'Queasy Rider:' The Failure of the Advanced Passenger Train.

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Contents.

Frontispiece: The prototype APT-P (370001) sits in the yard at the Derby Test Centre, June 1978. Only one half of the train is seen here. Source: *BR Publicity Photograph*

Abbreviations and Acronyms

AAPT	Advanced American Passenger Train
AGT	Advanced Ground Transport
APT	Advanced Passenger Train
APT-E	Advanced Passenger Train Experimental
APT-P	Advanced Passenger Train Prototype
APT-S	Advanced Passenger Train Squadron
ASLEF	Associated Society of Locomotive Steam Enginemen and Firemen
BR	British Rail
BRB	British Rail Board
BREL	British Rail Engineering Limited
CM & EE	Chief Mechanical and Electrical Engineer’s Department
TGV	*Train á Grande Vitesse*
WCML	West Coast Mainline

Introduction

When the Advanced Passenger Train (APT) was immobilised formally in 1987, all three prototype rakes were dismantled save one half set; numbered 370003. Visitors to *The Railway Age*, Crewe, can now visit this relic. Incongruously, the train that was once described by early enthusiasts as 'the Concorde of the rails' is now used to host children's parties at the aforementioned visitor centre.[1]

If you'll excuse the pun, British Rail saw the Advanced Passenger Train Project as a piece of birthday cake, yet it merely ended as the insipid icing. The APT Project highlighted British Rail (BR) as a mouldy concoction that urgently needed reform and an increase in funding.

The Advanced Passenger Train Project had its origins in the early 1960s. In 1962, Sydney Jones, Director of Research at British Rail, felt that there was a lack of understanding regarding the basic mechanics of railways vehicles, such as why locomotives derail and hunt. 'Hunting' describes the critical speed at which a train's wheel treads would slip on the rails, thus, reducing maximum speeds substantially. Gaining the support of British Rail's Chief civil engineer, it became possible to analyse and mathematically design vehicles that would be stable at up to speeds of 150 miles per hour.[2]

By 1973 the APT was seen to hold '…promise of being of great value to British

[1] Daily Telegraph, 19 March 1990, 'Wonder Train Shunted Off Into History'

Rail, the British traveller, and the economy…'[3] And certainly, the Advanced Passenger Train Experimental (APT-E) was a success. Unveiled on December 16th 1971 it achieved a new record speed of 150 miles per hour in 1975. The APT-E was delivered to the *National Railway Museum* in York the following year, retiring after clocking up some 23,559 miles.[4]

Whilst developing the APT-E, the green light was given to the Advanced Passenger Train Prototype (APT-P) and design work began as early as 1973. Although British Rail achieved remarkable success with its High Speed Train (HST) or 'Inter-City 125,' which was introduced into passenger service from 1976; the APT-P was still regarded as their saving grace. In an interview in *The Times* in 1970, British Rail's advertising executives Douglas Ellison and Derek Whithead proposed a fleet of APTs which would enter operation by 1976.[5] Yet, it was not until 1981 that the APT-P first accepted paying passengers, and less than ten years later, the only remaining prototype was shunted into a museum siding. The Advanced Passenger Train reached the end-of-the-line after a £40 million investment, and over twenty-three years of development.

With such hopes and expertise involved, why did the Advanced Passenger Train end in failure? This question is one that has never been fully answered. Written material about the APT desiccated following its failure, as an embarrassed industry and, to an extent, the British population, tried to put the vehicle at the back of their minds. Granted,

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[2] www.apt-p.com/APTWithHindsight.htm, 'APT - With Hindsight (10 December 2005)
[3] The Times, 22 February 1973, 'Was This Lame Duck A Swan?'
[4] H. Williams, *APT - A Promise Unfulfilled* (Surrey: Ian Allan Ltd, 1985), p.112

the recent reintroduction of the titling train (albeit an Italian model) on England's West Coast Main Line (WCML) has brought about slight nostalgia for the Advanced Passenger Train. However, no-one has ever properly asked, why did it fail?

Thus, I relied on primary evidence in the case of my research. The *National Railway Museum*, York offered me a wealth of source material. Also, I have sought virtually all available publicity material and technical specifics produced by British Rail. I balanced this with criticism from the contemporary news media; primarily *The Times*, *The Daily Mail* and *The Telegraph*.

I widened my research with a general look at the government's attitudes to the railways and the APT Project, primarily seeking White Papers and notable legislation. Also, having strong links with the BBC in Birmingham, I have been able to acquire several television documentaries and British Transport Films, some of which have since been deleted and are only available in their archives.

Finally, due to the recent occurrence of the APT's failure, I have relied on much oral history to aid my arguments. Many of the key players of the APT Project are still alive and their comments have been most useful. Furthermore, most of these individuals are members or are linked to the Advanced Passenger Train *Yahoo!* Group.[6] I have found this site most useful, with enthusiasts and experts on both the APT-E and then APT-P offering me advice, guidance and bridging several gaps in my knowledge.

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[5] The Times, 1 July 1970, 'Shunting British Rail To A Better Tomorrow'
[6] Advanced Passenger Train *Yahoo!* Group: an internet forum for enthusiasts of the Advanced Passenger Train. (http://finance.groups.yahoo.com/group/Advanced-Passenger-Train)

After collecting my sources, it became apparent that there are three major themes which led to the downfall of the Advanced Passenger Train. These will form the basis of each individual chapter. It seems logical to begin with the technical difficulties, for, without these, there simply would have been no clear reason to halt the success of the locomotive. The whole concept behind the APT was its innovative use of technology, but, as we shall see; the more individual innovation that goes into developing a vehicle, the more things are available to go wrong.

In Chapter Two, I will examine the internal struggle the Advanced Passenger Train faced in terms of British Rail's management structure. British Rail was clearly not ready to embrace the concept of a project team, with which the APT Project required. Operating on a more traditional 'functional' basis, it was easier to dissolve the Advanced Passenger Train in favour of the Inter-City 125. I will also consider the engineering consultancy firm, Ford & Dain, and their appraisal of the APT Project in 1981 and 1982.

In terms of funding and support, the government was crucial in the train’s success. However, when it became unlikely that the APT would sell as an export, it seemed that all was lost for the train. Furthermore, by 1982, the media had grabbed hold of the APT and every publication from *The Mirror* to *Private Eye* had poked fun at the already failing locomotive. Chapter Three, therefore, will highlight the intervention of both the media and, the contemporary government in the light of this.

Although it can be said, and I will argue this point wholeheartedly, the APT allowed complimentary and later projects to flourish, it must also be remembered that the

APT as a tilting locomotive in regular passenger service, never made it into the foray. As it stands, the Advanced Passenger Train was indeed a failure.

Chapter One - Technical Problems

During the late sixties, the British Rail passenger business was showing that rail could successfully compete with road and air, in spite of the negative aspects raised in the 1963 Beeching Report.[7] Dr Richard Beeching described BR as a crumbling network, which was not meeting the public's demands. However, timetabling enhancement, slight improvements in signalling, and track upgrading between 1962 and 1970 enabled the journey time between Manchester and London reduced from four hours and twenty-two minutes to three hours and fifteen minutes, for example. Electrification on both the East and West Coast Main routes saw passenger traffic double by 1975 from 1962 levels.[8]

Nevertheless, in 1975, British Rail was still losing £400 million each year.[9] If revenues were to be met profitably, it was felt that an even faster train was needed on the main trunk routes; one that would be cheap to build and cost effective to run. Therefore, the idea of the Advanced Passenger Train, a tilting train that could run on existing tracks, was born.

