LOCOMOTION

Concept to Creation….
the story of the reproduction 1973-75
by Mike Satow

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1 PREFACE

On 15th May, 1975, a full size reproduction of George Stephenson's first engine for the Stockton and Darlington Railway moved off under its own steam in front of a crowd of spectators who had gathered to witness the culmination of an unusual project.
Twenty seven months previously I had committed myself to the building of the reproduction without the use of money and as a training exercise for engineering students and apprentices in the North East of England.
The project, if it were to succeed, would need substantial support from industry, since some of the parts would be beyond the scope of training establishments.
The idea was regarded by many people as crazy and impossible. From my point of view it was an act of faith, faith that there is still a pioneering spirit in man waiting to be awakened.
Twenty seven months passed and we succeeded. Success was due to the wholehearted help and encouragement from people in many walks of life. Men who were busy with their own jobs, grappling with problems of a three-day week in early 1974, but they all found or made-time to listen, respond and participate.
At the end of this booklet is a list which attempts to identify all those who, in one way or another, helped to make this ‘impossible’ project succeed. If any names have been omitted. I can only apologise and excuse the lapse by saying that there was no committee, no office organisation, and hardly any paper work that did not represent a drawing or a calculation.
We just built it, as did Stephenson and his team.
To all who made it possible I record my sincere thanks and hope that they have achieved some measure of satisfaction in what we have done.

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2. INTRODUCTION

George Stephenson's Locomotion has been a familiar sight to railway travellers on Darlington's main line station, Bank Top. since 1892. Passengers have stopped and stared at it.

To the engineer the mechanics may be obvious. But the layman wonders. "What do those amazing rods, levers and arms do? Did it, could it, ever work? Surely such a little thing could not on 27th September, 1825 pull 32 wagons and a carriage with some 600 people the first public railway in the world to be worked by steam locomotives?
And was this black engine really the start of an industry spread round the world by engineers and bankers and managers from North East England?"
As the modern diesel Inter-City train arrives and passengers from Darlington scramble aboard for King's Cross. Aberdeen, or a European journey, many forget Locomotion and the peaceful railway revolution.

The engine was ordered from Robert Stephenson and Company of Newcastle on 16th September 1824 for a cost of £500. It was delivered 11 days before the start of the new public service, and shortly the area was described as "the grand theatre of practical operations of railways." although, as in the case of any innovation, the sceptics aired their views. For example, the Quarterly Review commented, "Can anything be more palpably ridiculous than the prospect held out of locomotives travelling twice as fast as stage coaches ?"

This little engine, 8½ tons in weight, worked regularly on the Stockton and Darlington Railway until 1840. A full account of its history and its design is in Loco Profile No. 25. "Locomotion". (published by Profile Publications. Coburg House, Sheet Street, Windsor. Berkshire SL4 IEB. but now out of print). The engine, second only in fame to "Rocket" which was built four years later, has been treasured in Darlington apart from visits to Philadelphia 1876, Newcastle in 1881 for the Stephenson Centenary, Chicago 1883, Liverpool 1886. Newcastle 1887, Paris 1889. Edinburgh 1890 and the Wembley Exhibition 1924.

In 1970 Lyn Wilson. a Lecturer at the Durham University Business School, walked along some of the disused and often overgrown railway tracks of Weardale.
Here, in the 18th and early 19th century was one of the world's mineral centres; lead, silver, zinc, bronze, iron, limestone, and the South West Durham coalfield. To exploit these resources, wagon ways. tramways, and railways were built, and it was men, horses, and winding ropes and winches which provided power.
The track of the Stockton and Darlington Railway west of Shildon can be clearly seen on a 1 in. map; in 1970 it was an overgrown jumble of thorn bushes at Phoenix Row, Etherley and Brusselton. An early branch line, from Bishop Auckland to Stanhope and extended westwards to the head of the Wear Valley later-still

provides a freight service from Eastgate Cement Works to Darlington, but operations cease on Sundays.

It was during his walks, and while waiting for trains at Darlington Bank Top Station, that Wilson wondered whether a reproduction of Locomotion could ever haul passengers on Sundays along the beautiful Wear Valley route. Somebody, he thought, ought to do something about it. Indeed, five years hence, the Anglo-French Concorde airliner was due to change air transport patterns with supersonic flights and one might compare the developments of 150 years of transportation between the 8 miles per hour Locomotion and the 1300 miles per hour supersonic airliner.

Wilson's dreams, which included among other things the involvement of the BBC Blue Peter TV team, remained an idea for more than a year. What one needed was a far-sighted engineer with the necessary skill and time available, and such people proved hard to discover.

During 1972 one of Wilson's engineering students, Raymond Parry. worked on a project for his degree which included an assessment of the possibility of building a replica of Locomotion, and this project was sufficiently advanced for Wilson to mention it on 20th February, 1973 to Richard Marsh, then Chairman of British Rail, when they met at the United States Embassy in London.
Marsh (now Sir Richard Marsh) had been Chairman of an afternoon meeting when Hugh Parker, Managing Director of McKinsey Inc., London, had spoken of "Challenges facing U.K. Boards of Directors". Among other things discussed was the problem of people getting enjoyment and satisfaction from their daily work, when so many developments in technology reduced men towards the role of automatons. Wilson was convinced that the building of Locomotion could involve a lot of people in a worthwhile, enjoyable, and educational venture which, with luck, could bring substantial benefits to North East England and the original home of the engine; but leadership was urgently needed.

