair. The paper was hung over the ropes to dry. To finish the paper, it was dipped into gelatine size in a size tank.

The drying loft.

After the opening, the collection continued to expand with additions such as a rag duster (3), a long cylinder with spikes along it revolving in an open wire mesh supported by a wooden framing. It sloped so the rags made their way from the upper end to the lower. From Ambert in France came a stone stamper trough (7) with three stamper heads, showing the first mechanical method of pulp preparation used in Europe. This was unique in Britain. Early methods of pressing the wet sheets were shown by a double head wooden screw press (16) complete with boxes for pressing blotting paper from Evans Adlard and a massive power driven press used by Balstons for their Antiquarian paper (17), the largest size of handmade paper. Of more manageable scale was a size press (19), used to expel the wet size from the sheets of paper. Its head was supported by wooden sidepieces. There was a steam-heated drying cylinder (21) supported on cast iron framing which also carried the bearings for the rollers around which the continuous felt passed. For polishing the sized sheets, there was a roller plate glazing machine (22). A pair of iron rollers was mounted in cast iron framing which also contained the reversing gearing. Paper was interleaved between zinc or copper plates and passed between the rollers, the upper one of which was spring-loaded. The rollers were reversed and the wad passed back through again. The gearing for the rollers was arranged so that they rotated at slightly different speeds, giving the paper a polish through the plates sliding across the paper.

Transfer to Manchester

Unfortunately the Vegetable Parchment Mill closed in 1968 and the exhibits were stored at the neighbouring Nash's Mill. This must have broken Jack's heart for not only was the collection rejected by the Science Museum in London but also it suffered flooding in storage. However he approached the Paper Science Department in UMIST. His letter finally arrived on my desk in the Department of History of Science and Technology where we were just beginning to organise a new science museum. On a visit to Nash's Mill, the sight of the exhibits covered with the detritus of a flood was not exactly encouraging. Although at that time I knew nothing about papermaking, I recognised the importance of some of the exhibits and accepted the greater part of the collection on behalf of the Manchester Museum of Science and Technology; a decision I have never regretted as it became one of our most popular displays. However, owing to their size and our usual storage problems, the rag boiler, storage chest, beater and hydraulic press had to be left behind and were scrapped.

The rest of the exhibits arrived in Manchester in time for a selection to be displayed in Grosvenor Street for the official opening. The larger pieces, such as the rag duster, the Evans Adlard and Balston screw presses, the plate glazing machine and the drying cylinder went first to the Rochdale store, then Stelling Street and Constantine Lloyds before presumably being transferred to the MOSI store. At Constantine Lloyds, they were joined by a section of an air-drying machine and stack of calendar rolls from Towgood's Sawston Mill as well as a rag cutting machine from Barcham Green's Hayle Mill. A kollergang with twin crushing stones and a Bentley and Jackson rotary guillotine were taken later into the MOSI store.

The stampers with their stone trough on display at Grosvenor Street.

Into Grosvenor Street were taken the stampers with their stone trough to show pulp preparation. These were displayed later with a replica camshaft based on one at Ambert. The papermaking vat with all its accessories together with a selection of hand moulds was displayed as well as the small size press and the section of the drying loft. When the Museum expanded into the rest of the Grosvenor Street building, the papermaking display was also enlarged. Showcases covered different types of fibres and watermarking techniques such as dandy rolls. One important exhibit here was Marshall's original dandy roll from 1825. The floor in one area was covered with a non-slip waterproof type of linoleum so that demonstrations of papermaking could be given.

Papermaking Demonstrations

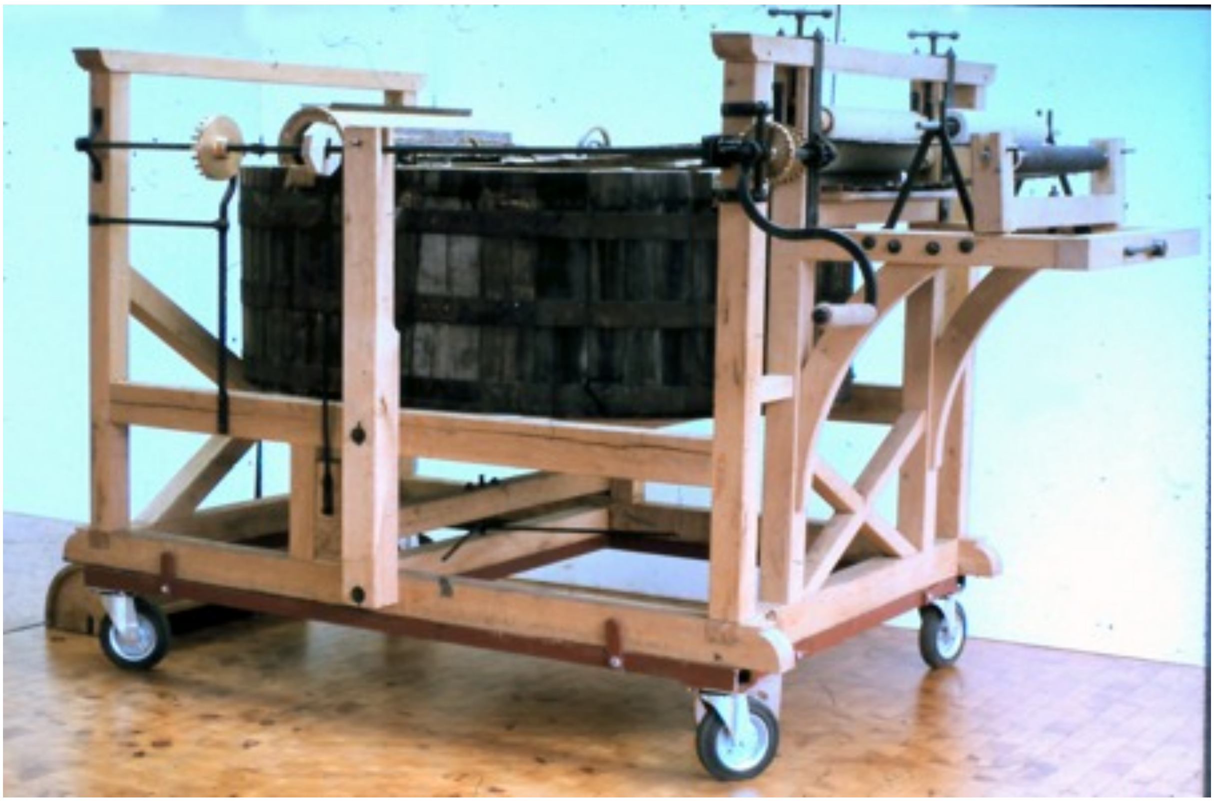
UMIST Paper Science Department helped with supplies of pulp. This was supplemented with more that we prepared in a small laboratory Clough beater. For the later display at Liverpool Road, we acquired a much larger beater about five feet long. For school parties, we had some small hand moulds about A5 size which could be dipped into a small basin of pulp. One or two of these had a laid cover with appropriate spacing for pulp testing. The sheets were couched off onto felts in the usual way, pressed in a letter copying press before being hung up to dry or dried on a photographic electrically heated glazer. The sheets might be taken home in triumph or taken to one of our printing presses. These demonstrations for schools became the third most popular of our education classes after steam power and textiles.

The lead-lined vat in use at Grosvenor Street for making a sheet of paper on a mould.

For papermaking demonstrations on Working Days, a steel tank was fitted into the lead lined vat to reduce the amount of pulp needed. We had some moulds slightly larger than A4 fitted with NPM watermarks, with both wove and laid covers. Robert Manders learnt how to use these large moulds properly so that he could give realistic demonstrations. The sheets were couched off onto authentic felts and pressed in the small size press which had a block built up in it because the height of the pile we produced was considerably less than a normal post. These sheets were dried hung on ropes on the framing of the drying loft.

Paper Machines

To show a paper machine, we first had a rather crude wooden model which was lent to the English Clay Company at St. Austell. We replaced it with a loaned workable one from Bertram Sciennes capable of producing a sheet about 6 ins. wide. It was based on a Fourdrinier machine and, as well as the forming wire, had a press section, steam heated drying cylinders and a calendar stack. Technical staff from UMIST helped to fit it up with water and steam supplies with the intention of running it to make paper but the Grosvenor Street Museum closed before any was produced.



Replica of N.L. Robert's original paper machine .

On moving to Liverpool Road, papermaking was allocated a larger area in the Byrom Street Warehouse so further exhibits could be displayed. One was a replica of Nicholas Louis Robert's original paper machine of about 1800. Owing to the Napoleonic War, Robert and his employer Didot were unable to develop the machine so John Gamble brought drawings to England and gained the support of the Fourdrinier brothers who were stationers. One of their descendents decided to sell the remaining five of the original six drawings. They were purchased by an American, Leonard Schlosser. Our London Science Museum decided they had no historical significance so they were exported to America where Schlosser had copies made. Through the help I gave him in preparing a brief history, he gave me a set of the copies from which Severn Lamb made us a replica so we could show the first paper machine. Schlosser presented this Robert replica to us because we were able to organise the production of full and half-size replicas for other museums in the USA, Europe and Egypt. In our enlarged display, ours was followed by the Bertram's Fourdrinier machine to show the development.

The other important papermaking machine, the cylinder mould machine, was invented in 1809 by John Dickinson who lived on Ludgate in the City of London. No detail drawings have survived. I happened to be in the Netherlands when the Dutch papermaking school at Apeldoorn was closing down and was able to secure as a present a small scale cylinder mould machine based on Dickinson's invention. It was a complete unit with electric drive, vat with the cylinder, press, steam heated drying cylinder and reel. It was in full working order. Alongside it, we displayed examples of both laid and wove removable covers from the mould machine at Balston's Springfield Mill. This in no way mentions all the small papermaking exhibits which, taken together with the larger ones made the National Paper Museum Collection the foremost collection of its type in Europe if not in the world.

Library and Sample Collections

When the exhibits arrived in Manchester from St. Mary Cray, I was surprised to find two crates of books. I was even more surprised when I looked through these books and found some of great value and rarity on the history of papermaking and technology. With the help of the National Paper Museum Trust Fund, we continued to enlarge this collection, concentrating on what has been published on papermaking in Britain. This library included technical books, mill histories and journals so it became one of the foremost collections on the subject.

The crates also contained watermark collections with samples of paper dating back to 1386. This may be the best collection of watermarks in Britain. Books on watermarks were added. Samples of paper made in Britain were collected to show what has been manufactured by the industry here. It was intended to continue adding contemporary samples which would of course soon be historic. To show how paper was made by hand, we were able to film the whole process at Hayle Mill thanks to the help of Barcham Green & Co. Parts of this could have been used at the appropriate places to animate the Museum displays.

Letterpress Printing

Objective

A start was made in 1971 to assemble a collection of printing equipment with the help of Dr. Derek Nuttall, Printing Historical Society. It was realised that the historical method of printing using cast metal type was quickly disappearing, being replaced by electronic methods and offset lytho. It was decided not to attempt to cover these modern methods but to concentrate on traditional equipment that formed the basis of the local jobbing printer in a small town. Therefore no attempt was made to preserve any rotary presses using rolls of continuous reels of paper for printing newspapers.

Printing Type

Guttenberg's method of casting individual letters which could be used over and over again revolutionised printing from the earlier use of carved wooden blocks. He also developed a press in which the assembled type could be mounted on a bed, inked, paper placed on top and pressed to transfer the image. We collected various founts of different letters of different sizes including some woodblock letters which were very useful for printing posters to advertise our Working Days, printed on our own presses. We assembled all the ancillary parts to fix the type in the cast iron frames ready for printing with composing sticks, etc.

We could show how type was cast with a hand mould that was presented to me when I was visiting a museum in Barcelona. It was an ingenious gadget, able to accommodate the different widths of the letters. But this method of producing type was tedious since only one letter could be cast at a time. Towards the end of the nineteenth century, various type casting machines were invented. While the Linotype was developed in America, it was manufactured at Broadheath/Altrincham. We were lucky to obtain an example of their first machine, the Square Base as well as the next, confusingly called the Model 1. The Square Base was one of the first machines in our Printing Collection. Its method of justifying the line of type before casting and distributing the letter moulds afterwards was very ingenious. Another machine for casting type was the Typograph. The moulds were suspended on a fan of wires. Pressing the letter key allowed an appropriate mould to slide down its wire to the casting position. After casting, the bottom of the fan was lifted up and the moulds slid back to their storage position. Our machine came from a printer in Knutsford.

A visit to the original offices of the Guardian in Cross Street showed just how large were the printing presses for newspapers. They had cylindrical printing plates. I realised that the manufacture of these could be shown by the equipment used for making the little ‘Stop Press’ inserts for adding the latest news flashes. The lines of type were assembled in a tray. A damp sheet of special heavy card, the ‘flong’, was placed on top and put in a press so that the letters were impressed into the flong. The flong was dried on a heated plate, curved to the correct circumference of the main printing cylinder so that the flat bed of the original type had now a curved mirror image. The flong was placed in the casting mould and type metal poured in from the casting pot. The new mini-printing plate was taken out to the trimmer which cut off the header and cut the plate to fit into the special section of the main printing cylinder. We displayed this range of machines in our printing section at Grosvenor Street together with a full size cast printing plate.