One cannot deny that the Advanced Passenger Train (or Class 370 as it was designated by BR) was superior in terms of technical achievements. British Rail told its staff in 1978 that it was '...the biggest single step in improved performance yet attempted by any railway.'[10] In terms of the Prototype version, the APT was able to tilt (or bank) up

[7] The Times, 1 July 1970, 'Shunting British Rail To A Better Tomorrow'
[8] S. Potter and R. Roy, *Design And Innovation, Block 3 Research And Development, British Rail's Fast Trains* (Milton Keynes: The Open University Press, 1986), (p.12)
[9] The Times, 14 August 1975, 'Economies Threaten Advanced Train'
[10] *Now On Test: British Rail's Best – Staff Information* (London: British Rail Board, 1976)

to nine degrees under automatic control, coaches were constructed of aluminium alloy to give a weight saving, and the passenger vehicles were fully articulated. APT was able to take curves between twenty and forty per cent faster than other trains of the time. In addition, the braking system was extremely sophisticated, using a combination of hydrokinetics and traditional treads to bring the APT to a halt. Hydrokinetic brakes work by pumping water under pressure between fixed and rotating vanes inside an axle to slow a vehicle down. It overcomes the limitations of friction brakes in absorbing and dissipating the large amounts of energy generated during high-speed braking using a cooling system. Innovations continued internally also, with air-conditioning throughout the train, and sliding power-operated doors, as well as chemical toilets; allowing one to relieve oneself even when the train was at a station stop! Yet it seemed the technology used surpassed the knowledge of the British Rail team at the Derby construction site. For, in 1982, BR admitted: ‘Experience has shown that, while the APT is a sound concept, there are rather to many novel features to be managed and developed at once…’[11] British Rail was simply not ‘advanced’ enough to handle a project of this calibre.

The most prominent of the APT-P's features was the fact that it tilted; a world first for a commercial passenger carrier. Tilting the coach bodies exactly the right amount to keep passengers comfortable when running through curves also helped to conserve power, as journey times were significantly reduced.[12] This aspect of the APT Project was crucial, as the locomotives would be running on tracks which were essentially laid down

[11] Daily Telegraph, (John Petty), 28 September 1982 ‘BR Admits APT Defeat’

150 years prior to its conception. The APT's tilting bodies were suspended on an air suspension unit carried by a swinging bolster. As each vehicle entered a curve, the tilt system measured automatically the amount of body tilt necessary to minimise side thrust, so as to maintain comfort levels. This measurement was conveyed to valves between a hydraulic pump and tilt jacks located on bogies. This process is shown in *Appendix 1*.

However, the tilting mechanism proved to be 'late' in practice, whereby sensors, which 'anticipated' the curves, were slightly delayed when compared to the actual position of the locomotive on the track. Therefore, the carriages were not tilting at exactly the same moment as the train was entering a curve. This made the ride somewhat jerky, causing problems for the APT-P's designers throughout the programme.[13] Even as late as 1981, progress round the reverse curves may have been smooth, yet there was some vertical and horizontal oscillation.[14] To cure the problems of jerkiness, sensors activating the tilt were relocated to the preceding coach. However, this was not allowed for in the original designs of the APT-P; the system was designed as a 'duplex' system, whereby two parallel sets of equipment and sensors were to be placed at the end of each coach. Therefore, should one fail, the second would continue to operate. By placing the tilt sensors on preceding coaches, there was not the capacity to provide for the full duplex system, and so one single fault could knock the entire tilt system out of action. This was due to a single link between the accelerometer (a device which measures acceleration) on

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[12] *APT-P – The Inter-City Development Train* (London: BRB, 1979)
[13] Dr. S. Potter, 'Managing High Speed Train Projects,' in J. Whilelegg, S. Hulten and T. Flnk, *High Speed Trains – Fast Tracks To The Future* (North Yorkshire: Leading Edge, 1993), pp.147-160
[14] P. Semmens, 'Practice & Performance Still Tilting After All These Years,' *The Railway Magazine*, 149 (2003) pp.44-45

one coach and the two tilting mechanisms on the following carriage. Engineers planned to rectify this problem on production trains, but, as the APT-P was to enter passenger service itself, it seemed flawed not to have overcome the problem in the research and development stage of the project. Also, the prospect of the tilt locking was a dangerous one; the carriages 'could collide in places where the gap does not allow sufficient clearance.'[15]

On the return trip of the APT-P's inaugural run in 1981 the tilting failed, 'sending food across tables, spilling drinks and jamming the electronic doors,'[16] thus, giving the media cause to nickname the APT 'queasy rider.' Famously, stewardess Marie Docherty when being asked about the jerkiness of the tilt replied; 'just stand with your feet apart.'[17] Naturally, this was disastrous for British Rail, especially following the relatively smooth previous run from Glasgow to London. Those quick to defend the APT have said that the feelings of nausea experienced on the return trip were due to BR providing excessive amounts of alcoholic beverage to the delegates before disembarking. However, such problems continued to persist on subsequent runs, suggesting the problem was more mechanical than passengers simply suffering from intoxicating liquors.

'[The British] … inherited an antiquated system. …It was as if the railway system was laid down by Angles, Dukes and Saxons. [Britain is] … a very small country and the

[15] The Times, 16 March 1981, 'New Train's Tilt Device Could Cause A Crash'
[16] Daily Mail, 8 December 1981, 'The Super Train Hits Trouble'
[17] *Ibid*

railways have to adapt to man-made and natural obstacles.'[18] Unlike France, the contemporary government was never willing to fund new railway trunk routes. Therefore, the Advanced Passenger Train seemed to be the obvious alternative; a fast, light-weight and cost-effective locomotive that could haul passengers at speeds of up to forty per cent faster than existing vehicles. British Rail were certainly willing to compromise lightly in terms of initiating a revolutionary locomotive project. For example, the French alternative to APT; *Train á Grande Vitesse* (TGV) cost in excess of £1000 million for just the Paris to Lyon line, whilst only £47 million was spent on the APT in total.[19] Although British Rail's financial state was appalling, what was the rationale in producing a cut-price revolutionary train, if it did not have adequate infrastructure to support it? One must remember that the Department of Transport had planned to spend a further £350 million on the project following a year's trouble-free service from the APT.[20] However, the irony remains; how was the APT ever able to prove itself when running on archaic tracks?

This is crucial in explaining the downfall of the APT. For the locomotive was born out of the need for a revolutionary train that could run on the existing network. The APT-P, therefore, in not being able to fulfil this proposal, was fundamentally flawed from the moment it left the assembly plant in Derby. It seems the fault, in terms of technical problems, lay with the designers. They were meant to overcome the problem of producing a train which would run on the existing network, after all. The Advanced

[18] Stephen Bayley in 'Surely Some Mistake?' *Off The Rails* (London: BBC TV, broadcast 1997)
[19] Potter, 'Managing High Speed Train Projects,' p.151
[20] *Modern Railways*, 39 (1982) p.15

Passenger Train was designed to reach the top speed of 155 miles per hour, but this was never achieved outside test conditions. When questioned over the issue, British Rail replied with further reasoning as to why the speed was restricted; 'recent analysis shows that speeds as high as 155 miles per hour are no longer commercially viable on the West or East Cast Main Line.'[21] This 'analysis' of the APT's capabilities consisted of blaming a rise in energy prices and Victorian railway engineers. In blaming 'Victorian railway engineers,' British Rail was criticising the very aspect of the railway infrastructure that the APT was meant to overcome! Certainly, many sceptics saw this as the downfall of the programme; the APT had failed to achieve its most important objective which embodied the word 'Advanced.'