Nobody seemed interested to commit themselves to a project for building a reproduction of the engine. However, Professor G. R. Higginson of Durham University Engineering Science Department kindly entertained to lunch Dr. E. C. Salthouse, Wilson and two representatives of the Engineering Industry Training Board in Newcastle on 5th April, 1973. The manager of the EITB was Bill Dodd, and the other representative, Brian Cunningham, a cousin of Wilson's by marriage. The idea of building a reproduction was broached and received with cautious enthusiasm.
On a paper napkin it was noted that some problems needed answers:
"We need plans-do any exist?
We need an engineer to manage the project.
We need a leader with railway credibility.
We need money-how much. £100,000?
We need BR support."

A few weeks earlier, on 14th February, 1973, the Director of the North of England Open Air Museum at Beamish, Frank Atkinson, had talked with Michael Satow, a qualified mechanical engineer and a person who had discovered and restored a narrow gauge steam locomotive and who was interested in industrial archaeology. The ideal of the Beamish Museum is "studying. collecting. preserving an exhibition of buildings, machinery. objects and information illustrating the development of industry and way of life in the North of England".
What could be nearer the ideal than Locomotion, and when Atkinson murmured to Satow. "What do you think it might cost to build a working replica of Locomotion No. 1, Any idea who might organise the thing?", the reply was. "£30,000 and me".

Two catalysts were making progress at the same time. Following the lunch on 5th April at Durham, Wilson contacted the manager of British Rail Engineering Ltd. at Shildon, and with some trepidation mooted the idea of building a reproduction of Locomotion.
After all, earlier attempts to seek support had resulted in respondents either telling Wilson that he was mad or putting the phone down to terminate the conversation! In this particular case the manager asked Wilson if he had heard of a Mr. Satow and Wilson replied. "Is he Japanese?" Already it was known that some Japanese had been measuring the original Locomotion with a view, it was believed, to manufacturing cardboard models. "No, he is not. He has retired as Managing Director of L.C.I. India. Could you meet us for lunch?"

The lunch was on 17th May, 1973 at the Eden Arms. Rushyford, and the host, G. W. J. Brecknell, the courteous and efficient manager of British Rail Engineering Ltd., Shildon, who was, indeed, 25th successor to Timothy Hackworth, George Stephenson's locomotive engineer. Wilson explained his dreams and reported the progress made by Parry and himself. Satow agreed that technically the project was possible and also explained that he had been appointed 14 days earlier as Co-ordinator for the Stockton and Darlington Railway 150th Anniversary Joint Committee and its programme for 1975.

Suddenly, the vision and dream of Frank Atkinson and Lyn Wilson might be resolved with the expertise of Michael Satow: the problems of man management, leadership, engineering skills and commercial acumen, noted down earlier on the back of a serviette, were solved in one person who was described later by The Times as "engineer extraordinary". A major step forward had been taken from non-credibility, incredibility, towards something believable and real; from fiction towards fact.

The feasibility of the project depended upon getting the boiler made satisfactorily. By mid-May Satow had found a Birmingham company which was prepared to make it for the very modest sum of £2,000. He had also met Bill Dodd of the Engineering Industry Training Board at Newcastle who was confident that apprentices could be involved in taking measurements from the original locomotive on Bank Top Station, Darlington, and preparing working drawings from them as it had been discovered that no records or drawings of the engine were preserved.

On the basis of these two factors, the estimate for production of the engine was reduced from £30,000 to £10,000. And by the end of May a budget and cash-flow statement put the total cost at £7,990. This figure was to prove very wrong indeed.
By mid-June it was clear that it might be possible to mobilise various commercial, industrial and educational organisations so that the preparation of plans and working drawings, casting and machining components, and assembly could be undertaken as a voluntary and co-operative endeavour.
If the project, an exciting educational exercise if nothing else succeeded, then one could say to the world. "North East England had the people with imagination and engineering skills in 1825 supported by far sighted bankers.
And today, in the 1970s, we have not lost that spirit of enterprise and co-operation".
June 1973 marked the end of the dreaming and the start of the action: a few people brought together through the desire to exploit an asset of the North East for the benefit of the region.
It sounded crazy, but it might work, and the team were "in at the deep end!"

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3. ACTION

The need now was for people who would get things done. And they are few and far between. Mike Satow exploited his I.C.I. friends, and Lyn Wilson and Frank Atkinson made their own contacts and fed to him information about who might be able to assist.

Frank Hodgkinson, formerly Manager of Purchasing, ICI. Calcutta. had retired to Stockton.
He might help, he did.

Bill McAlpine, owner of "Flying Scotsman" might help, he did.

George Hurry and his team at the South West Durham Training Centre at Aycliffe might help, they did.

George Wilkinson, Training Manager of Whessoe Ltd., Darlington. and his 27 apprentices and 3 instructors might help, they did.

Archie Brown, the helpful Scot and manager of British Rail Darlington area, and in particular Bank Top Station where George Stephenson's Locomotion was displayed, might help together with 'many of his team, they did.

British Steel drawing office apprentices might help, they did.

Dr. David Gregory-Smith and first year Engineering Science under graduates from Durham University might help, they did, and included the only lady member among the assistants, Ginny Clarke.

Ralph Proudlock, retired joiner from I.C.I., Wilton, might be the ideal person to build the tender, he was .

So it went on, and a list of those organisations involved and the names of people concerned is in the Appendix. Everybody did their bit and did it well. and the following paragraphs are used as examples of how the project moved forward.