Guillotines

Paper needed to be the right size to fit the text or block being printed. With so little finance for the Museum, we scrounged any paper we could; hence it needed trimming. As well as small hand table top guillotines, Bolton College of Art and Design gave us a free-standing cast iron framed guillotine by Furnival’s of Reddish that proved to be a very useful asset. We later acquired another with a blade for making perforations so the paper could be torn along the line of the holes. A much larger machine, really part of the National Paper Museum, was a Bentley and Jackson rotary guillotine for cutting rolls of paper into sheets. It had special expanding or contracting pulleys for altering the size of the sheets.

Hand Presses

We acquired an outstanding collection of hand presses that represented most of the different types available in Britain. Although we cast envious eyes at the early wooden press displayed in the John Rylands Library in Deansgate, we realised there was little chance of our ever obtaining it or indeed a wooden one. Therefore as part of the Caxton 500 anniversary celebrations, we commissioned a replica of Moxon’s press of the 1690s. To print on this wooden press was fascinating because one could feel the joints taking up the pressure compared to the solidity of later cast iron ones.

Councillor Langton with Dr. Hills looking at the replica of the Moxon's printing press with a sheet of special Caxton 500 anniversary watermarked paper which had been printed on the press.

We were lucky to be lent by Oxfordshire County Museums their Stanhope press, the earliest iron press invented by Lord Stanhope. The first iron press we acquired was an Albion. We purchased from Carrick Caterers in Sheffield one of the iconic Columbians with its ornate snakes and eagle as a counterweight, a must for any technical museum. These presses tended to be heavy and stood on small feet, so were tricky to move. The Britannia press from Liverpool proved to be particularly awkward. I had walked over from Lime Street station to the warehouse where the press was situated on an upper floor. There was a loading bay running up the front to a protruding hoisting beam and pulley at the top. The weight of the press was well within its capacity. But there were unexpected snags in the removal of the press. First, the Museum technicians could not find out how to gain access with their lorry because all the roads they tried led down the approach to the Mersey Tunnel. Luckily one of the policemen on duty let them out by a side road. When slinging the press, Sid Barnes looked at its feet and thought perhaps they should secure them in case they fell off. Harry Applebee thought they would be alright. Luckily Sid prevailed because when the press was lifted and hanging outside, both feet dropped down but were still tied on. At the bottom, the hoist was designed to lower goods into the basement so it was impossible to draw up the lorry directly underneath and lower the press onto it. Eventually a rope was tied on and some of the onlookers who had gathered were cajoled into helping haul the press onto the lorry. An Imperial press from Macclesfield was difficult to move within its building owing to the rotten floors but it was a worthy exhibit since it was probably the only one preserved in a museum.

Columbian printing press.

Treadle Platen Presses

The next development for the small jobbing printer was the treadle platen. Derek Nuttall acquired a very early example of the Cropper from Chester School of Art. In these, both the printing type and the paper moved together to give the impression, compared with later ones where the type was stationary and the paper moved across to it. The Cropper had safety mechanisms on it which prevented the operative's fingers getting caught. We displayed it alongside the barrier, safe from the operative's position but a visitor reached over the barrier and nearly had their hand trapped. The later development of these treadle platens was shown with one built by T.C. Thompson Ltd. of Manchester after the Second World War. Both machines proved useful for printing small keepsakes or items for sale such as Christmas cards. They also brought active demonstrations to the Museum through an experienced printer.

Flat Bed Presses

We had two flat bed presses for printing larger items. The earlier was a Wharfedale. These were mostly made by Dawson, Paine & Elliott of Otley but a few were made by Furnival's of Reddish. After turning down one at Hebden Bridge which would have involved taking it out over the river to avoid blocking the main street, eventually Blackburn College of Technology offered their Furnival which was in first class condition. It was used a lot for printing posters and advertisements for the Museum.

Another flat bed press was a Miehle made by Linotype. It was a further development on the Wharfedale and came from Kitson College of Technology in Leeds. It had to be totally dismantled to remove it. When it came to temporarily reassembling it in the Museum store, it was found that all the bolts had been properly fitted into their respective holes. They had not been marked on dismantling so it was almost impossible to replace them in their original positions.

What Had Been Achieved

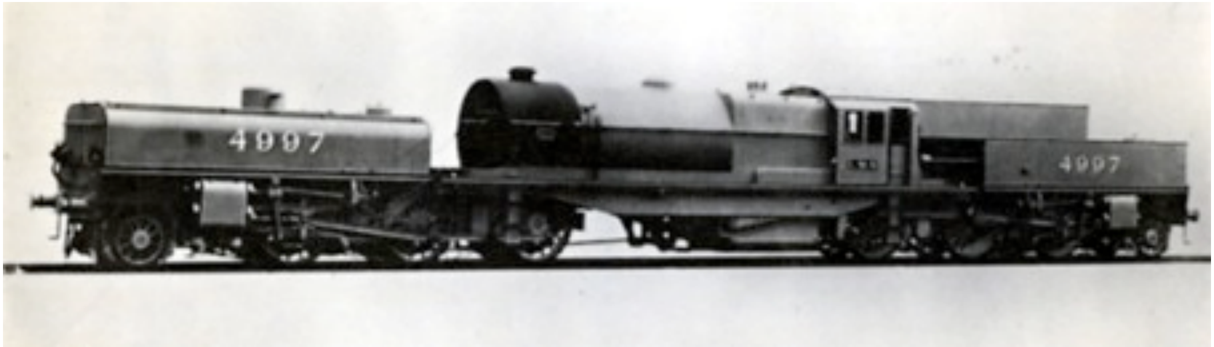
We were able to assemble a broad range of equipment necessary for letterpress printing. I have not listed all the small ancillary items needed to set up a typical printing shop. We were able to show the development of printing presses from very early ones. We recruited an experienced printer, Jack Richardson, to set up the presses for demonstrations and training the Museum staff. A popular gimmick was to see a sheet of paper made by hand in the paper section, have it dried and taken over to have it printed. There was also a small addition to the Museum's finances through sale of what was printed such as copies of the first pages of the Manchester Guardian and the Manchester Evening News.

Archives

I always considered the Archives as one of the more important sections of the Museum. While it might be possible to preserve one example of a machine made by a company, the archives of that company might show how a product originated and was then further developed. While there could be important aspects of any company such as its business and economic history, at the Museum we concentrated on the technical and scientific sides because these had not been covered by existing archival deposits when we started the Museum. It was often difficult to discover what records a company might have. Sometimes there was a sort of death wish to obliterate the past because they had failed. Sometimes we had a tip off from someone say in the Drawing Office and we might be offered some records that we could have when the company was finally closing. But our contact might leave so we lost some archives because we did not know when they were available. Also there was the time factor of our over-stretched staff to go and make contacts, to sort out relevant material and transport it. From Hayle Mill, Maidstone, I collected a large range of samples of handmade paper. The weight was rather more than ought to have been carried in an Austin 1100 car. Another car ahead suddenly turned left and, although I braked heavily, I almost slid into the back of the one in front of me. A collection from the National Vulcan Insurance Company of catalogues of various companies tested the strength of my Volvo but that was for only a short journey within Manchester.

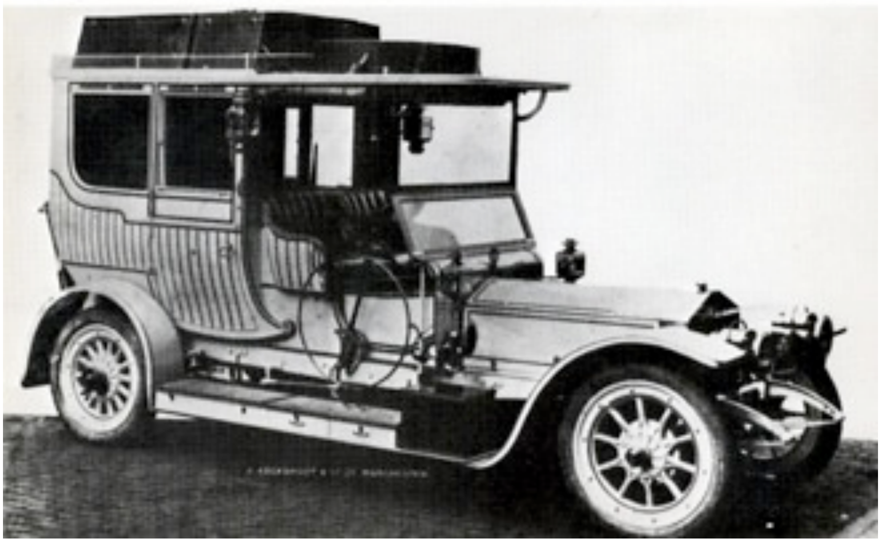
Sometimes we had luck, as when we were sorting brochures of Craven's. We had piled them on what appeared to be a table. The table, which was only a board on a trestle, collapsed, revealing the oldest photographic album we found there. Again, in a mill at Millbrook, I tripped on a plank that had been placed over a couple of steps so barrows could run up. The plank fell off the oldest Skinner's Textile Directory that we found for our collections. Someone spotted in a Scout waste paper collection a hoard of maker's photographs for busses built at Crossley Brothers.

At Beyer, Peacock, I remember overhearing the Chief Accountant saying to the Chief Draughtsman, 'If we can't sell them, let Mr. Hills have them'. At that Company, some of the more sensitive records, such as Minute Books put out for destruction, mysteriously disappeared, to reappear later in the History of Science Department. On the other hand, most of the early Beyer, Peacock correspondence was destroyed because the Directors said they would let me know when we could come and look at it. They never did. Luckily I was tipped off by the person who kept the pub at Beyer, Peacock's gate who also worked at UMIST so I was then able to go in and start the rescue of possibly the most important archival collection in the Museum.



Beyer, Peacock's makers photograph of the Beyer-Garratt locomotive for the L.M.S. Railway.

Sorting and collecting the archives was often tedious and dirty. In the attics of Beyer, Peacock, we found canisters full of the schemes drawings. At B. & S. Massey, we had to sort out any drawings we thought might be significant from the pile dumped in the middle of the Drawing Office after that department had closed. Lancaster & Tonge, engineers in Salford, had taken over the goodwill and drawings of various mill engine manufacturers. The drawings had been stored in an old air-raid shelter beside the main railway line between Manchester Victoria and Bolton. Access for people was through the only door which had a blast wall and meant a circuitous route to where a van could be parked. Alternatively there was a trap door in the roof by a car park. We chose the latter not realising that the rolls of drawings were covered in soot from passing locomotives that fell onto the person handing up the rolls.



The Rolls Royce ‘Pearl of the East’ with coachwork by Cockshoots, exported to India.

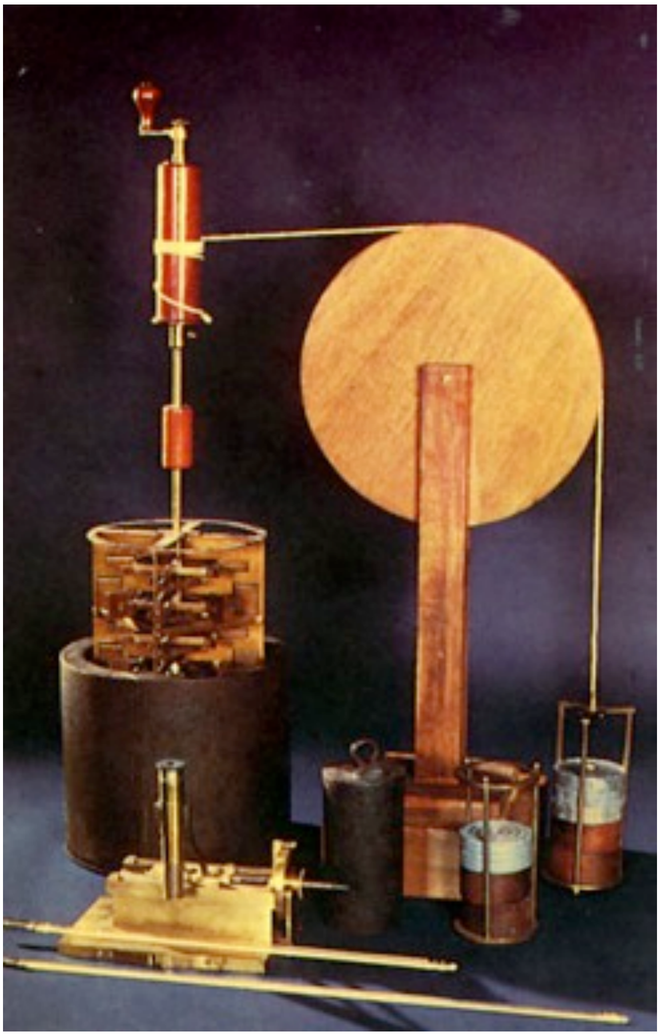
What Had Been Achieved

The archives have proved to be an important resource for the Museum staff researching the background of exhibits for restoration and display. In addition, pictures and material from the archives have been used for temporary exhibitions both within the Museum and on loan elsewhere. Also they have been the basis of a great deal of historical research on so many industries of the region by scholars and visitors to the Museum.

Chapter 9, Smaller Exhibits.