At this point in 1981, British Rail persevered with the APT, as, even at 125 miles per hour, it could still reach destinations much quicker than its locomotive contemporaries. This was due to the fact that it tilted, allowing curving speeds up to forty per cent higher than existing trains.[22] However, journey times would only be decreased slightly; certainly not the dramatic reduction in speed British Rail had originally proposed for the APT. Statistics suggest it would have only saved seven minutes between London and Glasgow, compared with the journey times of the Inter-City 125's, which were already in successful operation.[23] Regardless, savings would have been made in energy terms, as the APT was much lighter than other locomotives during that time. For example, the APT-P's aluminium coaches weighed 23 tons, compared with the 32 tons of

[21] British Rail quoted in: Williams, *APT*' (p.99)
[22] Williams, *APT* (p.100)
[23] The Times, 8 December 1981,'British Rail's New Train Tops 100mph (Later It Limped Home)'

the HST's Mark II coaches.[24] However, British Rail's excuse, described above, as to why the speed was restricted is extremely vague; one must therefore question the reasons for the reduction in maximum speed.

There were further technical problems which attenuates the issue; the APT would never reach its top speed without a major reworking to the signalling and overhead line systems on, in particular, the West Coast Main Line. In essence, the overhead equipment on the WCML was only properly designed for single pantograph 100 miles per hour operation.[25] The APT contained two power cars, and so, with two pantographs, it was difficult for the trailing pantograph to pick up sufficient current following on from the first. Therefore, the decision to switch from the gas turbine used on the APT-E to the electrically powered APT-P came following the worldwide fuel crisis, which continued throughout the early years of the train's development. Also, British Rail was concerned that a British Leyland produced gas turbine would not be as cost-effective in efficiency terms compared with the Asea proposed traction from Sweden.[26] However, such a conclusion was made in 1972, and the WCML had already successfully been electrified as far as Manchester by 1967.[27] Therefore, for the designers it seemed only natural that the APT was to be powered by electrical traction, as it was more widely available from when they developed the APT-E. But, as will be explained later, by limiting the APT to electrified routes, it immediately lost out to the flexibility of the HST.

The Advanced Passenger Train as a fully working part of the railway was merely

[24] G. Freeman-Allen, 'APT – The First Ten Years,' in *Trains Illustrated,* 30 (1977), pp.71-73
[25] Pantograph: A device which conducts electricity from overhead wires to power the locomotive.
[26] The Times, 7 August 1972, 'BR Likely To Drop Leyland Engine For Super Train'

a pipedream in the late 1960's, when the WCML was electrified. Electricity was only available on select Inter City routes, and, as we have seen, the decision to power the APT via overhead wires limited the speed of the vehicle. Once again, this highlights an innovative machine working alongside redundant equipment, even if only ten years had passed since a proportion of its proposed route, the WCML, was electrified.

The APT in fact currently holds the British Rail speed record at 162 miles per hour, yet this was only achieved under test conditions.[28] When let loose on working tracks, high speeds were impracticable, as the APT had to fit into a timetable, whereby the maximum other trains would be travelling was 125 miles per hour. BR eventually restricted the APT to this speed of 125 miles per hour, the same speed at which the HSTs were travelling at. Therefore, the only way to achieve speeds faster than 125 miles per hour would have been to bypass the production of the HSTs and instead simply build a complete fleet of APTs. Yet, with the technical difficulties of the Advanced Passenger Train Prototype, this could never have happened.

Furthermore, no one seemed to wonder at the logic during the design stages in placing the two driving cars in the centre of the train. In terms of collecting current, Hugh Williams, former APT-E Train Supervisor suggests that by placing them at both ends of the rake, more current would have been able to collect than with the chosen set-up.[29] However, Peter Semmens claims that this would not be possible, as top-and-tailing the

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[27] *Electric All The Way* (London: BRB, 1976)
[28] Williams, *APT* (p.100)
[29] *Ibid*

power cars would have upset the stability of the overhead wires at the speeds at which the APT-P was designed to run.[30] Regardless, it was still the overhead wires which scuppered the prospects of high speeds. It seems the designers of the project were not aware of the limitations already in place. Also, as passengers were not allowed to pass between the two 4000 horse-powered motor cars, the train essentially became a train of two rakes, with six carriages in each. Therefore, everything within the train had to be duplicated, from buffet facilities to ticketing staff. It seems absurd that BR would allow such a luxury amidst an extremely tight budget. Hence, one would assume that Semmens' argument correct in terms of pantograph positioning.

Returning briefly to the APT's pantograph; all censure cannot be accredited to the under-developed infrastructure. One can blame this speed restriction on the designers at British Rail's Research Department. The pantograph they designed and developed for the APT-P recorded unwarranted aerodynamic uplift of the head, forcing speeds to be reduced for safety reasons. Later in the APT Project, a new pantograph was developed in conjunction with Brecknell-Willis, but speeds were still limited to 140 miles an hour.[31]

Further problems arose from the use of both traditional tread brakes and, more advanced hydrokinetic breaks. Curiously, the hydrokinetic braking system was introduced so as to allow existing signalling spacing to remain, furthering the argument

[30] Semmens, 'Practice & Performance' p.44
[31] *Ibid*

Brecknell-Willis: specialists in the field of electrification and traction for all types of transportation systems including tramways, metros and railways. The company's capability covers the design, manufacture, supply, testing, installation and maintenance of , in particular, pantographs.

laid out above.[32] By using a water and glycol mixture to create a braking effect on the train's axles, the APT could be brought down from higher speeds, within the same distance as a conventional locomotive.[33] The workings of the APT's brakes can be seen more clearly in *Appendix 2*. However, it seemed that even with innovative breaking techniques, the Research Department at BR must have over-estimated available adhesion when calculating the train's braking distances. In poor weather, the APT would not be able to make a successful stop from 155 miles per hour within the confines of the contemporary signalling network.

In relation to the hydrokinetic brakes, a bearing failure led to an axle nearly breaking. It was just one example of many failures where one set off a series of unanticipated effects. As the bearing collapsed, the brake became loose and rotated against the central part of the axle and the aluminium flange of the brake rotor. This flange expanded, so, upon cooling, the bolts holding the rotor and axle parts also became loose.[34] This incident occurred in 1980, when an APT-P was carrying a party of British Rail hierarchy staff. The problem mentioned caused the APT to derail, forcing the official launch date to be postponed whilst all three trains were checked. British Rail was certainly embarrassed by this ordeal, especially as no official records exist for the derailment at Yealand. By law, all derailments have to be logged as a Railway Accident Report; yet, the omission of this particular incident suggests the government, along with British Rail, were trying to play down the incident, so as not to cause further resentment

[32] 'APT,' *Railnews*, 208 (1980) p.4
[33] *Ibid*
[34] Potter and Roy, *Design And Innovation*, p.45

towards the project. However, surely a bearing failure suggests that there were difficulties with the manufacture of the APT, rather than just technical problems arising from poor planning, as with the tilting system? Indeed, it later emerged that the bearing failure of the 1980 derailment was mainly due to an axle simply not being tightened enough.[35] The breakdown of the APT during its third day was also caused by poor quality control; it was simply that a grommet had not been fitted correctly, leading to an electronic short.[36]

The tread brakes also proved problematic, as, during manufacture, the designed gap between the axle and the wheel could be shortened, thus leading to dragging. The design problem was that the arrangement did not relate to the standards of construction and assembly of the rail industry. Therefore, this raises the question as to whether the design of the APT was unrealistic, given the contemporary manufacturing methods and maintenance facilities. Certainly, the APT Project Team included a handful of ex-aerospace engineers. It could be suggested that the process of manufacture on the APT was not fully in touch with the world of locomotive building.[37] Mark Oakley stated that 'there are … many who do not have [practical] experience and do not appreciate the systems they are supposed to be designing for.'[38] However, there is no actual evidence as to whether or not design faults led to the failure of the APT, so one must treat Oakley's substantiation with caution. Generally, the APT design required no more special attention than earlier projects. We must, therefore, consider the workshop 'culture' of the railway

[35] http://home.clara.net/gw0hqd/bumps/180480/180480.htm, 'Railway Accidents In The Proximity Of Carnorth' (9 February 2006)
[36] Potter and Roy, *Design And Innovation,* p.45
[37] Potter, 'Managing High Speed,' p.153
[38] M. Oakley, *Managing Product Design* (London: Weidenfeld & Nicolson, 1984), pp.73-92

industry to explain the processes, which led to the technical problems of the APT.