Whessoe Ltd., of Darlington can trace its origin back to 1790 and a Quaker ironmonger's small shop. In its history the company had built 27 railway engines. Mike Satow sought their help. In view of the company's connection with the railways, the technical challenge and obvious interest represented by the project, training manager George Wilkinson took on the building of the boiler. The 16 year old apprentices were understandably excited and there was no trouble finding volunteers; indeed, some of the processes were carried out twice in order that as many boys as possible could be involved. Altogether some 566 man hours were involved.

The Skernside Pattern Making Co. is tucked away in a back street of Darlington between Whessoe and the railway line. Directors Herring and Wurge recall. "Oh yes, we remember the day Mike Satow walked in all right!!" Herring reckons that the 200 hours his young apprentice, John Lee, had put in on the wheel patterns and the cost of the yellow pine he used would have cost about £380.
John McConnell is production manager of Blackett Hutton Ltd. of Guisborough and also president of the Teesside Branch of the Institute of British Foundrymen so was the obvious person to be approached in the effort to expand the web of contacts.
Three nineteen-year old apprentices were set the task of making moulds of synthetic sand from John Lee's patterns. Steel was heated to 1600°C. and then poured into the intricate moulds, not an easy job as steel does not flow as freely as the iron used by George Stephenson's men.
And if the problems really got tricky, or time was running out, there was always the team at British Rail Engineering Ltd. at Shildon, to call upon for help: Ted Wanless, Ces Parkin, Eric Green and many others.

Some of the work was done by "friends of friends" and Mike Satow and his request for aid was passed to the right person to take a decision and commission the required work. Some routes turned out to be dead ends; one didn't know unless one tried. The telephone directory "Yellow Pages" were culled and, for example, Mike Satow, Ken Briggs from I.C.I., or Frank Hodgkinson, might walk in unannounced to a foundry:

"Can I have a word with the manager?"

"Yes, that's me".

"Oh, well, you see, we have this great project and it seems you're the only possible foundry which can produce a set of brass castings for us. See, these are the drawings ….. pretty sure we can get some patterns made for you”
And, a few minutes later, in the pattern makers down the road. pretty sure we've got a foundry lined up to make the castings..."
From September 1974 onwards, components for "Locomotion" were being stored in Mike Satow's garage at Ormesby, or at British Rail Engineering Ltd., or in the Wagon Repair Shop at I.C.I., Billingham, where the giant chemical company permitted the engine to be assembled.

The corner stone of the weekend working party of volunteers for the assembly gang was Ken Linford, an engineer and, by employment, a trouble-shooter on nuclear power installations. He revelled in the chance to work with his hands. And the normal jobs of his assistants showed the variety of talent that was recruited;

The Sales director of a Teesside engineering company

A science master

An I.C.I. Ph.D. chemist

Four instructors from the I.C.I. Engineering Training Centre

The Pro-Chancellor of a university

A second schoolmaster

Ralph Proudlock chiselling away on the oak for the tender.

and looking on, pencil and paints at the ready, was John Wigston from Hartlepool-an I.C.I. laboratory assistant normally working 100 yards from the Wagon Repair Shop.

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4 THE ENGINEERING DEVELOPMENT AND THE LOCOMOTION REPRODUCTION

Throughout the formative period from 1804, when Richard Trevithick introduced to the world his "travelling engine", until 1827 and the developments by Timothy Hackworth of the "Royal George" at Shildon, locomotives retained the basic characteristics of stationary engines on wheels. Improvements were aimed at reducing the weight to that which the track would carry without damage and, at the same time, developing boiler designs which would meet the demands for steam and. if possible, not explode in the process.

It is against these conflicting demands of lightness, strength and performance that George Stephenson's entry into the field of locomotive building in the second decade of the nineteenth century must be seen. Stephenson was brought up in a coal mining area around Newcastle upon Tyne where foundry and engineering techniques were probably much less advanced than those of Leeds, the Midlands and Cornwall, and this background must certainly have influenced his approach to his early designs. The building of a reproduction of his first engine for the Stockton and Darlington railway has afforded an opportunity to consider and analyse his problems and their solutions, many of which have recurred in 1973-1975. Locomotion, preserved in Darlington, is far removed in detail from the machine supplied to the Stockton and Darlington Railway. The boiler is the fourth, following two failures and a number of experimental changes. The wheels, axle boxes, and suspension have no resemblance to what Stephenson designed. But the general layout and principles conformed to the only surviving sketch which depicts various alternative arrangements for coupling the wheels, guiding the crossheads and operating the valves.

Until about 1827, Stephenson adhered to the traditional layout adopted by Blenkinsopp and Hedley, using vertical cylinders fed from a horizontal Cornish type shell boiler, to the underside of which were attached the axle boxes and wheels. Guiding of the piston rods tended to follow accepted stationary engine practice, using the beam and link-type parallel motion, although attempts to use rather flimsy guide bars were already in evidence. His Hetton Colliery engine of 1821 made use of guide bars, and contemporary illustrations show that others were adopting them around that time. One of the most interesting features of Locomotion is the adoption, possibly for the first and last time, of the Fremantle parallel motion system, following his earlier experience with slide bars.
Most forms of link parallel motion achieve an approximation to a straight line over certain limits of travel and the final result achieved on the reproduction come within the acceptable limits of plus or minus 0.030 inches of the cylinder axis throughout the 24 in. stoke of the piston rod. But, as it stands on Darlington

station, the original linkage would deviate from a straight line by at least 1/4 inch at the ends of the stroke, due to inaccuracies in the length of individual links and positioning of the anchor points. Thus, from the outset, the linkage of the reproduction has performed without fault, although the limitations of manufacture and ignorance of the basis of correct setting must have led to chronic failures on the original. Stephenson could well have been justified in his theory, he was defeated by lack of understanding and skills.