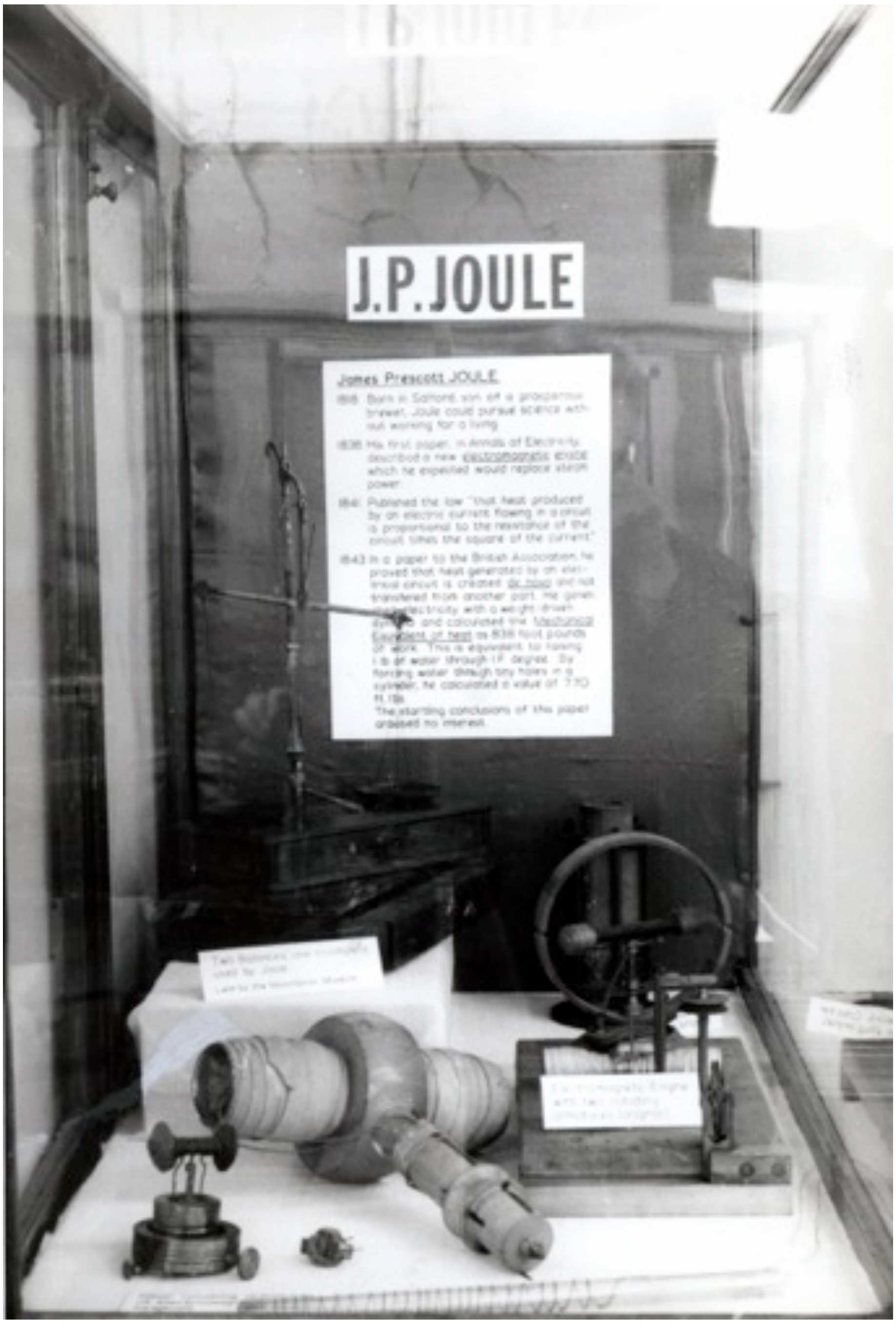
Scientific Instruments

Starting collecting exhibits for the Museum in the 1960s meant that it was unlikely we would obtain many early scientific instruments, even if we had the wherewithal to purchase them. There had been a fairly extensive manufacture of instruments in Manchester during the second half of the nineteenth century, particularly linked with test instruments for the textile industry. The collecting policy therefore aimed to assemble a few instruments not made in the locality to explain the historical development and for comparison with local products while the main thrust concentrated on products of local manufacturers. For display, one idea was to create period scientific laboratories or workshops of instrument makers. No attempt was made to rival Liverpool Museum with its navigation instruments or its clock and watch collections based on the industry in Prescott.

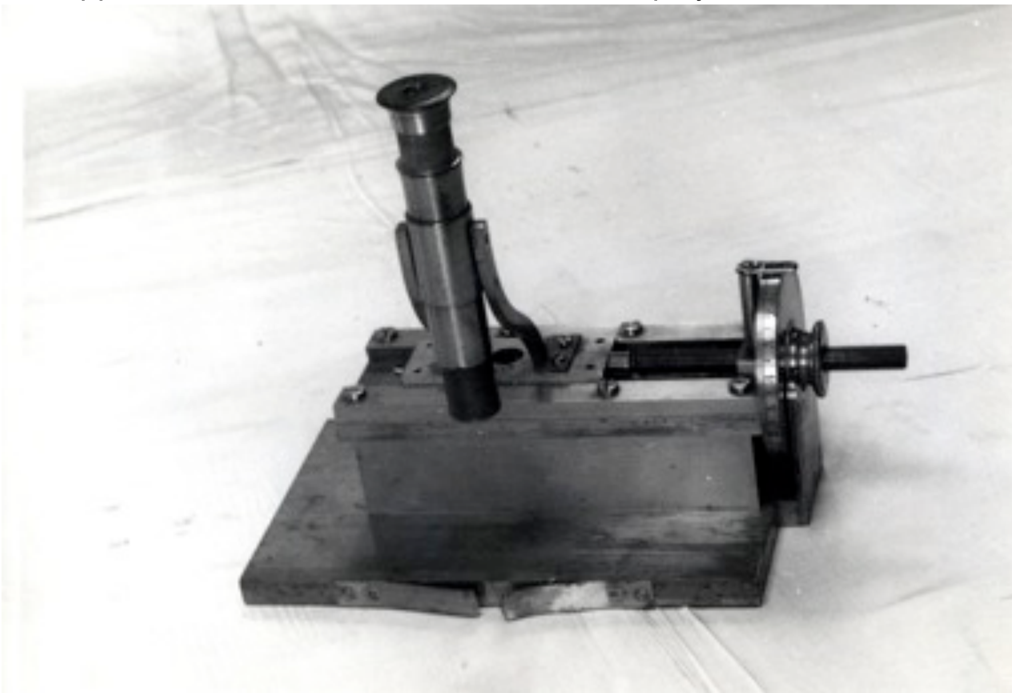


Replica of Joule's paddlewheel experiment.

We received a few instruments used by famous Manchester scientists. There were some pieces of John Dalton's lent by the Manchester Literary & Scientific Society, such as his eye, a couple of thermometers, a few glass bottles, a couple of his walking sticks barometers as well as his crib. All these could be employed to illustrate his scientific interests. We tried to show the effects of his colour blindness with appropriate charts. Prof. Cardwell was keeper of the Joule Collection at Joule House on Salford Crescent. He transferred the whole collection to Grosvenor Street. It consisted of original items as well as replicas. For Joule's famous paddlewheel experiment, there were two replica wheels as well as original thermometers and a travelling microscope made by John Benjamin Dancer. There were various coils for creating electromagnets, a pair of heavy metal gas bottles and their calorimeter for determining whether there was any heat gained or lost in the expansion of a compressed gas into a vacuum, as well as air and water pumps, coils of metal tubing and so on. It was a difficult collection to display to those who had no knowledge of Joule's achievements.

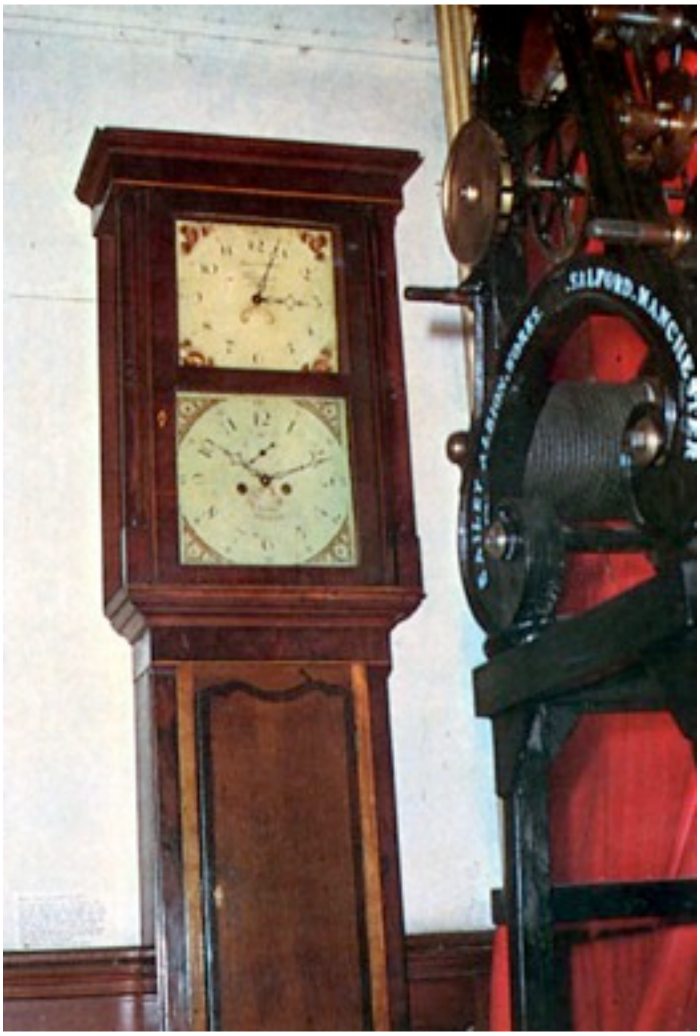


Electrical apparatus from the Joule collection on display at Grosvenor Street, 1972.



Travelling microscope made by J.B. Dancer for Joule so he could record more accurately the change in temperature measured by the thermometer.

More appealing and easier to understand were our few timepieces. One was the turret clock mechanism made by W.H. Bailey. We fitted it with a pendulum and connected up a weight to the going side of the mechanism so it could be wound up and tick away. We never did acquire one of Richard Roberts' clocks. We had a few small pieces such as a sundial to show the origins of timekeeping, and ones used in Victorian offices at the other extreme. But the real gem was the grandfather clock with two faces that I saw in the Managing Director's office of Frost's Silk Mill in Macclesfield. The hands on one face were driven by weight operated clockwork, I think without the striking side operating. The hands on the other face were driven by the mill line shafting from the waterwheel. The hands on this second face were synchronised with the first at the start of the working day so measured whether the line shafting had been rotating at the correct speed. At Quarry Bank Mill, the workers had to make up for 'lost time'. When the Frost's closed, the clock was put up for auction, obviously an attractive item. I sought the advice of one of the Manchester auctioneers who sent his wife along to bid on our behalf. Apparently to put off any rivals, she first bid for a batch of toilet rolls and then succeeded in acquiring this historic clock within our meagre budget. We did obtain a few examples of what might be considered other industrial clocks such as clocking-in clocks but I would have liked to have been able to extend this line further.



The grandfather clock with two faces that came from Frosts Mill, Macclesfield.
Bailey's turret clock mechanism is on the right.

To show the early history of microscopes, the Manchester Museum generously passed over a couple of the vertical Culpepper ones. Here again our main line of acquisition was mid-nineteenth ones by Dancer. We acquired an early example made soon after he first came from Liverpool and was in partnership with Abraham. This must date to around 1840. From the Garnett Benefaction of the Manchester Literary & Philosophical Society, E.H. Duckworth and other sources we gathered together a varied collection of Dancer monocular and binocular microscopes. When we acquired a microscope by a London manufacturer for comparison, my designer expressed surprise that there were other makers in addition to Dancer – such are the dangers of concentrating too much on ones own locality.

The Dancer microscopes were the centrepieces of a wide-ranging collection of instruments made by him. These covered spectroscopes and a large telescope presented by the Manchester Museum. It was complete with its wooden tripod so we arranged it inside a showcase and focused it through the window on the letters SWF of the Scottish Widows Fund on top of their building at Piccadilly. Our Chairperson, Mrs. Ann Durant, brought her cub pack on a visit and complained at having to lift up all the boys so they could see through it. A couple of other similar instruments were displayed alongside sighted on other objects. More exhibits included an astronomical telescope by Wray and a 1760 theodolite.

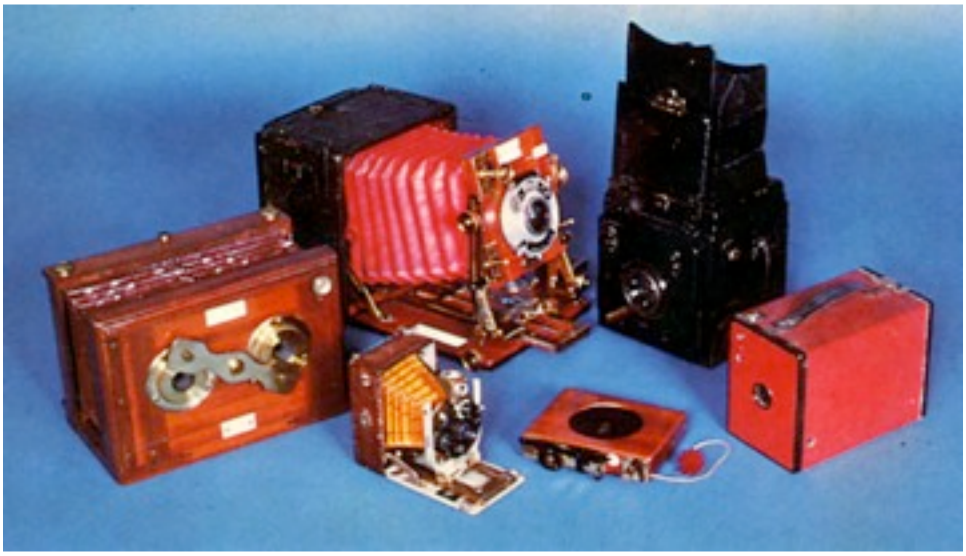
A surveyor's level with dial complete with its carrying box.