In older, ‘medium’ industries, such as that of the railways, there was a tradition that the shop floor could modify design details using their own experience; think of it as a final check on the original design. With the APT, this tradition continued, as a number of details changed without the design office being notified. They, themselves, only discovered what had been modified during trials of the APT.[39] A prime example of this can be seen when the builders did not believe that the lightweight APT designs would work, because they were so different from the familiar diesel and steam locomotives that they had produced before.[40] Therefore, modifications were made, using older technologies and equipment.

The Advanced Passenger Train was an innovative project and the manufacturing team at the Derby workshop did not seem to realise this. They worked on it as they would with any other locomotive, rather than viewing it as a totally new concept in producing trains. The APT was not a straightforward evolutionary engineering project, but one which depended on a research-based ‘scientific’ approach.[41] The traditional ‘cut-and-try’ method of rail engineering was made redundant by the introduction of the APT as modifications had already been made in the planning stages. Clearly, design was not compatible with production facilities and standards, thus leading to technical difficulties during testing.

[39] Potter, ‘Managing High Speed,’ p.153
[40] Potter and Roy, *Design And Innovation*, p.46
[41] Potter and Roy, *Design And Innovation*, p.60

The APT was an attempt to push the potential for higher speeds on existing track, thus reducing overall costs. However, this imposed many severe, technical constraints. Virtually all the major aspects of the train had to be innovated at the same time; new brakes, lightweight construction, the tilt and so on. As well as this, all the new innovations had to function together to the tight standards of safety required by British Rail.

In terms of technical problems, two clear reasons have emerged as to why the Advanced Passenger Train became a certified failure. Firstly, the lack of funding available for the Advanced Passenger Train Project meant that an innovative locomotive was working against an archaic railway network. Without the desire and finances to improve the track, signalling and overhead wiring with which the APT-P would be running on, the train could never achieve its full capabilities. However, this is where the paradox lies; the APT-P was created on the understanding that its innovativeness would overcome the backward nature of Britain’s contemporary railway network. Therefore, it was the fault of the designers of the APT-P for not having the insight to be able to make drastic changes before initial production began. The project was clearly unworkable given the constraints as described. In essence, the compromising nature of the APT certainly leaned in favour of changing as little as possible of the existing railway network to get substantial returns.

From this, one can deduce that there was a lack of communication between the designers and those responsible for infrastructure at British Rail. If this communication were bridged then perhaps it would have been realised early on that the brief set out in

1973 was unfeasible and greater emphasis would have been placed in the Inter-City 125. For, if the APT was not able to exceed the 125 miles per hour limit, then there really was no need for an Advanced Passenger Train. Granted, it was complete with innovations like no their train, but, as we have seen; the more innovations one invests in a machine, the more scope there is available for devices to fail.

Secondly, failure was caused by poor standards of manufacture. With the Advanced Passenger Train Project, the traditional 'cut-and-try' approach to engineering should have been omitted, yet it was allowed to exist as it had done before, in an unspoken agreement. The APT was a science-led project, what with mathematical and other modelling techniques, and those that constructed it should have treated it so.

Regarding the previous point especially, one must look at the Advanced Passenger Train Project's hierarchy to determine why such methods as 'cut-and-try' were not cracked down upon by the overseeing management. If this were the case, perhaps the technology was not too advanced for the British Rail experts, as previous examples may suggest. Perhaps it was the weakness of the management behind the project that failed to tame those working alongside them, and thus, led to the failure of the Advanced Passenger Train.

Chapter Two – Inadequate Management

Following the success of the APT-E, which was overseen by British Rail's Research Department, the APT-P was placed in the hands of the company's Chief Mechanical and Electrical Engineer's Department (CM & EE). Initial work on the APT-P began in 1973. Although this was comparatively early in the APT-E's tests, the CM & EE recognised the need for major modifications as early as 1973. Therefore, APT-E was a test bed for novel suspension and braking systems, but was not intended as a pre-prototype for the APT-P.[42] With the continued running of the APT-E, the P-Train design was continually modified in the light of these results. Compared with the APT-E, the APT-P was a much bigger operation for British Rail, hence the project transferring to the CM & EE Department. So much so, British Rail enlisted the help of some thirty sub-contracting companies.[43] All the equipment was then constructed at the Technical Centre in Derby, by British Railways Engineering Limited (BREL).

Thus, the organisation of the APT-P Project was very complicated, certainly more so than anything British Rail had attempted before. The workshops in Derby also had to be modified to handle APT's advanced design, particularly in the construction of passenger vehicles using automatic aluminium welding techniques.[44] The BREL at Derby produced the units numbered 370001-006, as well as a spare driving car; numbered 370007. As will be explained, the management system was not structured well enough to

[42] Williams, *APT* p.71
[43] Potter, 'Managing High Speed,' p.151
[44] *Tomorrow's Train, Today* (London: BRB, 1980)

cope with the innovative project. Therefore, I will examine how a poorly planned executive structure also contributed to the downfall of the APT-P.

At British Rail Research, the number of people solely involved with the APT programme was thirty, but with the move to the CM & EE Department, the group grew to 140, with forty outside contractors involved.[45] At its height, the APT team constituted ten per cent of the Department's total staff at the Railway Technical Centre. This showed how important the prototype stage was, as well as the increased investment the government was willing to provide the project initially; fifty per cent of funds came direct from the Department of the Environment.[46] However, this was in 1973, when it was truly believed that the APT-Ps would be running on the WCML by 1976.[47] The place of the APT Project Team in relation to the rest of the CM & EE Department can be seen clearly in *Appendix 3*. More importantly, *Appendix 3* also shows how different the APT Project was in relation to the rest of the CM & EE's activities. As a Department, the CM & EE was organised on 'functional' lines, with various divisions responsible for different aspects of construction; such as carriage design, power equipment, brakes and so on. However, it is clear that the APT Project was treated separately, with manpower allocated for one purpose only.

The functional structure of the CM & EE Department was highly appropriate for the evolutionary engineering philosophy of Britain's railways. Work was allocated by the

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[45] Potter and Roy, *Design And Innovation*, p.40
[46] 'APT,' *Railnews*, 208 (1980) p.4
[47] *The Times*, 1st July 1970, 'Shunting British Rail To A Better Tomorrow,'

Chief Mechanical Engineer and Electrical Engineer via his senior staff to the Traction and Rolling Stock Design Engineers, and it was their responsibility to co-ordinate the specialist jobs in their sections.[48] Therefore, a train design and development job would normally just be one of many booked in and seen through the various parts of the Traction and Rolling Stock division by the Senior Engineers, under the Chief Engineer. There was no concept of allocating people exclusively to one job, or to grouping people into project teams. If this was the case, why did British Rail introduce a self-contained project team for the APT-P? At the time, the decision to transfer the APT Project Group to CM & EE, and to retain the project team structure was viewed as the best way forward to implement a radical concept within an organisation geared to an evolutionary technological process.