The original engine was proverbially short of steam and the boilers of that period had negligible margins of safety. Both these factors had to be considered when designing the reproduction.
It is recorded that Stephenson, after starting with a simple "Cornish" flue boiler, experimented with a return flue version and even fitted cross tubes to the front portion of the flue in one of the Cornish boilers. These are said to have failed, and there are two possible explanations. The first is that the techniques and skills for attaching the cross tubes to the flue walls were inadequate and the second is that, if any of the tubes were vertical, there was inadequate clearance between the tube end and the boiler shell so that sludge would restrict the circulation and result in overheating. In 1975 it was possible, by welding, to overcome the first problem. The second problem has been solved by inclining the cross tubes at 45° to vertical, with alternate left and right inclination. Thus, the introduction of cross tubes has increased the nominal heating surface from 52 sq. ft. to 72 sq. ft. and tests to date indicate a maximum steaming rate of about 800 lbs/hour.

Cornish type boilers are essentially horizontal cylindrical shells with flat ends and a cylindrical flue running from back to front through the lower half of the shell. In the case of Locomotion, all plates were 2 in. wrought iron, with all joints single lap rivetted. Stress calculations showed that the shell and flue stresses were well within the limits dictated by present day codes (excluding the rivetting), but the unsupported flat ends were subject to dangerously high stress loadings. Re-design was obviously necessary, but one of the problems was that of achieving a satisfactory stress level in the ends without making them so rigid that differential expansion of the flue and shell would lead to equally damaging local stresses. This was achieved by "breaking up" the area of the end plates into zones, each of which was independently stiffened to make it self-supporting, yet free to "breathe" in respect of its neighbouring zones. Finally, each end is an aggregate of six sub-zones, with two longitudinal flexible tie bars connecting the opposite ends. The whole structure was welded by the apprentices at Whessoe Ltd. to obviate the limitations of single rivetted joints, although the correct number of "rivet heads" have been added as a cosmetic touch. The boiler was stressed to over double the working pressure (52 lbs. p.s.i.) and subsequent deflection measurements at 104 lbs. p.s.i. showed that the end plate stress is within the elastic range at this pressure.

The vertical cylinder type of locomotive suffered from the limitations that the thrust of the connecting rods would result in deflection of the springs and, conversely,

deflection of the springs would affect the position of the pistons in the cylinder, so that relatively large end clearances would be necessary in the cylinders.

Stephenson never fitted springs to Locomotion, but to compensate for undoubtedly severe irregularities of the track, he pivotted the rear axle mountings centrally below the boiler so that it would rock relative to the front axle. No trace of this arrangement survives in the original so the decision was taken to incorporate springs in the axle box mountings of all four wheels. The static load on each spring is approximately 4,000 lbs. the maximum connecting rod thrust being about 800 lbf. By adopting a three blade laminated spring with the rate of 6,400 lbf. per inch, the vertical oscillation of the engine is limited to plus or minus 1/8 inch, with the axle box travel limited to plus or minus 1/4 inch. On modern track this has proved adequate and the ride of the engine is extremely steady.

When Stephenson built the original he adopted spoked cast iron wheels. These failed rapidly, due, no doubt, to contraction stresses in the spokes and the bending moment of the crank pins on them. Hackworth solved this problem by adopting a design of a ribbed disc wheel attributed to Wilson of Newcastle. This is a composite cast iron wheel in two parts, an inner and an outer, fixed together by wooden plugs driven into registering half-holes around the outer and inner circumferences of the two components. The type is commonly known as the plug-wheel and Hackworth remained faithful to it for some 20 years or more. Although this type of wheel overcame the failings of the earlier spoke design, the limitations of foundry techniques of the day resulted in failures of the axle and crank pin bosses. Examination of the bosses on the original revealed that they are, with the exception of the 'odd' wheel, reinforced with wrought iron shrink rings of random size and section, indicating that repairs were necessary from time to time. The ‘odd’ wheel centre (on the right hand back wheel) is almost certainly a later design and incorporates improvements from both the mechanical and foundry points of view. The wheels for the replica were cast in steel by Blackett Hutton Ltd. of Guisborough and Wilson's Foundry Ltd., at Bishop Auckland.

The limitations of the boiler in supplying steam have already been mentioned. Stephenson was obviously aware of this and there is little doubt that he designed the valves and events to achieve some degree of expansive working. As far as can be ascertained, he used a valve with 1/8inch steam lap and an eccentric advance of about 19°. Unfortunately, the valve gear on the original engine is in such a state of wear and incorrect assembly that it is difficult to ascertain what proportion of the 4.3/4 inch throw of the eccentric was intended to arrive through the 2:1 linkage at the valve as travel. Assuming that the travel was meant to be 2 inch the cut-off would have been around 92% so that the expansive working would have been very small.

On the reproduction, the layout has been brought into line with that shown on the original Stephenson sketch and lap has been increased to 7/16 in. and eccentric advance to 35°. 2 inch valve travel has been adopted, with an eccentric throw of

4.1/4 in. to compensate for slackness and deflection in the linkage. The cut-off is now 75% with admission set to 2º after dead centre. The original regulator consisted of a wing valve on the bottom of each valve chest. These wing valves were connected by rods to a double lever on the bottom of the spindle which emerged through the top of the boiler shell in front of the rear valve chest. All the mechanism was inside the boiler and, since it could only be assembled after placing the cylinders in position, it must have been necessary to remove the flue or a boiler end plate to gain access. A new regulator, consisting of a 3-part progressive disc valve was. designed. This is integral with the steam branches to the valve chest but can be inserted before the cylinders are placed in position, the joints being made within the valve chests.