We also had a whole range of what might be termed commercial scientific instruments. Makers included Roncetti and Casartelli. Perhaps the smallest were coin balances for weighing half and full gold guineas. There were instruments for checking textile production such as twist counters, yarn scales and balances, as well as templates for ascertaining the number of threads in warp or weft of cloth. Slide rules of various types, mechanical calculators such as Comptometers as well as a few typewriters showed how an office might be equipped in the pre-computer age. Our largest scientific instrument must have been one of Metropolitan-Vickers' mass spectrometers built in 1985, a true pioneering design.

Photographic Collection

The photographic collection owes a great deal to the enthusiasm of Harry Milligan. He was a founder member of the Manchester Region Industrial Archaeology Society, member of the Manchester Amateur Photographic Society but above all he was the photographer at Manchester Central Library. He was enthusiastic about a science museum for Manchester and took the photographic collection from Beyer, Peacock into temporary storage at the Library which involved shifting around a ton and a half of plate glass negatives. Harry was over the moon when he discovered tucked away in the negative store at Gorton Foundry three paper negatives dating from 1856. Harry recognised the importance of this collection as one of the earliest industrial uses of photography as well as being the work of James Mudd, a Manchester photographer better known for his landscapes and portraiture.

The opening of Grosvenor Street coincided with Harry's retirement from the Central Library. He came to the Museum most days on his little motorbike and established a small darkroom, useful for fulfilling orders from the Beyer, Peacock collection which had been moved over from the Library. Harry also helped in the archives where he was something of a hazard through his pipe smoking. He had a habit of placing a match with which he had just lit his pipe back in the box with the inevitable conflagration occasionally. Luckily no damage was done except for a few burnt pockets.



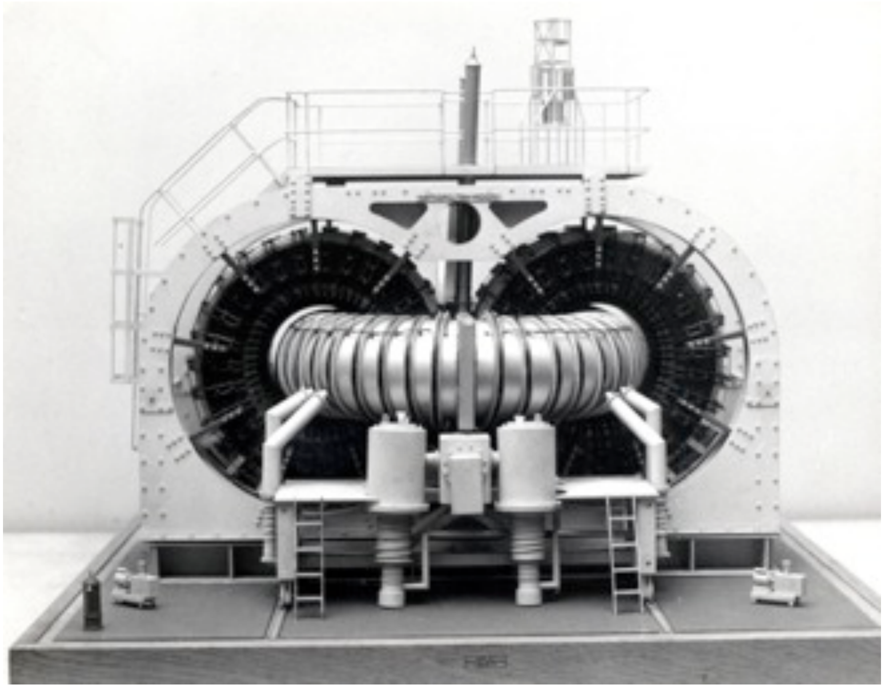
Various examples of cameras made in the Manchester region.

Harry knew most of the local photographic community which helped when exhibits were being offered. He soon assembled a wide selection based principally on Manchester manufacturers. One of the earliest collections was that of J.T. Chapman consisting of both cameras and library from the old-established firm of Foxall Chapman. Perhaps through chemists in the textile bleaching, dyeing and printing industries, Manchester became an early centre of photography. One of the earliest practitioners was Dancer. His daguerreotype photograph taken of Market Street in 1842 must be the earliest known photo of Manchester. It was saved from export and purchased with the help of a grant from the Science Museum Preservation Fund. Dancer also pioneered microphotography and we were able to gather together a good collection of his slides. Another aspect of Dancer's work was his interest in stereoscopic photography. We acquired one of his early stereoscopic cameras as well as the double photographs and viewers. Another stereoscopic camera was by Lancaster.

Other Manchester makers were Billcliffe as well as Thornton Pickard of Altrincham. Examples of their work showed the development of the camera but the collection extended beyond cameras. There was darkroom equipment such as a Furnival horizontal enlarger and a very large one used for producing calico printing rollers from Pin Mill Brow. This one proved to be a very useful asset because it could cope with photographing the large Beyer, Peacock engineering drawings. From Foxall Chapman probably came a pair of large glass chemical storage jars, magnificently decorated with the names of photographic chemicals. Unfortunately one was smashed when a showcase was being moved. To show off the photographs, we acquired various projectors, particularly the 'magic lantern' type for showing glass slides. Sometimes one was pressed into use for lectures in the Museum. All in all, the photographic collection was very comprehensive covering general photography with only a few intrusions into movie film.

Electricity Galleries

Although Manchester may not have featured much in the early days of investigations into electricity, the area certainly caught up later with important firms connected to this industry. By the time of the expansion of the Museum into the whole of Grosvenor Street, we had assembled significant holdings of a wide variety of electrical apparatus. For display, we split this into two sections, generation on the ground floor and smaller items on the first.



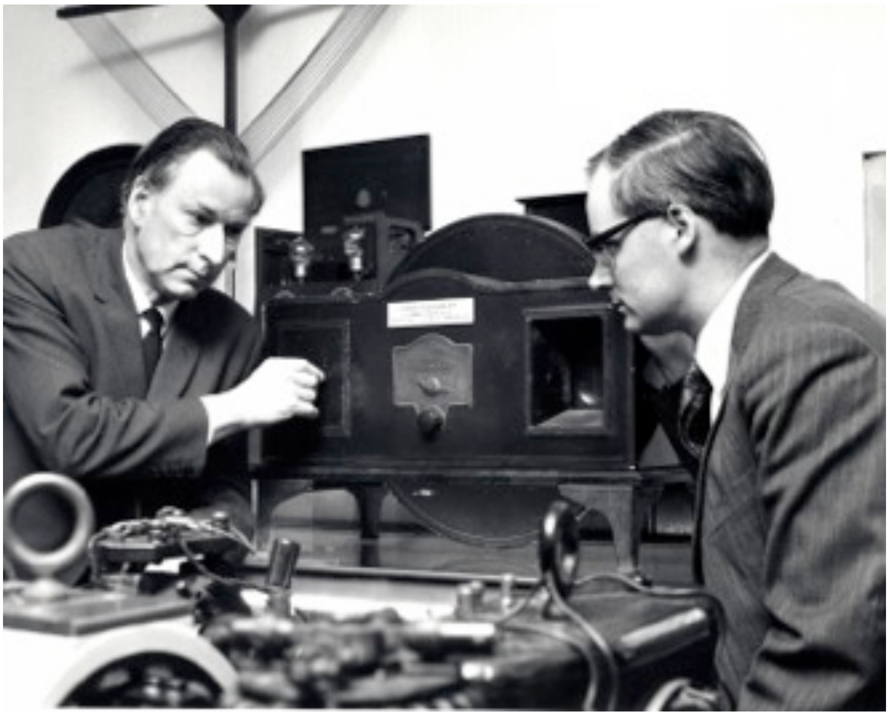
Model of Metropolitan-Vickers ‘Zeta’.

The generating display was divided into sections for DC and AC supply. After an introductory showcase to explain the principles, there were early DC dynamos driven by concealed electric motors. The current they generated illuminated early types of light bulbs as well as an arc lamp. There was a ‘Manchester’ dynamo, a type improved on the Edison by John Hopkinson. This was made by Mather & Platt, pioneers also of electric traction equipment. Near by was a Royce dynamo. When first setting up this display, Sid Barnes started up one of the dynamos but it produced no current. He soon realised that, through it being out of use for many years, there was not enough residual magnetism left. Once that was sorted, the dynamo performed well. After Glover’s cables closed in Trafford Park, we were able to secure Royce motors and control panels off their Royce cranes. S.Z. de Ferranti had pioneered large scale AC generation and distribution. The Company presented an early AC generator and switchboard. Sid was able to show that this came from the Grosvenor Gallery in London, one of the earliest electricity supply stations in London. There was also a joint in a 10,000 volt cable which supplied this station from Deptford. These displays were augmented with appropriate switches and meters.

Gordon Fowler and Dr. Hills looking at early incandescent light bulbs.

Mrs. Jesse Fowler looking at part of her husband's collection of electrical apparatus.

For the lighter exhibits upstairs, we were lucky to obtain two important collections. One was the North Western Electricity Board's collection of domestic appliances such as washing machines, cookers, meters for monitoring supply as well as a few small items such as radios and irons. The other collection was purchased from Gordon Fowler with the help of finance from Ferranti arranged through Lord Bowden. Gordon Fowler was Managing Director of Staveley Instruments, housed in a building on the other side of Upper Brook Street from the Museum. He had collected a wide range of smaller items such as telephones, radios, telecommunications apparatus, all types of meters, switches and much more. His collection included a Baird televisor, a rare exhibit. Some of the radios and loud speakers were arranged to be operated by push buttons. A Wimshurst machine was set rotating to generate sparks which interfered with the sound on an optical track on a 16 mm. film being projected in the adjacent lecture theatre.

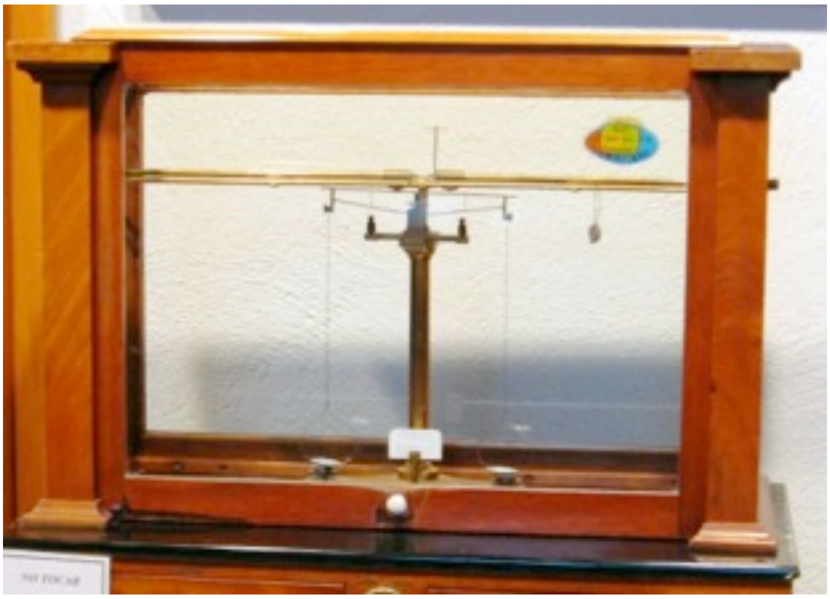


Gordon Fowler and Dr. Hills with the Baird televisor.

One field in which Manchester became famous for pioneering was computing. We collected a small range of mechanical calculators for office use to show the start. We were offered the Hartree mechanical analogue computer by the University but we had no space to display it so its main control unit went to the Science Museum in London. However we did receive from Ferranti some parts of F.C. Williams' University computer including a cathode ray tube. We saved a Pegasus computer from Brooklands College with the help of a grant from the Science Museum Preservation Fund. It was too large to fit into Grosvenor Street so was stored by Ferranti but we were able to display a model of it in a small gallery on computer development with some actual parts such as the memory and printing systems. Linked with computers and transmitting devices was a collection of electronic valves. One was a cavity magnetron which was the core of radar. This delighted Donald Cardwell because he had worked with them in the Second World War.

Wimshurst machine with other electrical apparatus on display at Grosvenor Street

Chemistry
Production of chemicals was an important industry in the region as it was linked with the finishing of textiles. This section was mainly developed by Robert Manders through his background of chemistry. He was helped by our Research Assistant, Robert Bracegirdle. An important collection of chemicals was the Shunck Collection which came from the University and contained an early sample of the synthetic dye mauvine. From the Society of Colourists and Dyers in Bradford come some bleaching samples. As well as apparatus such as glass measuring vessels and containers, there was a selection of chemical balances. A particularly fine early one was housed in a wooden framed case with rounded ends filled in with curved glass panels. Replicas of Joseph Priestley's apparatus showed the type which he used to discover various gases as well as his electrical apparatus. In another corner on the top floor the staves of a wooden vat were assembled together with the stirring apparatus but most production chemical apparatus was far too large to be accommodated in Grosvenor Street.



An example of a nineteenth century chemical balance inside its wood and glass case.

Miscellaneous Exhibits

From the skylight above the main staircase, a beam was inserted from which was suspended a Foucault pendulum. It was released at certain times to show the rotation of the earth. School children were more interested to see if they could reach over the banisters and touch the wire to upset the swing.