Kit Spackman, Tilt System Development Engineer on the APT-E states that British Rail's 'biggest single mistake' was to move the design staff from British Rail Research to the CM & EE Department. All of the development team was left behind, and thus the APT Project lost a large pool of high technological knowledge which was not replaced quickly. The CM & EE Department had 'to learn the hard way, by bitter experience.'[49]

Although Spackman's point is valid, the APT-P Project Group clearly contained specialists with skills necessary for the train's development, such as ex-aerospace engineers. However, British Rail records from the time evidently show that the specialists

[48] Potter, 'Managing High Speed,' p.149
[49] *Ibid*

duplicated the engineers' skills already in the CM & EE Department also.[50] Furthermore, no team can possibly contain all the skills and experience needed to see through the development of as major an innovation as the APT. As in all branches of industry, the team had to rely on colleagues and their bosses being aware of how they were getting on and stepping in to assist them in area of expertise and experience where this was necessary. But, the APT Project Group lacked the guidance and general support of the CM & EE Department and the accumulated railway experience that such supervision would have embodied. Hence, particularly when other parts of the British Rail organisation were involved, the APT team learnt mainly from their own mistakes, as Spackman suggests. The imposition of a project team structure served to encourage the isolation of the APT Project Group from its new department, as will be discussed later. Of course, such problems were, and are still, not unique to British Rail and the APT. Oakley, for example, discusses why departments which have a hierarchical, functional structure, to efficiently carry out routine tasks, tend to be 'mechanistic' and unsuited to activities like innovative design, which require a more flexible, 'organic' team design.[51]

Nevertheless, the transformation from research to development of the APT was especially difficult. It was a radical innovation in an industry which had long been organised with evolutionary developments in mind, such as the HST. As a radical development it required a different form of management, (for example, a project team), while the usual evolutionary design work continued in the functional departments. The imposition of one type of management on top of another caused overlaps and uncertainty

[50] Potter, 'Managing High Speed,' p.149

in the responsibilities of staff.

Given the nature of the APT Project, it is hard to see whether, in 1973, any alternative organisation for its development would have been preferable. Setting up a separate enterprise to develop the APT was certainly not acceptable. Just passing over the project to CM & EE without the project team would have produced immense problems of implementing a radical innovation in an organisational structure geared to evolutionary developments. The whole success of the APT up to this point had been due to the commitment of British Rail Research and the use of a project team, so that the implications of any one design change could be followed through in other areas.

One must remember that the APT-P was stationed at British Rail's Shields Department, near Glasgow. Shields, a working maintenance depot 300 miles from the Railway Technical Centre in Derby, where the vehicles were constructed, was not the best place to undertake development work. This was particularly so, as the prototypes faced considerable technical problems. The commissioning team lacked experience in running trains on an operational track and the staff of Shields Depot were by no means used to undertaking work on the scale that was necessary to debug the APT-P. People with a better working knowledge of maintenance depots and with experience of operating service trains would have advised against such an arrangement, no doubt. Regardless, a developed project team would not be expected to possess such experience, but would rely upon others within their department for advice. The organisational and personal isolation of the APT team within the CM & EE Department resulted in lack of such support.

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[51] Oakley, *Managing Product Design*, pp.80-81

Mistakes were made which should never have happened.

However, the management structure as described does not fully explain why there was such hostility towards the project from within British Rail. Within the CM & EE Department there was a great sense of hostility towards the staff that worked on the APT-P. Peter Plisner, BBC *Midlands Toda*y's Transport Correspondent, sums up this antagonism; 'the APT team were so hated that they were made to toilet elsewhere in the building, as their nearest toilets were in an office occupied by conventional British Rail designers.'[52] A number of key engineers viewed the whole approach of the APT as a threat to their professional reputation.[53] The APT was not only observed as a frivolous high-tech irrelevance, but as something that was a distraction to valuable staff who would do better to spend their time developing 'practical' trains. In the light of the APT's technical problems, British Rail was careful to describe the APT-P trains as pre-production prototypes; certainly by no means a definitive item of hardware.[54] Therefore, a workshop manager was led to believe that the work his team were to carry-out on the APT was perhaps more low priority and experimental than 'real' trains, such as the HST.

Regarding the High Speed Train, as a new concept in passenger train, it was a great success for British Rail. The HST came abut due to a lack of confidence on the part of the traditional railway engineers within the CM & EE Department. As has already been explained, by 1970, it was clear that the APT would require a longer development

[52] Peter Plisner, BBC *Midlands Today* Transport Correspondent; oral history interview conducted by author, 14 February 2005, 1 session
[53] Potter and Roy, *Design And Innovation*, p.47

period, with passenger service several years away. Therefore, the CM & EE Department began to canvas for a simple, quickly developed high-speed train, which, more importantly, would be fully operational within two years. They were also powered by diesel engines, allowing them to operate on lines the electrically-powered APT would not be able to.

By 1976, the HST, or Inter-City 125, was servicing Great Britain's major railway routes. For those against the APT within the CM & EE Department, the success of the HST was a major coup; to them, it proved that the traditional and evolutionary school of engineering within British Rail was just as strong as the radical and theoretical-based research being applied to the Advanced Passenger Train.

However, if it were not for the research work undertaken for the APT, the HST may never have entered the foray (certainly not as swiftly as it did) something the management were not quick to admit.[55] For example, the design of the HST was suspiciously similar to that of the APT-E, save for it not tilting. The research into suspension designs for the APT essentially created the bogies for the Inter-City 125, making high speeds possible.[56] Aesthetically, the HST also came as a fixed formation train; with double streamlined power cars located either end of the passenger coaches. In 1973, British Rail maintained that the HST and APT were complimentary, with the HST representing an 'intermediate stage' of the APT's 'technological breakthrough.'[57] Yet,

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[54] I. Allan, *British Rail Fleet Survey: 5 High Speed Trains* (London: Brian Haresnape, 1983), p.11
[55] Dr. Sydney Jones quoted in: *The Times*, (Michael Baily) October 29 1973, 'Britain's Super Train In Danger Of Being Left At The Start'
[56] *The Times*, February 28th 1990, 'Obituary: Dr. Sydney Jones, Inventor Of The Advanced Passenger Train'
[57] Dr. Sydney Jones quoted in: *The Times*, (Michael Baily) October 29 1973, 'Britain's Super Train In

ultimately the success of the Inter-City 125, which is still in use to this very day, brought about the demise of the Advanced Passenger Train. Granted, the HST marked the final development in the evolution started by Richard Trevithick, James Watt and the Stephensons, and the APT marked a way in which the railways of the world were to develop. However, if Britain was simply not ready for such an innovation, it is not difficult to see why the Inter-City 125 succeeded and the Advanced Passenger Train did not.

In the first four years of HST service, passenger numbers increased by forty percent.[58] However, according to Derek Shilton, it was not increased speed which brought about this boost in numbers. Shilton's model showed that over half the increased patronage associated with the introduction of the HST services were due to 'the quality of the coaches, the image of the HST, the extra advertising it received and perhaps an increased awareness by the public of the service on offer.'[59] The HST was indeed backed by a huge national advertising campaign, depicting entertainer Jimmy Saville, who assured the British public that "this is the age of the train."