Much re-design has been needed, but every attempt has been made to preserve the outward appearance in line with the original. A water gauge, two lock-up spring safety valves and a steam pressure gauge are necessary external additions, but beyond these, there is little to distinguish the reproduction from the original.

It is hoped that what has been created would be what George Stephenson would have liked had he been favoured with modern opportunities. Building and operating the reproduction has certainly heightened our respect for him.

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5. THE ENGINE COMPLETED

Throughout the winter 1974/75 assembly work pressed ahead. There were really only two serious set-backs, one on the gauge of the wheels and the other on the axle box mountings. The engine itself, as built by Robert Stephenson & Co. at Newcastle was totally non-standard. When sub-assembly drawing was started in 1973 it was found that serious dimensional incompatibilities existed. What had happened was that instead of measuring, say, every big end component, the dimensions of only one had been measured and this had been applied to the ends of all the appropriate rods. A halt had to be called while standard components were evolved so that they could be made in the required multiples and to fit the end of any rod.

When one realises the lack of continuity which attended the design for the reproduction, it is surprising that so few serious problems arose when assembling the components. The engine wheel sets were found, when finally gauged, to be suited to anyone operating a railway of 4 ft 6½ in. gauge! This was traced to an error in converting the dimension from one convention to another, resulting in the axles being 2 in. too short. This could have been a major setback to progress, but it typifies the co-operation that characterised the whole project that two new axles of the correct size appeared almost overnight and the situation was thus saved. Only one other major error, which has never been explained, was discovered just before mounting the boiler and cylinders on the axles. The mounting brackets were all 4 in. out of position. Extension pieces had to be fabricated with great speed, welded onto the brackets, and the mounting holes for the axle boxes re-drilled in situ in the correct location.

On Sunday, 23rd March, 1975. Satow phoned Wilson at 18.55 and said. "If you've got a bottle of champagne you can open it now". The locomotive had moved easily on air pressure with pistons, con rods, valves and couplings moving correctly. Wilson immediately reported the fact to Professor Higginson, the man who had acted as host at the lunch at Grey College, Durham University almost two years earlier when representatives of the Engineering Industry Training Board had been present and had offered their wholehearted support. Higginson expressed his delight and, recalling the cockshy which had been made round the luncheon table assessing the sums of money which would be involved if a reproduction were to be created, he expressed his amazement at learning that it had been built at no cost thanks to the co-operation of everybody concerned.

On Sunday 6th April, the engine steamed under its own power for the first time.

Wilson's diary records a cold day: "Up at 06.20. Drove via Durham to collect cine camera from my office and arrived at 1.C.I.. Billingham at 08.00”.

The objective was to have Locomotion towed out of the Wagon Repair Shed at 09.00 and this was achieved. However, departure for the test tracks on the east side of the works was delayed when it was discovered that the top three sections of the smoke stack which were raised as one unit could not be matched to the base of the stack and a small amount of metal needed to be cut off. A mobile crane gave assistance and soon all was well. I.C.I. locomotive Yorkshire towed us on a long British Rail flat bed truck with brake, and coupled to the Locomotion tow bar. We proceeded slowly, with overcast skies and steady drizzle.

Lit the boiler at 11.15 (using a cigarette lighter and not a burning glass as Robert Metcalf had done in 1825). Heat came slowly. Recirculated hot water from the belly of the boiler by draining it and pumping in again from a bucket. By 14.00 the boiler itself was extremely hot and there appeared the opportunity of frying eggs or fish-assuming we had any, on the metal plates but the pressure gauge was very recalcitrant and still registered zero. However, after sorting out the indicator, 22 lbs per square inch was shown and it then took a further hour to register 42-45 lbs. Both safety valves were checked by the Vulcan Insurance representative.
At 15.00 Mike got the locomotive to move. He went up and down the track for an hour or more with considerable consumption of film on the part of the spectators present: Ted Clayton. Ken Linford, Keith Pattison, Laurie Waters, John Fletcher and myself."
The tender was still incomplete and lacked wheels. The next two week-ends of feverish activity resulted in the completion of details, lagging the boiler, painting and varnishing and, finally, fitting of nameplates. The last job was completed at 08.50 on Monday. 21st April, 1975 and 10 minutes later the Anglia TV crew were in position to film the emergence of the finished engine into the chill, wet April weather. A diesel loco and a service truck with brake were coupled to the front and the ‘train’ was towed some two miles to its test track. Three hours later, with safety valves hissing, the "Locomotion" reproduction had completed its first double run over a mile track.
No faults, no drama, attended the occasion.

The engine was now moved to its home, the North of England Open Air Museum at Beamish, some eight miles south-west of Newcastle where the original locomotive had been built 150 years earlier. Frank Atkinson and his team had prepared a section of track for Locomotion, and on 15th May the replica was unveiled to the world.
A press conference was arranged by R. Brian Baird Associates of Newcastle, and Mike Satow brought the engine, in steam, to its launching platform at 11.00. There was a crowd of about 400 people present including many representatives of the press, radio and television.

Over the previous three months there had been discussion about who was the best person to introduce Locomotion to the world and it was agreed that there was no more worthy candidate than Mrs. Peggy Satow. She made a charming and excellent speech and, at the third attempt, broke a bottle of champagne on the base of the smoke stack.