In the basement where there was public access, we displayed a fine scale model of one of the Manchester liners, the 'Manchester Regiment'. It served to remind people of the importance to the region of that Ship Canal.

H.B.Marton, Opthalmics Optics Department, UMIST, presented a large collection of opticians instruments. There was a case of lenses for checking eye focus, reading charts, spectacles and early contact lenses. We were able to arrange simple demonstrations showing what happened to rays of light passing through different lenses.

When Liverpool Road Station was settled as the permanent home of the Museum, the opportunity was taken to purchase a collection of memorabilia commemorating the opening and early years of the Liverpool & Manchester Railway. This consisted of glass goblets, tankards and other pottery and printed headscarves. Some of these copied and manufactured for scale at the 150 Anniversary celebrations.

Conclusion

This account has given only brief coverage of the exhibits collected at Grosvenor Street. It has made little mention of the many people who helped to make it all possible. For instance there were the Chairmen of the Joint Committee such as Alderman Bobby Rogers, Councillors Bernard Langton, Ann Durant and Anthony Goldstone as well of course the members of this and other committees. There were the staff in the Town Clerk's department and those in the Bursar's department at UMIST who carried so much of the administration. Volunteers on Working Days and at other times helped with demonstrations and there were all the people who gave exhibits to help augment the collections. By the time Grosvenor Street closed, the collections had swelled to fill that building to capacity as well as other stores so that our collections became recognised as having much more than local significance and indeed some were of international importance. It is true to say that, without the work of that small dedicated staff and others at Grosvenor Street, there would be no MOSI today. From such small beginnings, a mighty museum has grown.

Appendix 1, List of Some of the Exhibits Collected up to 1977

Steam Engines

Before 1971, construction of a replica Newcomen engine, and preservation of the Haydock engine, Elm Street Mill engine, Cameron pump, Magnet Mill valve gear, various model engines had been accomplished. Work on cladding the frame of the Newcomen engine began in 1971. Development was demonstrated by positioning it next to a 1946 high speed steam engine donated by the North Western Gas Board. Two small engines were acquired from English Electric and AEI donated a 1934 350 Kw steam turbine. Dr. Hills urged the preservation of Astley Green colliery winding engine. (Annual Report 1971)

The Barnes Mill engine from Rochdale was presented by Courtaulds together with a generous donation towards preservation. Erection of the Haydock, Elm Street and Barnes mill engines awaited a permanent museum site. Greengate Polymer Coatings donated a small Ashworth & Parker engine. (Annual Report 1972)

The replica of Thomas Newcomen’s 1712 engine was completed; an early grasshopper type engine presented by R. Platt was being erected so that it could be turned over by steam, as was the small vertical engine from Bury. (Annual Report 1973)

The Metropolitan Vickers steam turbine made a striking contrast with the Newcomen engine. The latter was demonstrated every afternoon at three o’clock. (Annual Report 1974)

Preservation of the Durn Mill engine from Littleborough demonstrated the change from beam to horizontal engines although its erection awaited a permanent site. (Annual Report 1975)

Excavations at Bridgefoot, Cumbria, with staff and students from Manchester Polytechnic unearthed an atmospheric pumping engine circa 1780. Cumbria County Council allowed the piston to be displayed in Manchester. (Annual Report 1975)

In 1977, a model of a McNaughted beam engine, a Schaffer & Budenberg indicator and sectioned models of steam engines were obtained. (Annual Report 1977)

The following engines could be demonstrated under steam; one third replica of Thomas Newcomen’s first steam engine; 1840 grasshopper steam engine; 1845 vertical steam engine; 1890 horizontal steam engine and Fluidine engine. The steam turbine could be demonstrated by push button control. (Draft Museum Policy Doc., 1976) A film was made about the Newcomen engine. In conjunction with Courtaulds, films were produced on “Power behind the Spindle” and “The George Saxon Engine at Magnet Mill”.

Internal Combustion Engines

The Museum opened in 1969 with the following engines on display; Crossley atmospheric gas engine, Crossley horizontal four-stroke gas engine, Crossley ‘M’ type oil engine, Royce 2 cylinder car engine, Rolls Royce Merlin engine, Rolls Royce Derwent jet engine.

The North Western Gas Board donated a 1924 Crossley gas engine. (Annual Report 1971)

Gardner Engines Ltd. donated an early petrol driven air compressor used in a Mersey tug. (Annual Report 1972)

Crossley and British Leyland lent a number of sectioned engines. (Annual Report 1973)

The atmospheric and other gas engines were connected to a gas supply so that they could be demonstrated every afternoon. A Crossley TSH two stroke diesel engine and an early Gardner 4L2 diesel were donated. (Annual Report 1974)

A model of a sixteen cylinder Crossley diesel engine and early Gardner marine engine were presented. The gas engines were converted to run on North Sea gas. (Annual Report 1975)

Donations included a National gas engine, a Crossley diesel engine and a sectioned National diesel engine. Crossley Premier Engines repaired the atmospheric gas engine. (Annual Report 1976)

Sectioned models of internal combustion engines were obtained in 1977. (Annual Report 1977)

The following internal combustion engines could be demonstrated; 1875 Crossley Otto Langen atmospheric gas engine, 1888 Crossley Otto four stroke gas engine, 1895 Robinson four stroke hot tube gas engine and 1928 Petter petrol/paraffin engine. The following engines ran under push button control; National single cylinder diesel engine, a model of a Crossley diesel engine and a demonstration four stroke engine. (Annual Report 1977)

Hydraulic Power

A small Tangye hydraulic press and a pump by Bellhouse were preserved. The latter was adapted from hand to power operation. A lift cage was taken out of a Manchester office block but not the operating mechanism.

As the Manchester hydraulic power system was closed, pieces of high pressure pipe, valves and metres were preserved. Examples of wooden and stone pipes from beneath Manchester streets were also preserved. (Annual Report 1973)

A Gilkes water turbine and a water pressure engine used for blowing a church organ at Preston were presented. (Annual Report 1974)

Horse Power

A horse wheel for driving agricultural machinery in a barn was donated by a farmer at Waenfawr in North Wales.

Electrical Equipment and Machinery
Early radio valves including a cavity magnetron were presented. Early electric motors, dynamos, light bulbs, meters and household machines were presented, the latter from the NORWEB collection.

Early Royce motors and control units were donated by W.T. Glover, Trafford Park. (Annual Report 1972)

Equipment including Leyden jars, generators, meters, switches, radio telephones etc. were purchased with money from the Science Museum Preservation Fund. NORWEB donated testing meters, an early transformer while there came from the Shirley Institute a Wimshurst machine, and from elsewhere a mirror galvanometer, an induction coil, a pre World War II television set, and early electric fires. (Annual Report 1973)

Electrical exhibits included Ferranti alternators, a switchboard from the Grosvenor Gallery and DC dynamos. (Annual Report 1974)

The DC generators and alternators were demonstrated in the ground floor Electric Generation Gallery. Telephones, motors, switchgear, telegraphy, radio, television, lighting, metering and a 1930s kitchen were displayed upstairs. St. Ambrose College presented an early electrostatic machine; the GPO Microwave Department parts of the first microwave link between Manchester and Glasgow. A Metro-Vic. switchboard came from the Cavendish Laboratory, Cambridge, and circuit breakers and fuses from B. & S. Massey. (Annual Report 1975)

Donations included an early Bell telephone, a pair of oil lamps, bicycle oil lamps and two miners' safety lamps made by the Protector Light & Lamp Co. (Annual Report 1976)

During 1977, the following donations were made; radio valves, a crystal set, coils, switches, meters, early light bulbs, thermal resisters, an electric fire, a radar display unit, a Vigilant alarm, oscilloscopes, a galvanometer, a fault tester, a telephone switchboard, a washing machine, a spin dryer, gas lamps, a "King of the Road" battery powered cycle lamp, and a Hopkinson/Mather & Platt single phase alternator. (Annual Report 1977)

The following machines could be demonstrated by push button control; 1890 Mather & Platt "Manchester" dynamo, motorised three earlier generators, 1900 Humphries "Vulcan" dynamo which provides current for the 1883 Siemens alternator and light bulbs, and the 1912 ECC dynamo which lights arc and other lamps; transmission of electrical current, the wireless loudspeakers, magnetic force; the Wimshurst machine, carbon filament light bulbs, modern filament light bulbs and the principal of the battery. There was a slide presentation on the history of electric generation. (Draft Museums Policy Doc. 1976)

Machine Tools
Early exhibits presented were a Carver lathe and a thread cutting machine from Derker Mill, Oldham, a pillar slotting machine and from Arthur Bebbington an 1842 Whitworth planning machine.

An 1835 Sharp Roberts slotting machine, an early shaping machine, a Muir pillar drill and grinding machine, an early lathe, a keyway milling machine, a Massey pneumatic hammer and small planning machine were donated. Staveley Machine Tools donated an early Whitworth measuring machine. (Annual Report 1971)

The following machine tools were donated; Pennington Mill an early lathe with a wooden bed, by P. Wright a watchmaker's lathe, Avon Mosely a double head shaper and Stockton Heath Shovel Forge an early tilt hammer. (Annual Report 1972)

A model of a Craven boring machine and a large lathe were presented by Stockport College of Technology. Edgar Allen of Openshaw loaned a Whitworth gearcutting machine made by Whitworth once at Beyer, Peacock's. Other machine tools were being prepared for display. (Annual Report 1973)

A large Whitworth lathe, an early shaping machine, pillar drills and other tools were displayed. A pair of Holtzapffel treadle lathes, a pillar drill, a gear cutting machine, a Craven boring/drilling machine, a Yorkshire pillar drill, a drill made by Pollock & McNab, two dovetailing machines by Robinsons of Rochdale, a shaping machine, a milling machine and a planning machine were donated. (Annual Report 1974)

The Blacker hammer and Walker punching and shearing machines were being overhauled and the machine tool display re-arranged. Crossley presented a Whitworth measuring machine. (Annual Report 1975)

A continuous rod rolling machine was obtained from R. Johnson & Nephew. Donations included Whitworth taps, reamers, plug gauges, ring gauges, a handsaw, callipers, files, moulders' tools and a wire bending machine. A portrait of William Muir was purchased with the help of the Science Museum Preservation Fund. (Annual Report 1977)

During 1977, this display was rearranged so that many of the machines could be driven by line shafting and so could be demonstrated.

Miscellansous Manchester Engineering Products
A roller grinding corn mill was donated by Henry Simon Ltd. (Annual Report 1974)

Avro propeller blades and a Bradbury sewing machine were obtained in 1977. (Annual Report 1977)

Paper and Printing
The original National Paper Museum at St. Mary Cray has been described in the earlier part. When the Museum opened in 1969, a display of some of these exhibits was arranged in Grosvenor Street. These included the set of stampers, the lead-lined vat and its parts, the small size press, the section of the drying loft and a few hand moulds. A Clough beater was obtained to prepare pulp for demonstrations to school parties.

Additional watermarks were added to the collection. An early guillotine, an Albion press, a cropper treadle platen press and a set of Stereotyping machines were added to the paper and printing sections. (Annual Report 1971)

Linotype donated the first type of machine they built in the UK. J. Barcham Green donated a selection of wooden drying crosses. (Annual Report 1972)

A fine collection of handmade paper dating from the 1830s was donated by J. Barcham Green and paper with watermarks was donated by Edward Towgood and Wookey Hole Mills. Papermaking machines were donated by PIRA and Bertram Sciennes, a sulphite digester model from Bovings. An ornate Columbian press was purchased. (Annual Report 1973)

Donations included a wide collection of paper samples and some books on printing from F.W. Bailey; a display of watermarks from Green Son & Waite, a Britannia hand press and a Wharfedale press. (Annual Report 1975)

Donations during 1976 included a Bentley & Jackson paper cutter circa 1875. Catalogues, drawings and watermarks were added to the National Paper Museum Collection. A "Dougsen" dandy roll was loaned by Green Son & Waite. Three hand presses and a Thompson platen press were re-arranged. A grant from the Science Museum Preservation Fund allowed a Miehle printing press built by Linotype to be moved from Leeds Polytechnic. (Annual Report 1976)

The papermaking area was re-organised during 1977 and officially opened in 1977. A Japanese fan was donated. An iron Stanhope press was loaned by the Oxford County Museum. The following were donated, a Gem No. 1 printing press, guillotines, a stapler, a lead cutting machine, a type high gauge, a perforating machine, printing type and plates. A replica wooden "Common" press built to John Moxon's design of 1693 was purchased with a grant from the Science Museum Preservation Fund. A Typograph was purchased. (Annual Report 1977)

Making paper by hand could be demonstrated. This could also be illustrated by a film shot at Hayle Mill in Kent. A small paper making machine was connected to a steam supply for further demonstrations. The following printing equipment could be demonstrated:- the Common, the Stanhope, the Columbian and Albion hand presses, the Cropper treadle press, the Thompson powered platen press and the Wharfedale flat bed press. A wide range of material could be printed including the front pages of the 1821 Manchester Guardian and the 1865 Manchester Evening News.

Photography

A collection of cameras was donated by Foxall Chapman before the Museum was officially launched. A large camera for copying drawings was removed from Pin Mill Brow.