Certainly, British Rail realised the marketing and image value of the HST. Some Inter-City 125s were used as flagships for certain routes in order to raise awareness of rail services in general, even though it may only run once a day (such as the 'Cotswold And Malvern Express')[60] British Rail were able to execute this programme with the HST as it

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Danger Of Being Left At The Start'

[58] Potter and Roy, *Design And Innovation*, p.36

[59] S. Shilton, 'Modelling The Demand For High Speed Train Services,' *Journal Of The Operational Research Society*, 33 (1982) pp.713-722

[60] Potter and Roy, *Design And Innovation*, p.37

could genuinely run on any rails within the British Isles, not requiring track modifications or overhead wires.

By 1976, market conditions had changed since the APT concept was drawn up. Therefore, it was becoming obsolete even before it has carried its first fare-paying passengers. If, with the introduction of the HST, speed was no longer a key issue, the APT was simply redundant in favour of its cheaper and simpler offspring. For, the Advanced Passenger Train was born out of a desire to reach speeds higher than ever before. Granted, by the late seventies it was agreed, due to technical problems described previously, that it would not exceed the top speed of the High Speed Train, but it would still have cut journey times. Yet, the British public now favoured modernity and comfort over speed. The HST did indeed offer slightly faster journey times that the locomotives that preceded it, but the improvement was only slight compared to the speeds the APT was proposed to reach. However, by the time the APT came into the public domain, it could only offer slightly quicker journey times than the High Speed Train and came complete with all the associated technical problems. Therefore the British public were sold on the idea of the HST; a reliable locomotive that promised and delivered within a short space of time.

British Rail quickly realised that their commercial market had shifted and, in 1976 went about a total reorganisation of the CM & EE Department, which took three years to complete. *The Observer* stated that ‘Reid [British Rail’s Chairman] has turned British Rail from being an organisation dominated by the engineers into a customer-orientated market-led business.'[61] In many ways, British Rail were only following suit with other nationalised industries, but such a decision was required in a business that was losing £400 million each year. Regardless, this shake-up damaged the APT Project Team dramatically. The 120 APT 'posts' were dispersed across the Department and the APT Design Engineer became in-charge of all Inter-City rolling stock. APT development continued, but as a project sponsored by the Inter-City sector. The APT Project went from being a tightly-knit group to being managed on the same linear-progression as the rest of the department.[62] *Appendix 4* clearly shows this dramatic change. Being a project team, following the reorganisation, the APT staff duplicated the skills already in the Traction and Rolling Stock division further than before. Similarly, they were working on a project which was despised by people who were likely to turn out to be their new bosses. Therefore, many left and obtained posts elsewhere. By 1977, the project was drained of its most capable and skilled people, just as the APT was entering the crucial testing and debugging phase. When the project required the strongest focus and greatest skill, poor relations within the CM & EE Department ensured that the resources were dissipated or lost.

Thus, by early 1982 it was clear that the Advanced Passenger Train was facing its greatest setbacks to date, further underlined by the disastrous attempts to bring it into passenger service during the previous December. In light of this, the British Rail Board approached the engineering consultancy firm of Ford Dain Research Limited to

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[61] *The Observer* quoted in R. Ford, 'Engineers Eclipsed,' *Modern Railways*, 41 (1984), pp.413-417

undertake an assessment of the technology and management of the APT Project before they decided how to proceed with the floundering locomotive. As has already been discussed, the root problems of the APT were thought to be either the technical troubles or the inadequate management. Therefore, Ford and Dain examined both of these areas.

Unlike today, few established methods existed in the early eighties for appraising large technical projects. Therefore, such appraisals tended to be based on professional experience.[63] The general approach adopted by Sir Hugh Ford, former Professor of Mechanical Engineering at Imperial College, London, and his partner Richard Dain, for assessing the APT-P, was to ask a set of critical questions.[64] They included determining what ere the aims of the project, and whether or not they were being adhered to, as well as asking if the overall system was correct in concept.[65] Ford and Dain thoroughly examined the specifications, drawings, test and operational reports and statistics on the failures of the APT. Following a discussion with all those involved in the project, their results were published.

The technical analysis of the APT Project was reported in January 1982. Interestingly, the authors concluded that the technology was generally sound.[66] They did, however, admit that certain major sub-systems were too complex to achieve the levels of reliability needed, given the finances available.[67] Furthermore, the brakes and tilt control mechanisms were criticised, with Ford and Dain suggesting that problems were dealt

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[62] Potter, 'Managing High Speed,' p.154
[63] Potter and Roy, *Design And Innovation*, p.50
[64] www.asfmra.org/join_rpra_guidelines.pdf, 'Preparation Of Technical Appraisal Review Reports' (9 February 2006), p.1
[65] Potter and Roy, *Design And Innovation*, p.50
[66] www.apt-p.com/APTWithHindsight.htm, 'APT - With Hindsight (10 December 2005)

with in an evolutionary manner, rather than simply going back to the original specifications. Regardless, the APT –P, when technically assessed, appeared to be sound in both design and in general principles.

However, their analysis of the management structure the APT Project, published in June 1983, was far from constructive. The fact that the project was slotted in to the CM & EE Department, which was organised on divisional lines (initially functional-based, but sector based following the 1980 reshuffle) was of particular concern.[68] They argued that within the CM & EE Department, the fact that the APT Project had become isolated meant that some engineers were undertaking work in areas in which they lacked experience. Regardless, Ford and Dain still favoured a task panel approach to the APT, but one that was to be substantially different to the initial set-up of the APT-P Project Team.[69]

The findings from the Ford and Dain report had an immediate effect on the APT programme. A Project management quickly emerged in 1983, which integrated both the project team and functional department models. Staff were not removed from their positions within the CM & EE Department, yet the Project Manager was given the authority to ensure his work was completed to a deadline. Essentially, the reshuffle of the APT Project saw it reformed into a matrix organisation. An example of a matrix organisation can be seen in *Figure 1* below:

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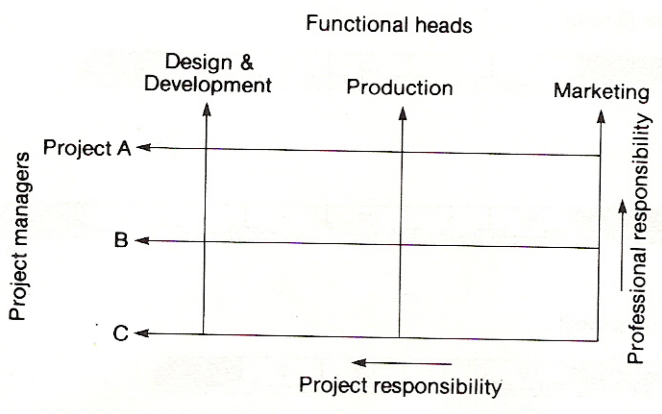
[67] Potter and Roy, *Design And Innovation,* p.48
[68] Potter, 'Managing High Speed,' p.154
[69] *Ibid*



<u>Figure 1:</u> B. Twiss, *Managing Technological Innovation* (4th edn, London: Pitman, 1992), p.241

To explain *Figure 1*, the members of a project team are responsible operationally to their project managers, whereas they also remain members of their functional departments, such as 'Vehicle Testing' or 'Bogie Suspension & Brakes,' as seen in *Appendix 4*. The matrix organisation formed existed only for new projects, and did not replace the existing organisation.[70] This matrix structure provided a more settled situation for the APT. Although internal rivalries will always exist in any large organisation, such a flexible project team structure makes the avoidance of conflict that much easier.[71]

Certainly, the Ford and Dain report had a positive effect on the APT-P, paving the way for its most prosperous period. By 1984, the APT-Ps were running more reliably than before and from August 1984, the APT saw regular passenger service as relief trains on the WCML. In December 1984, an APT covered the Euston to Glasgow run an hour and ten minutes quicker than the fastest scheduled train.[72] However, this was to be the

[70] B. Twiss, *Managing Technological Innovation* (4th edn, London: Pitman, 1992), p.242
[71] Potter and Roy, *Design And Innovation*, p.51
[72] Potter, 'Managing High Speed,' p.157

APT-P's last run on Britain's rails as a passenger carrier.[73] Why, after all the investment and reshuffling following the Ford and Dain report, did British Rail decide to finally pull-the-plug n the Advanced Passenger Train?