On that evening on television and in all the national press the following day the story of the engine was told. While to the railway enthusiast the position of Locomotion in history is well known, to the layman it is another of George Stephenson's engines invariably associated with his name and on this occasion both the Hartlepool Mail and the newscasters of "News at Ten" on ITV fell into the trap of calling the reproduction "The Rocket"!

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6. THE 150th ANNIVERSARY OF THE STOCKTON AND DARLINGTON RAILWAY

The reproduction was closely associated with the celebrations for the 150th Anniversary of the Stockton and Darlington Railway in 1975. Throughout the construction of the engine Mike Satow had been acting as Co-ordinator for the celebrations and, through the generosity of his employers and colleagues, Lyn Wilson, from Durham University Business School, had been granted leave of absence to act as Commercial Manager for the Anniversary. "Satow & Dad" (to quote Wilson's children on S. & D.) were thus ideally placed to use the locomotive for promoting the Anniversary celebrations of George Stephenson's contribution to railway travel. The engine appeared on television; it ‘starred’ at the Great Yorkshire Show, Harrogate, 8-10th July. and obtained valuable publicity in the West Riding of Yorkshire; on 30th June it was a major feature involving the television personality, Jimmy Savile, who, a week earlier, had provided national publicity on television for the forthcoming events at the end of August at Shildon, the RAIL 150 Exhibition, 24-30th August, and the Grand Steam Cavalcade on 31st August.

British Rail, not unnaturally, test all new and prototype motive power before allowing it into service on their lines. If the reproduction was to lead the Cavalcade, it would have to demonstrate its ability to complete the course without mishap. Accordingly, a trial run over the Cavalcade route from Shildon to Heighington and back was arranged for the 23rd May 1975. The engine would be manned by a crew from British Rail and braking would be supplied by a brake van attached to the front, or downhill, end of the engine (much to the annoyance of photographers who materialised in surprising numbers!). The trial was to be slotted into the mid-day traffic, with a pause at Heighington to inspect the engine and let traffic through.

Up to this date, the engine had run less than five miles, all in short runs of a few hundred yards, so it was a considerable act of faith on the part of British Rail to turn it loose in the midst of the normal week-day traffic. No one knew how the boiler would steam, whether the solitary feed pump would maintain the water level, or how the motion and bearings would behave.
The B.R. crew, in spite of many years on 'steam' had never encountered a single-eccentric valve gear and the only person on board who knew how to drive it, Mike Satow, had no knowledge of the route or its gradients. At mid-day, under a brilliant sunny sky, the engine and its brake van were standing, with safety valves simmering (at the reduced running-in pressure of 40 lbf/sq.

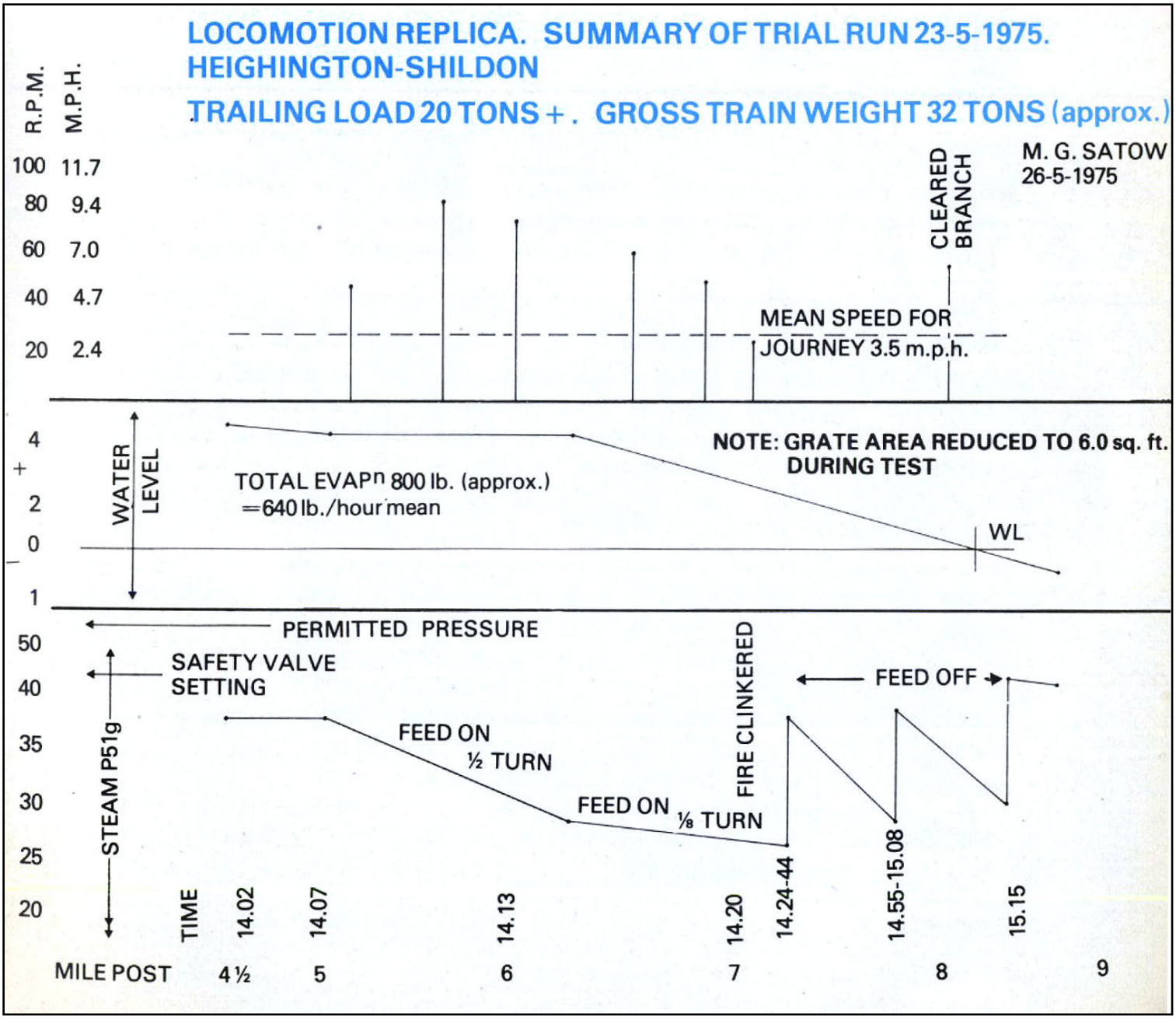
in.), at Shildon, waiting for possession of the up line. A DMU came into Shildon station and the trial was under way, with a supply of tools and oil stowed in the brake van against emergency.