The collection of equipment was increased with the inclusion of cameras, enlargers, projectors, etc. (Annual Report 1971)

A Sanderson camera, a Lancaster stereo-camera, a projector, an enlarger, a Kodak Brownie, a flash outfit and "Paget" colour slides were received. (Annual Report 1973)
A collection of Thornton Pickard cameras, other cameras, and dark room equipment were donated. (Annual Report 1974)

Camera accessories were donated. (Annual Report 1975)

An 1842 photograph of Market Street, Manchester, taken by J.B. Dancer was purchased using funds from the Science Museum Preservation Fund and Greater Manchester Council. Donations included an 1850s portrait taken in Beard's studio, a Furnival enlarger and a folding Kodak camera. Lantern slides were purchased. (Annual Report 1976)

The following were donated in 1977:- an Agiflex camera, a Sands Hunter camera, a Kolflex camera, a cine camera, a microfilm camera, an Agiflex lens, meters, a developing tank, three Kodak cameras, a Kodak studio dolly, an Agfa camera, a New Baroness camera, Voigtlands and Monte Carlo cameras, a wooden handstand camera and a ¾ ins. slide projector. (Annual Report 1977)

Railways

"Operations on the Liverpool & Manchester Railway proved to be one of the most significant developments in transport history. It launched a second phase of the Industrial Revolution through new industrial enterprises necessary to support it and other similar railways." (Proposal for UNESCO World Heritage Site)

Before the Museum was formed, Beyer, Peacock donated the major collection of their archives including Minute Books, Order Books, Schemes Books, General Arrangement Drawings, and a ton and a half of glass plate negatives. The negatives were housed in the Central Reference Library until such time as Grosvenor Street was ready.

The major railway exhibits have been described in the first part of this history. Some models of locomotives and trucks were also collected. The collections of railway signalling and permanent way are listed in the appendices 3 and 4.

Dr. P.H. Spriggs gathered an interesting collection of railway signalling equipment. (Annual Report 1971)

Sections of Manchester tram rails were donated. (Annual Report 1972)
British Rail, Dow-Mac Concrete Ltd. and Pandrol helped to develop the display of railway track. (Annual Report 1973)

Samples of permanent way were received from the Iron Bridge Gorge Museum Trust. (Annual Report 1974)

Wooden sleepers, block instruments and a model locomotive built circa 1840 were donated. (Annual Report 1975)

Horse-drawn Vehicles

In 1976, two fine models of carriages were donated by Cockshoots. (Annual Report 1976)

Chemistry

Schunck's collection of dye-stuffs and chemicals came from Manchester University. A small display of polyurethane products was donated. A series of chemicals showing the properties of phosphorus were donated by ICI, Albright Wilson. The

Department of Chemistry at Leeds donated some stainless steel dyeing equipment. Sir Humphrey Davy's balance and other very early balances were donated. (Annual Report 1971)

A collection of organometalic compounds and samples was given by Associated Octel, Morganite Modmor, UKAEA, Fisons Scientific Apparatus, CIBA Geigy and L. Binnis. (Annual Report 1973)

Chemicals used to make cosmetics and a range of bleached cloth were donated. (Annual Report 1974)

Scientific Instruments

Early collections received were the Joule Collection from Joule House, Dancer instruments and the Flatters & Garnett Collection from the Manchester Literary and Philosophical Society, and replica Priestley apparatus.

Dancer instruments including a telescope, microscopes, microphotographs, camera and photographs were donated and an early Abraham & Dancer microscope was purchased with the help of a grant from the Victoria & Albert Museum. Another grant enabled the purchase of a unique clock with two faces from Frosts Mill, Macclesfield. (Annual Report 1971)

Donations included a display of clocks, a fine microscope, a spectroscope, theodolites and a collection of microphotographs. (Annual Report 1972)

Various calculating machines and a pointer sundial were donated. A replica clock with foliot and verge escapement was purchased. (Annual Report 1973)

A mass spectrometer, early spectacles and a number of optical instruments were donated. Small coin balances and small scales were purchased. (Annual Report 1974)

Donations in 1975 included a microscope, a lantern projector with slides, a surveyor's level made by J.B. Dancer and two chemical balances with air damping. (Annual Report 1975)

Donations included an astronomical telescope made by Wray, a spectroscope, slide rules, hydrometers, spectacles, two hour glass timers, a timing clock and a long case clock by Standing of Bolton. A microscope signed by Frank's opticians and another with the name Dancer were purchased. (Annual Report 1976)

During 1977, the following donations were received; a hydrometer, a wooden slide rule, a rotoscope, a Schaffer & Budenberg tachometer, a Slater pocket balance, Thornton drawing instruments and a Casartelli aneroid barometer. (Annual Report 1977)

The following equipment could be demonstrated: five clocks, seven principles of optics, telescopes and the Foucault pendulum. Chemical demonstrations could be given by arrangement.

Textiles

"Cotton textiles were the most important factor in the economic success of Britain in the nineteenth century". (UNESCO World Heritage Site Proposal)

Early exhibits were a hand Jacquard loom from Macclesfield, the great and flyer spinning wheels from the Manchester Museum, hand pirn winder, Tathams carding engine circa 1860 for condenser cotton, large hand loom with flying shuttle from Bury Museum, the Franklin ribbon loom from Courtaulds.

An early circa 1800 carding engine was lent by Tathams. Bobbins, line shafting, Harrison knitting machines were donated. A replica Spinning Jenny was made in the Museum workshop. An Asa Lees mule, a bobbin winder and a beamer were stored. (Annual Report 1971)

Courtaulds donated a carding engine with flats; Bolton Institute of Technology an early gassing frame; Pennington Mill a narrow Lancashire loom and a small knitting machine; E. Turnbull and Sanderson Fabrics printing blocks and rollers; Standfast Dyers & Printers a molten metal process for printing. (Annual Report 1972)

The textile display was re-arranged to show spinning on the ground floor with weaving and calico printing upstairs. A shortened spinning mule was erected from salvaged parts to form a hand-operated machine. A primitive African hand loom, a hand Jacquard loom and an early Northrop loom were acquired. (Annual Report 1973)

A carding engine, a drawing frame, a ring frame from around 1900 and spinning wheels were brought from store. A Heilman combing machine, a pirn box, a braiding machine, hand printing blocks and a Mather & Platt three colour printing machine were donated. (Annual Report 1974)

A fitter from Platt International helped to shorten and move a roller drafting, self acting mule from Shiloh Spinners, Elk Mill. Donations included a roving frame from Royton Mill, special gauges, a genuine whorl, a model horizontal kier, printing blocks and various testing machines. Mrs. Fielden donated a remarkable portrait woven on a Jacquard loom in 1839 of Jacquard which required some restoration. The ribbon loom was refurbished and the weaving display re-organised. (Annual Report 1975)

The power loom and the roving machine were put in working order. Carrington Viyella loaned an early knitting machine. Donations included a Barber & Coleman knotter, various cloth and cotton samples. (Annual Report 1976)

The piano card cutting machine for Jacquard cards and the ribbon loom were made operational. The Leesona pirn winder, a Harrison knitting machine and the braiding machine were wired so that they could be operated by push buttons. Problems with the Lancashire loom were overcome. The following items were donated; calico printing blocks, a textile guillotine, a model hydraulic press, a reel winder, and mills for textile printing rollers. (Annual Report 1977)

Cotton spinning demonstrations included the spindle and whorl, the great spinning wheel, the flyer spinning wheel, the Hargreaves spinning jenny, the 1775 Arkwright water frame the roving frame and the self acting mule. The ring spinning frame was push button controlled. Weaving demonstrations included the hand loom with flying shuttle for plain weaving, the hand Jacquard loom with two flying shuttles, the Lancashire loom for plain cloth, the Franklin ribbon loom, the Leesona pirn winder, the Jacquard card cutting machine, the braiding machine, a flat bed knitting machine and a circular knitting machine. Dyeing and calico printing could be demonstrated on request.

Archives

Preservation of archives from companies etc. was seen as a crucial part of the Museum's work because they helped to fill in the background to the exhibits. The collections formed the basis of historical research by many people as well as providing material to supplement the displays in the galleries and temporary exhibitions. The archives were catalogued and administered for the public by an archivist and a photographic technician. A list of the major holdings is given in appendix 5.

Temporary Exhibitions

Temporary exhibitions were seen as a way of displaying objects not on permanent display. They also drew in people who had already seen the permanent displays and wanted to return again. Those borrowed from elsewhere were supplemented with material from the Museum collections, particularly the archives. Many more were prepared than are listed below.

An exhibition about Beyer, Peacock was prepared for the Manchester Museum and moved to the Museum when it opened in 1969.

An exhibition on "Pioneers of Flight" from the Science Museum was staged. It was viewed by over sixty parties and two hundred members of the public. (Annual Report 1973)

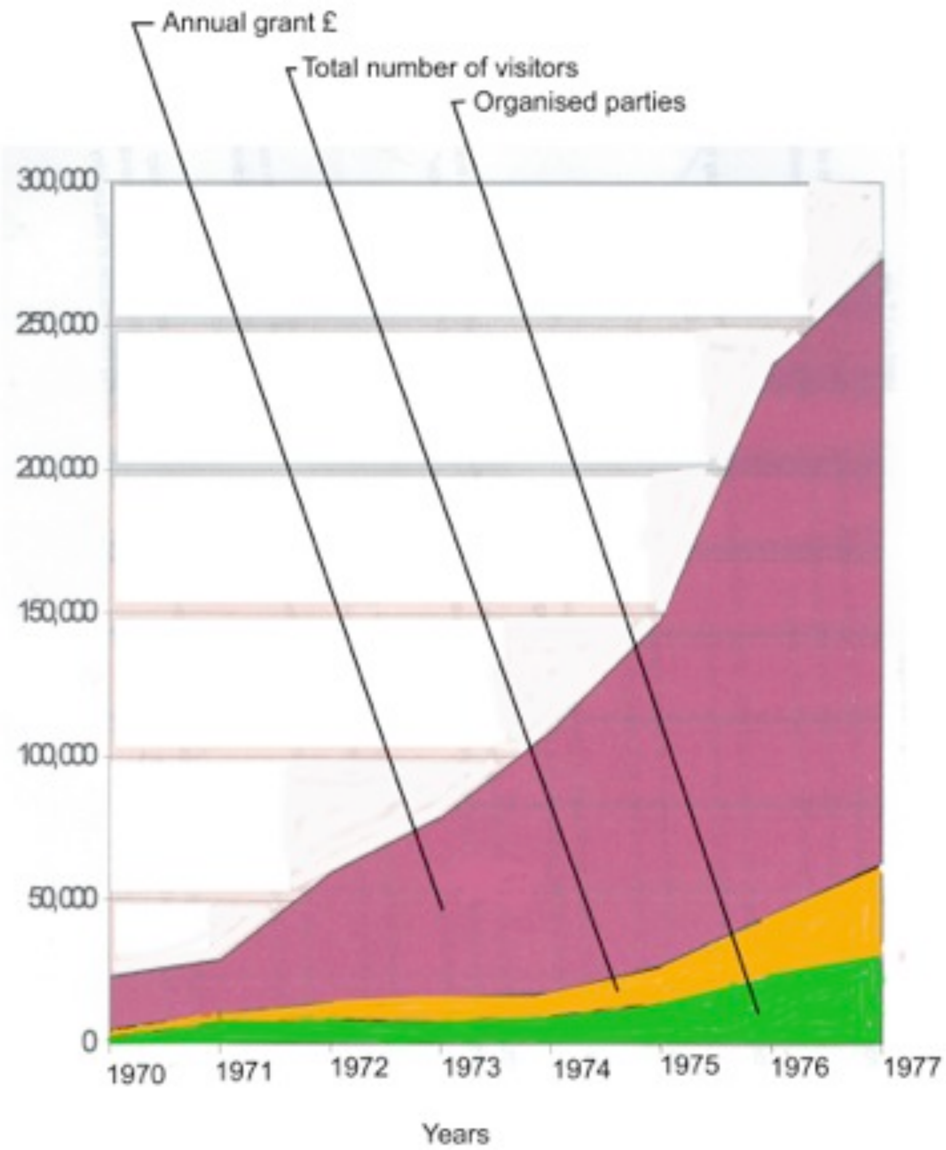
An exhibition to celebrate the centenary of Marconi's birth showing the major developments in radio and television was opened on July 4th. (Annual Report 1974)
The Science Museum provided a temporary exhibition of small exhibits. (Annual Report 1975)

Temporary exhibitions during 1976 included the Science Museum's "The First Century of Railways" and one commemorating the centenary of Clayton Aniline. Travelling exhibitions were loaned to the Science Museum and the North Western Museum & Art Gallery Service. (Annual Report 1976)

In October 1977, the "Caxton 500" exhibition was staged. Exhibitions were staged at Kendal Milnes, Bradford, the Royal Exchange Theatre and William & Glyn's Bank. (Annual Report 1977)

Appendix 2, Comparison of Annual Cost and Visitor Numbers between 1970 & 1977

Year	Grant £	Casual visitors	Organised parties	Total visitors
1970	**12,670**	**3,186**	**1,713**	**4,899**
1971	**12,670**	**5,459**	**4,654**	**10,113**
1972	**24,885**	**7,613**	**7,187**	**14,800**
1973	**36,000**	**10,291**	**5,734**	**16,025**
1974	**Unknown**	**10,744**	**6,678**	**17,422**
1975	**62,500**	**16,115**	**11,071**	**27,186**
1976	**121,669**	**25,702**	**19,393**	**45,095**
1977	**124,357**	**37,869**	**24,797**	**62,666**


Annual grant £
Total number of visitors
Organised parties
300,000
250,000
200,000
150,000
100,000
50,000
0
1970
1971
1972
1973
1974
1975
1976
1977
Years

Appendix 3, Holding of railway, tramway, tramroad rails and plates

Manders, R.G.