By 1984 the commercial requirements had changed completely. 'The APT was regarded as a train of a specific design, which the passenger business did not want, instead of a generic technology that could be applied in a variety of ways,'[74] such as the HST. Speed was no longer a priority as it had been in the 1970s, paving the way for locomotive design that was simpler and reflected commercial needs on the part of British Rail.[75] The Advanced Passenger Train was not adaptable, whereas the HST and its successor, the 'Inter-City 225,' were. With the HST able to run on almost every part of the existing network, integration of rail services was much easier. The APT proved to be too lean and inflexible a design to adapt to the commercial requirements of the 1980s. In contrast, the later-designed Inter-City 225 was conceived from the start as a 'robust' design which could be adapted to the way British Rail was evolving as a commercial force. Thus, marketing and service innovations could succeed, and were given higher priority; from at-seat service to the introduction of 'Parkway' stations on motorways at the edge of cities.

It seems that the technical difficulties experienced during the Advanced Passenger Train's development stemmed from the difficulties of managing the innovation process

[73] Semmens, 'Practice & Performance' p.44
[74] <u>*www.apt-p.com/APTWithHindsight.htm*</u>, 'APT - With Hindsight,' Professor Alan Wickens
[75] *Inter-City Into Profit* (London: BRB, 1984)

once the project moved from British Rail Research to the CM & EE Department. Traditionally, the CM & EE Department would execute a job through a functional manner, and this was only capable of evolutionary innovations, such as the HST. Essentially, the APT required an innovative management structure to match its pioneering technological status. It was exceptionally difficult, therefore, to accommodate a radical innovation project, which required organic structures, into one that managed itself in a mechanistic manner. Established procedures and staff caused major problems as many saw their positions within the CM & EE undermined or even threatened. As has been explained, these bitter rivalries halted the innovation from being developed to its maximum potential. Regarding the technical problems, it was only under a matrix organisation that the technical bugs, which blundered the APT's career, were finally eliminated. This poses questions as to whether innovation problems are really technological or whether they are a matter of the way in which the project is organised and managed. In the case of the APT, it seems that the two are complimentary. Simply, British Rail was not sufficiently 'advanced' for this project in both its handling of the technology and the management behind it.

Granted, the Ford and Dain report, aided the APT's fortunes, but it was simply too little, too late. By 1984 market conditions had changed so dramatically that there was no longer a commercial need for the original concept of the Advanced Passenger Train.

Chapter Three – The Intervention of the Government and the Media

One must consider how the contemporary governments perceived the Advanced Passenger Train, as they were the primary financers of the project, with British Rail still being a nationalised industry. Transport, as ever, played a major factor in the government's policies of the period described and in the light of the increase in internal air traffic, the resurgence of inter-city bus travel, and, in particular, motorways; the future for rail travel was bleak. Furthermore, the British media was quick to criticise the APT once cracks began to show. By manipulating public opinion, it was perhaps the final nail in the coffin of the APT saga.

Initially, one of the reasons the contemporary government was willing to support the APT Project was its export value in the many wide-open markets overseas. For example, on October 27th 1969 in Washington D. C., The Budd Company, a consortium of North American railroad companies, and the British Railways Board, signed a licensing agreement for Britain to provide the USA with a broad 'package' of technology and an operation of an Advanced American Passenger Train (AAPT).[76]

The American interest mirrored that of the need for a fast locomotive that could run on existing tracks, as in Great Britain. Yet, the British government knew that more vehicles would be required in the USA, and so there would be a greater return on their investment. However, the agreement made between The Budd Company and the British

[76] *The Advanced American Passenger Train* (London: BRB, 1969), p.1

Railway Board clearly stated that the Advanced American Passenger Train was ready to go into production in 1969.[77] This was not the case as the British APT-P only surfaced to a commercial audience in 1981. Therefore, despite three years of intensive effort, British Rail failed to penetrate the wide-open market as a marketable version of the APT was far from complete. In 1973, whilst the APT-P was merely at the design stage, the French stepped in with two advanced trains of their own.[78]

Blame for the lack of overseas success with the APT has often been placed of the railway worker's Associated Society Of Locomotive Steam Enginemen And Firemen, (ASLEF), and their strike which lasted from 26th July1972 to the 8th August 1973. Due to the single man driver configuration in APT-E's cab, ASLEF 'blacked' the train for twelve months on the grounds that they declared it to be unsafe for one person to be at the controls of a train travelling over one hundred miles per hour.[79] This, therefore, essentially brought production of the APT Project to a halt; crucial during a time when British Rail was seen as a serious provider of US exports.

However, it is unlikely that the union strike brought about the failure to penetrate the American market. Simply, the British government was not willing to invest the required amounts to push the project forward at a rate whereby a workable locomotive could be produced in the short-term. Once again, a situation was created for the APT where minimal investment was expected to give financial success. Perhaps, if the governments of the period had investment more money and manpower into the project,

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[77] *The Advanced American Passenger Train* (London: BRB, 1969), p.10

[78] *The Times,* (Michael Baily), October 29 1973, 'Britain's Super Train In Danger Of Being Left At The Start'

the long-term gains of the APT would have been rewarding, rather than a major failure.

Britain did later manage to export a high speed train in the guise of the Inter-City XPT which was introduced across the Australian states of New South Wales and Victoria.[80] However, the XPT was based on the specifications of the HST, which had already proved its success in Britain prior to its Australian launch in 1981. With fewer curves on its vast network, the HST was better designed for Australia than the APT, with high speeds being reached relatively cheaply. Certainly, the idea of selling British Rail technology abroad was high on the Labour Party's agenda in 1977; 'there are further important tasks - … to win increasing export orders.'[81] However, the Inter-City XPT only used select design features of the APT, with the Australian government rejecting the idea of introducing their own version of the Advanced Passenger Train. Therefore, as a springboard for other ideas and projects the APT was a great success, but, as a working railway export vehicle itself, it was an immense failure.

It is here where the crux of the relationship between the Advanced Passenger Train and the governments of its time lie. There appears to be a mentality of 'seemed a good idea at the time' emanating from the government; they were willing to abuse it for progressive ideas and prestige gains, but when substantial investment was required to ensure its success, the government became shy, fearing disappointment before the APT had even been allowed to fail. Again, a viscous circle was created, as British Rail was unable to demonstrate that the prototype APT could operate a reliable passenger service,

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[79] http://www.apt-e.org/main/mainline.htm, 'APT-E On The Mainline' (February 1 2006)
[80] Potter and Roy, *Design And Innovation*, p.36
[81] *Transport Policy: A Government White Paper From The Department Of Transport, Scottish*

thus making the government reluctant to consider authorisation of a fleet of production trains.[82] However, without the necessary investment initially, how were the staff at British Rail expected to prove themselves properly? Perhaps with a less haphazard policy towards transport and a greater desire to consider the fate of Britain's railways in the long-term, the APT may have had a better survival rate, in the British Isles and, possibly, abroad.[83] Therefore, one must consider the government's transport policy in the 1970s and 1980s, to see why the government did not further their investment in the APT.