Shildon to Heighington is downhill all the way and the little engine ran happily down, with two brief checks for bearing inspection, till it came to rest in the head shunt at Heighington. Here, whilst DMUs passed it, full of rather astonished occupants, a thorough check was made, with no faults revealed. So far, so good.
The return trip started off in equally fine style, but the pressure gauge soon showed that all was not well.
Two miles short of Shildon, with a steadily increasing adverse gradient, pressure was down to 23 lbs/sq. in. and progress was nominal. A halt had to be called, the fire cleaned and pressure 'blown-up'; a lengthy operation without a blower! A hesitant restart was followed by slowing progress as the gradient stiffened towards Shildon, with the headway over the following DMU scheduled passenger service rapidly dwindling to zero. A second stop, half-a-mile short of Shildon, was necessary, whilst the DMU was held at Heighington. At the following attempt, there was just enough steam to enable the engine to drag its brake van clear of the running line and into the yard, before gasping to a halt. But not often does a DMU have the distinction of being held up by Locomotion!

The trial was, in the mechanical sense, completely successful. All systems functioned perfectly, bearings remained cold and some useful data were collected on firing and boiler performance. An analysis of the data obtained on that historic run is given below. There is little doubt that, given the experience gained in handling the engine and with the full grate area in service and the full rated boiler pressure available, the engine would have made the run without stopping.
But, at least, it had qualified for its place at the head of the Cavalcade!.

LOCOMOTION REPLICA. SUMMARY OF TRIAL RUN 23-5-1975. HEIGHINGTON-SHILDON

TRAILING LOAD 20 TONS +. GROSS TRAIN WEIGHT 32 TONS (approx.)



**LOCOMOTION Concept to creation,
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7. THE GRAND STEAM CAVALCADE, 31st AUGUST 1975

The original engine had taken part in the 50th and 100th Anniversaries of the Stockton and Darlington Railway in 1875 and 1925. For the 150th Anniversary celebrations which culminated in the Grand Steam Cavalcade on Sunday 31st August, the Locomotion reproduction led 33 steam engines and British Rail's new High Speed Train in a Cavalcade along the original route of the Stockton and Darlington Railway from Shildon to Heighington.

The weather was glorious. A crowd estimated at 350,000 strong lined the trackside to witness a never-to-be-repeated occasion. Alan Pegler gave a running commentary on the superbly prepared locomotives and the Joint Committee's Souvenir Guidebook provided a wealth of information for both rail enthusiast and idle spectator.

The occasion was witnessed not only by hundreds of thousands of visitors but also by more than 500 representatives of the World's press, and tele- vision crews from 17 countries. One wondered where else, and on what occasion, more representatives of the media could have been gathered apart from a Coronation or the Olympic Games.

The engine was driven by Albert Hawman and fired by Basil Moses, both from British Rail, Darlington, under the direction of Mike Satow. The two former were wearing period costume and Mike a black and yellow uniform designed by his wife and donated by the West Auckland Clothing Co. Ltd.

At the end of the day it was recognised that the Stockton and Darlington Anniversary celebrations had focussed the attention of the world not only on the North East but also on the part played by private enterprise in preserving our transport heritage.

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8. LOCOMOTION TODAY

After Satow and Wilson's meeting in May 1973 thought was given to the ownership and protection of the reproduction in the unlikely event of it being built. There were plenty of pitfalls and time was short.

Educational, commercial and industrial organisations were rallying to give their services to the project, and it seemed desirable that the engine should be preserved and maintained for the especial benefit of the people of the North East of England, of whom so many were involved themselves or had friends who were concerned in the work.

It was therefore decided to establish a Charitable Trust. The "Locomotion" Trust. Although such a scheme seemed simple it took nineteen months to form the Trust and proceed through the regulations of the Charity Commissioners and the Inland Revenue. It must be recognised that similar projects require not only engineering skills and enthusiastic assistants but also access to ample supplies of paper, carbon paper, a typewriter and telephone!

Extracts from the Trust Deed show that the engine is owned by The "Locomotion" Trust to "advance the education of the public with regard to railways in particular by. the construction of a full scale working replica of the first railway engine to provide a service for passengers, namely. Stockton and Darlington No. 1 Locomotion, and the maintenance and permanent display and demonstration of the said replica for the benefit of the public as an item of historical technical and general interest and educational value

Other objects of the Trust are:-

"to collect donations, accept donations on special trusts within the objects of the Trust.

to encourage the education of the public in engineering, technology and the management of engineering and technology through the provision of student scholarships or lectureships or professorships at appropriate educational establishments.

to encourage the maximum participation by firms, individuals and training establishments in the design, manufacture and operation of the said locomotive

to arrange with responsible organisations the loan or hire of the locomotive for exhibitions, demonstration and educational purposes provided that when not on loan or hire the locomotive shall be preserved at the North of England Open Air Museum at Beamish in the County of Durham as a live testimony to the commercial and technical enterprise of the North East of England in the early days of the railways of the world".