Approx Date	Description	Importance	Accession number	Remarks
11751c	Wooden rail & sleeper for flanged wheels from Nidderdale, Yorkshire.	Second type of railway track developed, probably in England in 17th century.	1974.52	
218th c	Tram plates, sleeper and remains of waggon wheel; cast iron, from Coalbrokdale area.	"Dead end" development in technology, but used widely, particularly around Ironbridge and Forest of Dean. First use of iron for rails.	Loaned to Ironbridge	
318th c	Tram plates and saddles for use with stone sleeper blocks; from Peak Forest Tramroad, Derbyshire.	As (2) above, but different type of sleeper; local	1971.15	
41825?	Cast iron edge rail with supporting feet, for use with stone sleeper blocks; from Duffryn Llynfi & Porthcawl Railway, South Wales	Good example of early parallel section iron edge rail, self supporting	1979.20	
51828?	Cast iron edge rail, part, to be held in chairs; Cromford & High Peak Railway, Derbyshire.	Incomplete example of "fish belly" section iron edge rail 1 yard long, supported by joint chairs at ends, not fished, local		
61830?	Two stone sleeper blocks, chairs & short portion of edge rail from Liverpool & Manchester Railway	Similar materials to those used with (5) but rail may be later parallel rolled section. Local		
7	Rolled wrought iron rail, supported by three cast iron chairs from Cragg Pit, County Durham.	Use of wrought iron rolled to a parallel section, double headed or bull head type.	1973.60	
81860s?	Short portion of T section steel rail ? And cast iron chairs used with wooden cross sleepers; from Cwm Croesor, North Wales.	Early edge rails were T section, later double head, later still bull head; similar rails were used on Ffestiniog Railway much earlier, in 1840s. Fish plated joints, supported in joint chairs.		
Late 91830s	Portion of Great Western Railway bridge rail, used with longitudinal sleepers, Brunel's "baulk road" ; survived until 1892 the abolition of broad gauge.	"Dead end" development in technology, but used widely thought GWR; similar sections used for some early street horse tramways.		
Post 101840s	For Corris Railway quarry section.	As (9) above, but narrow 2ft 3 in gauge line.		
111970s	Timber sleeper, cast iron chairs, short potion 45 cm of 95 lb/yd bull head steel rail, oak and spring steel keys.	Standard BR track materials until 1970s; similar equipment used on LT etc.	1973.29.1	
121970s	Dow Mac F27 pre-stressed concrete sleeper, short potion, 60 cm of 113 lb/yd flat bottom rail with cast in malleable shoulders, bonded cork pads & Pandrol PR401 clips/ nylon insulators.	Standard BR track materials of present day for track circuited line; rails held by resilient clips.	1973.9.2	

131970s	Desk paperweight consisting of model, about 1 fourth scale of timber sleeper end with rail & fastening from Pandrol Ltd.	Shows how resilient clips may be used with timber sleepers, portable.	1973.17.1
1970s	Desk paperweight consisting of model, about 1 fourth scale of concrete sleeper end with rail & fastening from Pandrol Ltd.	Similar to (12), potable	1973.17.2
141970s	Model, about 1 fourth scale of Dow Mac pre-stressed concrete sleeper with flat bottomed rail & Pandrol fastenings	Similar to (12), potable	1973.17.35
19th/ 1520th centuries	Nine shims of street tramway rail, grooved; all the types used in the City of Manchester from the earliest horse drawn car lines to the latest electric.	Show evolution of rail section from "bridge" rail supported on longitudinal timbers to "girder" rail supported on mass concrete.	1971.88
1620th century	Two different sections of street tramway rail; short portion of each, about 30 cm; from former track in Grosvenor Street, Manchester	Local	
	Granite setts from Manchester streets; as used around the rails in street tramways	Can be used with above item to construct short portion of street tramway track, in conjunction with suitable photograph in display.	
1720th century	Length of street tramway rail, about 1 m, from Twickenham railway bridge, London United Tramways.	Retains end of tie bar used to keep rails to gauge in the absence of cross sleepers; universal method of street tramway construction in this country.	

<u>Appendix 4</u>, <u>Holding of mechanical point, signal lever frames and interlocks</u>

Manders, R.G.

Date	Description	Importance
C1874	Midland Railway rocker & tappet locking 10 levers, horizontal locking in tray behind levers. Length 4 ft, depth 3 ft, height 4 ft. From the end of New Mills Tunnel.	Design related to Saxby patents.
C1870	Midland Railway, tumbler locking 10 ? levers. Length 4 ft, depth 3 ft, height 4 ft. From Marple	Earlier Saxby design
C1870	London & North Western Railway tumbler & hook locking 19 levers, vertical locking beneath levers, length 10 ft, depth 6 ft, height 4 ft, 2 ft beneath floor. From Preston No 2A box, LNWR In store at Newton Heath.	Designed by Webb.
C1860	Mackenzie & Holland No 11, "soldier" locking 8 levers. Length 4 ft, depth 3 1/2 ft height 4 ft. From Maccelsfield Goods Yard, North Staffordshire Railway. In store at Newton Heath.	
C1873	Mackenzie & Holland No. 5 cam & rocker locking 8 lever frame, 1 lever preserved. Length 4 ft, depth 3 ft, height 4 ft. From Pratt sidings Stoke on Trent, North Staffordshire Railway. In store at Cheadle Hulme, exposed to weather, deteriorating.	
C1876	London & North Western tumbler locking 10? Levers. Length 4 ft, depth 2 1/2 ft, height 4 ft. From Middlewood Lower Junction. In store at Newton Heath, incomplete but parts from other frames present.	
C1888	Saxby & Farmer, tappet locking 13 ? Levers. Length 6 ft, depth 3 ft, height 4 ft. From Brooklands, Manchester South Junction & Altrincham Railway. In Store at Newton Heath. Most of the interior fittings of the Brooklands Signal Box were also acquired for preservation with a view to reconstruction as a complete exhibit.	Brooklands Station opened in 1877
C1890	Tweedie of Carlisle, tappet locking. 2 levers, length 1 ft, depth 3 ft, height 4 ft. From Threlkeld, Cockermouth, Keswick & Penrith Railway. In store at Newton Heath.	
C1892	Lancashire & Yorkshire Railway, tappet locking 4 levers, length 2 ft, depth 3 ft, height 4 ft. From Darwen L & Y R.	
C1884	Railway Signalling Co., tappet locking 12 levers. Length 6 ft, depth 3 ft, height 4 ft. From Mersey Bridge MSJ&AR. In store at Newton Heath.	
C1860	Stevens & Co. tappet locking. 2 levers. Length 1 ft, depth 3 ft, height 4 ft. From Stalybridge on the Oldham Ashton & Guide Bridge Railway	Invented by James Deakin an employee
C1886	London & North Western Railway, interlocking only, no frame	

Half of the locking for 5 levers. Length 3 ft, depth 2 ft, height 10 1/2 ft.
From Preston No. 1 box. In store at Newton Heath.

Operation of points and signals: electrical frames/ interlocking
British Pneumatic Signalling Co., electro - pneumatic with tappet interlocking.
2 "slides" of 8 slide frame, slides rather than levers. Signals operated by
low pressure compressed air controlled electrically. Length 2 ft, depth 2 ft,
height 4 ft. From Audenshaw West Junction Box, Great Central Railway.
In store at Newton Heath.

London Midland & Scottish Railway.
20 levers, miniature. Length 3 1/2 ft, depth1 ft, height 4 ft. From Crewe
Gresty Lane Box, LMSR

General Railway Signalling Co. slide frame
16 of 32 slides. The remaining slides are in store. On display in the basement staircase

Appendix 5, Catalogue of Library and Archive Collections circa 1982

This list gives brief details of the larger holdings in the Archives. There are other smaller items not included.

Prime Movers, Steam

Library

Number of books and text books on steam engine design.; Photographs taken by R.L. Hills of about 40 of the last mill engines.; Catalogues of mill engine builders such as Musgrave, Bolton.

Archives, Boilers

Daniel Adamson; Drawings of boilers from 1945 to 1960 showing the transition from the Lancashire boiler to the modern package type.

Archives, reciprocating steam engines

Buckley & Taylor, Oldham; A few engineering drawings of mill engines from about 1900 to 1920.

Galloways, Manchester; Engineering drawings showing many important designs, but not many can be identified as order books have been lost. A few catalogues, 1890 – 1930.

B. Goodfellow, Hyde; Extensive collection of engineering drawings with both good general arrangements and details of mill engines, mill layouts and shafting and a few machine tools, 1870 – 1930.

J. & W. McNaught, Rochdale; Good collection of their mill engine drawings including both layouts and details, also photographs, 1870 – 1925.

J. Petrie, Rochdale; The engineering drawings of this firm were in a very poor condition through bad storage and few were worth saving, 1890 – 1920.

G. Saxon, Openshaw; Engineering drawings, mostly details of mill engines, the general arrangements having been lost, 1890 – 1930.

Scott & Hodgson, Guide Bridge; Good collection of engineering drawings of mill and winding engines, and some other machines, 1890 – 1930.

Worsely Mesnes; Wigan; Order books, sketch books, engineering drawings, photographs, patent specifications, advertisements, indicator diagrams of colliery winding engines, 1870 – 1940.

Yates & Thom, Blackburn; Engineering drawings of the vertical cross compound steam engines installed at the Stuart Street, Manchester, and Midland Electricity Cos. power stations circa 1910.

<u>Archives, Steam Turbines</u>
Daniel Adamson, Hyde; Engineering drawings of steam turbines, 1920 – 1950
<u>Prime Movers, Internal Combustion</u>
<u>Library</u>
A few books on the history and design.

<u>Archives</u>
Crossley Brothers; Photographs of gas, petrol and diesel engines for general use and installed in boats, pumping and electricity stations, etc. 1890 – 1940

<u>Transport, Railways</u>
Archives
Beyer, Peacock Gorton; Very important collection of minute, account, costing, order, schemes and letter books, general arrangement and other drawings, photographs, 1854 – 1966. The photographs are probably the oldest collection of industrial photos in the world.

J. Clark Collection; Railway photographs taken in the last days of steam, 1955 – 1966.

Hick Hargreaves, Bolton; Forty five drawings on loan of early locomotives, 1831 – 1854. These must be among the earliest drawings of railway locomotives in existence. [They were later removed by Hick Hargreaves.]

Metropolitan-Vickers, Manchester; Catalogues, etc. of their electric locomotives.

Railway Signalling; Collection of station layouts of the North West showing signalling arrangements – on loan.

Sharp Brothers, Manchester; Order book circa 1840

<u>Transport, Road</u>
<u>Archives</u>
J. Cockshoot, Manchester; Important collection of photographs, illustrations, builders' drawings, notes, etc. of the coaches and coach built motorcar bodies supplied between 1890 – 1939.

C.W.S. Coach-building Works, Manchester; Plate glass negatives of milk floats, bread vans, hearse, etc. built in the 1930s.

Crossley Ltd., Levenshulme; Photographs of motor and trolley buses built between 1930 – 1948.

Morris Ltd., Salford; Photographs of fire engines built in the 1930s.

Rolls Royce, Manchester and Crewe; Photographs and catalogues of Rolls Royce motorcars connected with Cockshoots.

Machine Tools
Library
Large holding of catalogues of various companies which came from Cravens when they closed.

Archives
Bretts Ltd., Coventry; Selection of engineering drawings of drop and other hammers made before they were taken over by Massey's in the 1920s.

Craig & Donald, Coventry; Engineering drawings of machine tools made principally for the ship building industry 1900 – 1930.

Craven Bros., Manchester and Reddish; Important collection of minute and account books, catalogues and photographs of the very large machine tools made by them between 1860 – 1966.

B. & S. Massey, Openshaw; Engineering drawings of steam, pneumatic and drop hammers built between 1870 – 1920. Important collection on these specialised tools.

Shanks, Ltd., Dunferline; Photographs of machine tools built between 1860 – 1930, mostly for ship building.

Smith Bros., Glasgow; Order books and engineering drawings, mostly arrangements of machine tools for ship building, 1860 – 1930.

Whitworth, Armstrong Whitworth, Openshaw; A few catalogues and other books.

General Engineering
Archives
Lancashire & Tonge, Salford; Photographs of various machines they built in 1930s.

S. Marsden, Ashton under Lyne; Engineering drawings of nut making machines, 1900.

Massey Harris, Manchester; Some catalogues of agricultural machines.

W.F. Mason, Manchester; Makers of catering and kitchen equipment. Collection includes catalogues of their rivals, 1900 – 1940.

E. Timms, Runcorn; Well borers. Engineering drawings including pumping engines and ancillary equipment.

Papermaking
Library
The Museum houses the extensive collection of the National Paper Museum which is slanted towards the history of the subject. It contains many rare and important books which also contain the history of engineering and technology. It has extensive runs of the *Paper Maker* and *The World's Paper Trade Review*.

Archives
The Clapperton, Clayton Beadle and Schieland collections of early watermarks are most important. The J.B. Green collection of samples of handmade paper from Hayle Mill, Maidstone, ranges from 1840 – 1920. This collection also contains catalogues and samples of their rivals from 1910 – 1930. The NPM Collection also contains other samples of watermarks and fine quality paper including paper manufactured up to the present time to show the extent of the British industry.

Electrical Engineering
Library
An important collection of books and catalogues was purchased from Mr. G.S. Fowler. Some of these relate to the very early days of the industry.

Archives
W.T. Glover, Trafford Park; Manufacturer of electrical cables. The collection contains photographs, advertisements, catalogues, etc., 1900 – 1960.

Metropolitan-Vickers, Trafford Park
A few catalogues and details of electric locomotives of the 1930s.

Textiles
Library
Historical books from the Textile Institute have been added to the Museum's own collection of books on the cotton industry. Catalogues of firms like Platt Bros., Howard & Bullough, Asa Lees, etc. are included.

Archives
Richard Arkwright documents; Two very important documents about the 1769 spinning patent and the subsequent development of the early mills, also letter from Smalley.

Carrington Viyella; Photographs of various mills and machines, some taken by Rex Wailes.

Mill layouts; Plans of spinning and weaving mills from various sources.

Millbrook and Staley Mills; Accounts and other records, 1905 – 1930.

Plum Mill, Heywood; Notes on the building of the mill, 1905, some correspondence for the 1920s with fine letterheads.

Textile Samples
Calico Printers Association, Manchester; Samples of cotton cloth used in 1949 Jubilee Exhibition dating back to 1800. Pattern books with printed cotton samples, 1795 – 1930.

Birch Vale Collection; Pattern books, 1920 – 1930.

Other samples; Pattern books, pattern cards, etc., and Bleachers Association samples.

Photography

Library

J.T. Chapman Collection; Very important collection of books, 1845 – 1890, used by J.T. Chapman as his working library.

Archives

Growing collection of photographs of Industrial Archaeology, including buildings, machines, etc., some taken by Museum staff and others presented. Also old types of glass lantern slides, etc.

Chemistry

Library

A few text books and some histories of firms.

Collections of Samples

Forbes collection, Roscoe collection of chemicals, samples of pharmaceuticals and general chemicals manufactured in Manchester, samples manufactured by Associated Octel; Armstrong & Wynne collection of naphthalene derivatives; samples of polyurethanes manufactured by ICI. Samples of the first commercially manufactured magnesium made by Sondstadt for Roscoe.

Scientific Instruments

Archives

Duckworth collection on J.B. Dancer consisting of notes, reprints, etc. Also collection of Dancer microphotographs.

Miscellaneous

Histories of various firms.
Proceedings of Institute of Automobile Engineers, 1922 – 1944.
Journal of Textile Works Management, 1909 – 1950.
Proceedings of the Manchester Association of Engineers, 1911 – 1959.
Catalogues, photographs etc. of other firms not mentioned above.
Some portraits, photographs of Manchester scientists and engineers.
Some periodicals of Industrial Archaeology Societies, etc.
Industrial Archaeology Record Cards for the area.

Appendix 6, Attendees at the Royal Visit to the Greater Manchester Museum of Science and Industry, 5 May 1982.

Her Majesty The Queen

His Royal Highness, the Duke of Edinburgh

Mr. G.N.C. Flint, Chairman Museum Trust and Founding Trustee
Councillor A.S. Goldstone, Deputy Chairman Museum Trust, Chairman Recreation and Arts Committee, GMC and County Councillor

Sir Peter Parker, Founding Trustee

J.B. Clarke, Trustee, County Councillor
G. Colin, Trustee, County Councillor
H. Davies, Trustee, County Councillor
Mrs J. Montgomery, Trustee, County Councillor
M. Morris, Councillor
R.C. Rogers, Councillor
Prof. D.S.L. Cardwell, Trustee
Prof. W.H. Chaloner, Trustee
Prof. R.M. Haszeldene, Trustee
Prof. A. Smith, Trustee

Messrs. T.J. Anderson and D.I. Goldstone

Dr. J. Taylor, Chairman Greater Manchester Council

P.D. Quick, Hon. Secretary
J.M. Marriot, Hon. Treasurer

Dr. R.L. Hills, Director, North Western Museum of Science & Industry and Curator Designate, Greater Manchester Museum of Science & Industry

Mr. A. Little, Consultant Architect, Thomas Worthington & Partners

Wm. Thorpe & Co. Ltd., Main Contractor

Appendix 7, The Education Service.

> "The main impetus for the creation of the Museum came from UMIST and the City of Manchester Education Department. A museum of science and technology was seen as one way of helping people understand our modern civilization. Therefore an Education Officer was appointed by the City of Manchester Education Department as soon as there were sufficient exhibits on display. Mr. R.G. Manders was the first Teacher in Charge. As the Museum expanded, so more staff were employed until there were three teachers, a secretary and a technician. Museum staff also helped to give lectures and guide parties. The numbers of visitors in organised parties are listed in Appendix 2 and show how important was the Education Service. For schools, the most popular topics were steam power, textiles and papermaking. Many schools in the surrounding conurbation took advantage of these classes."

The following list shows how the Education Service, and indeed the Museum staff as well, developed contacts beyond schools and so helped to introduce the Museum to a broad range of the general public. At first, the Museum staff helped by lecturers from the History of Science and Technology Department, UMIST, showed people round the Museum. These annual lists start in 1970/71.

Ten evening lectures were given in association with the University Extra-Mural Department and the Workers Educational Association. Evening parties from the Mottram Amenity Society, Manchester Amateur Photographic Society, Festiniog Railway Society and the Wilmslow Church of England Societies visited the Museum. Classes ranged between those for third year juniors to mature students. A large number of contacts were made in the educational sector. External lectures were given on BBC Radio Manchester. (Annual Report 1971)

The following groups visited the Museum; Macclesfield WEA, Marple WEA, Wilmslow Guild, Chester Group IA, Institution of Production Engineers, Women's Engineering Society and the Printing Historical Society. Three WEA extra-mural courses were run. (Annual Report 1972)

The additional teacher appointed in May was fully employed giving history and science lessons. A course on the "History of Industrial Power" was run with backing from the WEA. A paper entitled "The Preservation of Mill Steam Engines" was given to the First International Congress on the Conservation of Industrial Monuments. A demonstration model of Watt's separate condenser was developed for use in the lecture room. A model two-cylinder steam engine was purchased for demonstration during lectures. A UMIST student completed a thesis on Craven Brothers. (Annual Report 1973)

Holroyds presented a model beam engine for use in lecture demonstrations. Lectures were given to groups such as the WEA, Polytechnic students, University students, the Midlands branch of the Newcomen Society, groups of science teachers and the Greater Manchester Arts and Recreation Committee. Small groups of sixteen year old school pupils were employed painting and decorating. (Annual Report 1974)

During July 1975, films were shown to pupils from Parrs Wood School and a Museum quiz was introduced for younger pupils. An Extra-Mural Evening Course was run during the autumn and also WEA classes came from Altrincham, Bury, Rochdale, Salford, Warrington and Widnes. Courses for Polytechnic students continued and lectures were given to students from Lancaster, Nottingham, Salford, two groups from Stamford USA, Université Le Mans, Owen's Library, four UMIST departments and many other colleges. Members of the Newcomen Society, the Printing Historical Society, the Royal Photographic Society, the Antiquarian Horological Society and the Association of Teachers of Printing & Allied Trades attended meetings. External lectures were given at the Science Museum in London and Dudley. In September, the Institution of Production Engineers held a special meeting. In March, special meetings were staged in the Spinning, Internal Combustion Engines and Electrical Generating Galleries. The annual conference of the Institution of Electrical Engineers was held in Manchester so they were asked to inaugurate the new "Uses of Electricity" Gallery. An education workshop, able to accommodate thirty children, was opened. (Annual Report 1975)

During 1976, courses were run for University, UMIST, Polytechnic electrical students, the WEA, science, history and geography and teacher training students. The Museum was used by the North Western Branch of the Institution of Mechanical Engineers and the North Western Federation of Museums & Art Galleries. The Education Director and two officers provided by the Local Education Authority organised a wide-ranging education programme for primary and secondary children including classes on "Textile Printing" and "Electrical Generation". The education officers handled over 10,000 visitors in parties. Lectures were given to the Newcomen Society in London and the Manchester Literary & Philosophical Society. The Museum provided resources for third year university projects and a number of post-graduate theses. (Annual Report 1976)

In 1977, lectures were read to students from Manchester University, UMIST History of Science & Technology Department and students from London, Russia as well as the USA. Electrical, mechanical and civil engineering students visited the Museum. Special visits were arranged for the City of Manchester Cultural Committee, Sheffield Library & Arts Committee and civil representatives from Frankfurt. The Museum was the venue for meetings of the Institute of Physics, the Royal Photographic Society Historical Group and the Business Archives Council. External lectures were given to Bristol, Manchester and Keele Universities, the Archaeology Conference at Lancaster, Lymm & District Local History Society, Business & Professional Women's Club, the Institute of Petroleum and Todmorden Rotary Club. On Tuesday afternoons, special school lessons were devoted to textiles. The development of push button demonstration models was extremely popular. To make the Museum's resources more widely available, a slide loan scheme was being developed. During a week in July, over 200 pupils from 75 schools visited the Museum. (Annual Report 1977)

The Education Service continued until the Grosvenor Street building closed in July 1983.

<u>Museum Bibliography</u>.

Reports

Report on a Museum of Science and Technology, by the Working Party of the Joint Committee, 31 October 1966, Ed. D.S.L. Cardwell.

'Report on the Future Development of the Museum', typescript, 1976, R.L. Hills.

Annual Reports, 1969 – 1977, Manchester Museum of Science and Technology and North Western Museum of Science and Industry, Ed. R.L. Hills.

Standing Commission on Museums and Galleries, *The Preservation of Technological Material*, H.M.S.O., 1971.

Ibid, *Report on University Museums*, Typescript 1976, H.M.S.O., 1977.

Booklets published by the Museum

Beyer, Peacock, Locomotive Builders of Gorton, R.L. Hills

A Brief History of Papermaking, R.L. Hills

Cotton Spinning, R.L. Hills

John Benjamin Dancer, H.B. Marton

William Fairbairn*, A. Hayward*

Eaton Hodgkinson, B. Warburton

The Newcomen Engine, R.L. Hills

Photography, H. Milligan

Platen Presses, D. Nuttall

Joseph Priestley, K.R. Farrar

Leaflets

Bailey's Horizontal Hot Air Engine

Bedson Rolling Mill

1842 Daguerreotype of Manchester

The Linotype Machine

Marconi

The Spinning Jenny

The ‘Waterwheel’ Clock

Weaving

Various postcards

Articles by R.L. Hills

Althin, T., *Festskrift Torsten Althin*, Sweden, 1997, ‘Working Machinery’

Geigy Circle, Nos. 17 & 18, ‘The Manchester Museum of Science & Technology’.

History of Technology, Vol. 2, 1977, ‘Museums, History and Working Machines’.

Industrial Archaeology Journal, Vol. 4, No. 1, R.L. Hills & H. Milligan, ‘Rescue Operations at Beyer, Peacock’.

Industrial Monuments, Transactions 1, (First International Congress on the Conservation of Industrial Monuments), June 1973, ‘The Preservation of Mill Engines’.

Ibid, Transactions 3, (Third International Congress on the Conservation of Industrial Monuments), June 1978, ‘Problems of Displaying and Working Textile Machinery in a Museum’.

Manchester Association of Engineers Transactions, Vol. 151, 2006 – 7, ‘The North Western Museum of Science and Industry’.

Manchester Memoirs, Manchester Literary & Philosophical Society, Vol. 132, 1993 – 4, ‘A Monument to the Industrial Revolution: The North Western Museum of Science and Industry’.

Manchester Technology Association Year Book, 1970, ‘The Newcomen Engine in the Manchester Museum of Science and Technology’.

Museums Association Journal, June 1968, ‘The Manchester Museum of Science and Technology: An Experiment in Education’.

Newcomen Society Transactions, Vol. XLIV, 1971 – 2, ‘A One-Third Scale Working Mdoel of the Newcomen Engine of 1712’.

Ibid, Vol. LI, 1980 – 1, ‘Industrial History through Film’.

Pioneer, Journal of the K1 Group of the Welsh Highland Railway Society, Issue 3, Summer 1996, ‘Rescue at Gorton’.

Railway Magazine, May 1984, No. 997, Vol. 130, 'What a Whopper, Moving the South African Class GL Beyer-Garratt'.

Ibid, Oct. 1986, No. 1026, Vol. 132, 'An Electrifying Return'.

Railway World, July 1984, Vol. 45, No. 531, 'The Railway Collection at Liverpool Road'.

The Red Rose Steam Preservation Society, 'The Mill Engine Collection for Liverpool Road, Manchester'.

Stationary Engine Research Group, Bulletin Vol. 5, No. 3, Autumn 1983, 'The Mill Engine Collection for Liverpool Road Station'.

The Stationer & Newspaper Maker, No. 39, Spring 1986, 'The National Paper Museum'.

Textile History, Vol. 2, No. 1, December 1971, 'The Manchester Museum of Science and Technology Textile Display'.

There were other articles published by members of the Museum staff of which I have no record.

Some Theses Based on the Collections in the Museum

Cockshoots Rolls Royce Motor Car Bodies
Richard Arkwright's Waterframe
J. & W. McNaught's Mill Engines
Courtauld's Last Mill Engines
Testing the Model Newcomen Engine
Beyer, Peacock's Accountancy Methods
Cravens, Machine Tool Builders

Films

Hand Made Paper

The Spinning Mule

Hand Loom Weaving

The Newcomen Engine

Two Thousand Pounds Per Square Inch, Manchester's Hydraulic Power Supply

Power Behind The Spindle

The George Saxon Engine at Magnet Mil