The locomotive has starred in television and in a multitude of articles in the press. During 1975 it captured the imagination of the public, not only because it appears when in motion like a high-prancing pony, but also because it was built through the efforts of volunteers and industry training schemes in an era when many people equate work solely to material rewards. The Locomotion project was successful because people wanted to be involved in doing something creative even though it meant working late, as was often the case. Work was fun and vice versa.

The engine may be seen in other parts of the country, for example, during the winter at the National Railway Museum at York (sicut Hadrianus in hiberna Eboracum contendit), but during the summer it operates in steam on most weekends at its home, the North of England Open Air Museum at Beamish, some eight miles south-west of Newcastle and Forth Street, still there where George Stephenson and his team built the original "travelling engine" in 1825 for the Stockton and Darlington Railway.

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9. CONCLUSION

It will have been recognised that this endeavour to recreate Locomotion involved many organisations and many people from all walks of life, all shades of political opinion, almost all ages, and certainly both sexes. The project was conceived in a University and a Museum and, ultimately, what appeared at the outset to be a crazy idea was crowned with approval and respectability: the reproduction Locomotion was visited by Her Majesty the Queen Mother, HRH the Duke of Edinburgh, a former Prime Minister, Harold Macmillan, and the Prime Minister in 1975, Harold Wilson; the Locomotion Trust received a Certificate of Commendation in the British Tourist Authority "Come to Britain" competition 1975; and Locomotion Enterprises won a Gold Award from the Sales Promotion Executives Association in 1976 for exploiting the engine on behalf of the Stockton & Darlington Railway 150th Anniversary, the North of England Open Air Museum at Beamish, and the North East of England, while the Company was recognised by the Institute of Marketing for its "highly entrepreneurial activity".
The Chairman of the North East Development Council used the example of Locomotion an innovation in engineering and marketing pioneered through the skills and resources of engineers, managers and bankers in Northumbria in 1825 to demonstrate some characteristics of the region when giving a picture of the engine to the Russian All Union Chamber of Commerce in Moscow in 1975 as "a token of friendship from the people of North East England".

Many people especially in education-are involved in "projects" from which one may learn. These projects often involve using resources not only from educational institutions (paid for by taxpayers) but also from industry and commerce where businessmen make available their time, staff, materials, equipment and, sometimes, money itself.

While in retrospect the Locomotion project may appear ‘obvious’, and almost easy in concept and implementation, this was in fact far from the case. However, after the concept was defined and problems recognised and possible solutions examined, then people co-operated towards the venture when:-

The total project was explained to them.

The way in which their particular skills could be used was demonstrated.

Top management, if appropriate, was informed of the contribution being made.

Progress reports on the total project were made available.

People who contributed were thanked.

All over the country, in highway and byway, in garret and in tool room, in school and in college, there are worthwhile projects requiring effort and contribution from individuals and from corporate bodies.
We hope that this history of the Locomotion reproduction will offer a useful example of how benefits of many kinds may be obtained from a co-operative endeavour.

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B. Wigglesworth	Trainee	*British Steel Corporation*
J. Wigston	Private volunteer	
D. J. Wilkes	Student	*Durham University*
M. Wilks	Staff	*Laing Offshore Ltd.*
A. Wilkinson	Trainee	*Stockton Castings Co. Ltd.*
G. Wilkinson	Group Training Officer	*Whessoe Ltd.*
B. Withers	Staff	*British Steel Corporation*
C. Willson	Trainee	*I.C.I. Agricultural Division*
M. Wilmore	Trainee	*Cleveland Training Centre*
L. S. Wilson	Staff	*Durham University Business School*
R. Wolverson	Director	*Stockton Castings Co. Ltd.*
T. Wolverson	Director	*Stockton Castings Co. Ltd.*
W. G. Wood	Director	*Cleveland Training Centre*
H. Worge	Director	*Skernside Pattern Making Co. Ltd.*
M. Wynne	Training Manager	*I.C.I. Petrochemicals Division*
B. Wylie	Instructor	*Swan Hunter Training & Safety Ltd.*
M. Yates	Instructor	*South West Durham Training Association*
A. J. Yuill	Student	*Durham University*

It Can be Done

Somebody said that it couldn't be done
But, he, with a chuckle, replied
That maybe it couldn't but he would be one
Who wouldn't say so till he tried.

So he buckled right in, with the trace of a grin
On his face, if he worried, he hid it;
He started to sing as he tackled the thing
That couldn't be done, and he did it.

Somebody scoffed, "Oh you'll never do that
At least no one ever has done it,"
But he took off his coat and he took off his hat
And the first thing he knew he'd begun it.

There are thousands to tell you it cannot be done;
There are thousands to prophesy failure;
There are thousands to point out to you one by one
The dangers that wait to assail you.

But just buckle right in with a bit of a grin,
Throw off your coat and go to it;
Just start to sing as you tackle the thing
That cannot be done, and you'll do it.

Edgar A. Guest

Kindly provided by Lord Robens of Woldingham P.C., D.C.L., L.L.D., Chairman of Vickers Ltd., who learned these verses from Alderman Flowers, his employer in early life in the Manchester & Salford Co-operative Society Ltd.