Certainly, post-war, transport policy in Britain has been subject to swings of the political pendulum.[84] For example, the Labour government between 1974 and 1979 were constrained by the idea of reducing public spending. However, they strengthened the framework of support payments via local authorities, ensuring that, by 1977, only trunk road construction was the direct executive responsibility of central government.[85] Yet, in their 1974 Manifesto, they pledged to 'move as much traffic as possible from road to rail and water.'[86] However, as has been explained in the previous chapter, economic wants and needs changed drastically and in Labour's 1977 White Paper on Transport Policy, they admitted that passenger demands were so volatile that no-one could seriously predict

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Development Department and The Welsh Office (London, 1977), p.37

[82] Williams, *APT*, p.111

[83] 'APT,' *Railnews*, 208 (1980) p.4

[84] J. Farrington, 'Transport Geography And Policy: Deregulation And Privatisation,' *Transactions O f The Institute Of British Geographers*, 10 (1985), p.109

[85] *Transport Policy: A Government White Paper From The Department Of Transport, Scottish Development Department and The Welsh Office* (London, 1977), p.13

[86] N. Fowler, *The Right Track, A Paper On Conservative Transport Policy* (London, 1977) (p.37)

what was to happen.[87] Nevertheless, over the period of Labour government, between 1974 and 1979, British Rail suffered from pricing restraints, tighter investment controls and, from June 1975, cash limits.[88]

Therefore, by 1979 they claimed, 'it is not therefore immediately possible, nor is it a long term aim [to achieve such a switch from road to rail].' [89] This was an indication as to the failure of the Labour administration's Railways Act in 1974, as well as the transport obligations by government White Papers in 1961, 1967 and 1978.[90] These 'obligations' required the nationalised industries to achieve profit targets and positive rates of return from investment. The 1974 Railway Act was thought to put railways on a break-even footing, unlike previous Transport Acts, by reducing British Rail's debt to the government from £438.7 million to £250 million and increasing their borrowing power by £100 million. However, it was ultimately found to be wanting, as financial losses continued to mount throughout the 1970s.[91] Hoping to salvage the railway network with one-off, bulk payments, the Labour government had solved little, thus, hindering further investment in the rail industry. In terms of British Rail, the outcome of the 1974 Act and the aforementioned White Papers was a tighter regime expected to improve its profitability in the short-term, with less guidance from the government.

Regarding the Inter City services, which the APT was designed to operate under, passenger services were to meet all direct costs and depreciation, plus an increased

[87] *Transport Policy: A Government White Paper From The Department Of Transport, Scottish Development Department and The Welsh Office*, p.48
[88] T. Gourvish, *British Rail 1974-97: From Integration To Privatisation* (Oxford: Oxford University Press, 2002), p.21
[89] Gourvish, *British Rail 1974-97*, p.37
[90] Farrington, 'Transport Geography And Policy,' p.110

contribution to indirect costs of twenty-eight million pounds.[92] Indirect costs, in this case, provided financing for areas of British Rail which cannot easily or conveniently be attributed to individual projects or be directly identified with a specific activity, but which are nevertheless incurred as a consequence of a research project being undertaken. The government also stressed that British Rail were to cover all indirect costs by 1985, thus achieving a commercial objective. However, as has already been observed, BR was not financially adept to achieve such returns, even with the reversal of fortunes brought about by the introduction of the HST. Former British Rail Chairman Peter Parker argued that the railways were already starved of essential investment and had reached the 'crumbling edge of quality.'[93] Labour's 1977 White Paper stated that to ensure continuing investment in the Inter City programme the operation must show that it can 'pay [its] way.'[94] Yet, for a project such as that of the Advanced Passenger Train, commercial success comes second to research and development, which requires vast amounts of money.

The Conservative Party, which came into power in 1979, certainly didn't make the climate easier for the Inter City sector to achieve profits the government wanted. Their 1980 Transport Act saw the deregulation of the bus industry outside of London.[95] This Act essentially swept away fifty years of tight governmental licensing restrictions

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[91] Gourvish, *British Rail 1974-97*, p.21
[92] T. Gourvish, 'British Rail's "Business Led" Organisation, 1977-1990,' *The Business History Review*, 64 (1990), pp.122-23
[93] *Ibid*
[94] *Transport Policy: A Government White Paper From The Department Of Transport, Scottish Development Department and The Welsh Office,* p.37

and introduced competition on long distance express coach routes.[96] As a result, there was a sixty per-cent growth in passenger carriage via coach to seven million between 1980 and 1982.[97] British Rail did manage to maintain their passenger volume, but only by reducing fares. Therefore, British Rail lost a further fifteen million pounds as a result in 1980, 1981 and 1982.[98] In trying to conserve funds by privatising the coach network, the Conservative government were, in fact, causing more problems for the railways. Despite already having to compete with private car ownership and internal air travel, British Rail now had to contend with the coach operators of Great Britain, who were able to undercut their fares and offer more direct routes to cities across the country, in some cases.

Of course, with the Advanced Passenger Train being seen as crucial to the success of the Inter City sector in the long-term, the 1980 Transport Act came as a great worry; it proved that other forms of public transport were capable of providing as good a service as the railways in terms of inter-city travel. One must remember that full-scale privatisation of the public sector came much later and, at this point in time, the 1980 Transport Act was seen as a great threat to the railway network in its entirety.[99] Furthermore, with the government pressuring British Rail to achieve financial success, its no wonder the Advanced Passenger Train was rushed into premature passenger service in 1981. Clearly the technology of the train was not ready for commercial usage, yet the government was

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[95] F. Poole, *Business & Transport Section - Buses,* Research Paper 99/59, 1999, p.1
[96] J. Hibbs, *Running Buses, Who Knows Best What Passengers Want?* (London: Adam Smith Institute, 2003), p.5
[97] Farrington, 'Transport Geography And Policy,' p.109
[98] Farrington, 'Transport Geography And Policy,' p.111
[99] Gourvish, *British Rail 1974-97*, p.99

anxious to reap the benefits of what it saw as a costly and lengthy investment. This was especially so, as the HST had delivered great revenues for the Inter City sector with a much shorter production period.

However, the APT's continuing problems had a damaging impact on the investment strategy of Inter City in general, and the WCML in particular, damaging the work of the HST. In May 1980 a submission for 54 APT-S 'Squadron' trains had been made, envisaging a total investment of some £250 million.[100] However, as further delays and tension rose, a fundamental reassessment of the project was necessitated. This new strategy embraced the endorsement of a scaled-down, more conventional design for 20 units, abandoning elements of the original train.[101] Still, sceptics on the British Rail Board, mainly Sir Robert Reid, Geoffrey Myers and Michael Posner, were mindful of the need to achieve the viability for Inter City required by the government. Therefore, British Rail had realised that, in order to achieve further financial support, they must comply with what the government wanted and that was clearly profits over innovation. Therefore, in the early 1980s, the government wanted British Rail to invest elsewhere in order to achieve income on the network; conversions of locomotives to electric traction, new multiple units to replace elderly predecessors and new heavy freight locomotives. The APT-P became a victim of tightened budgets, as research and development was hardest hit.[102]

[100] *Investment Submission For Advanced Passenger Trains (APT-S) On West Coast Main Line*, P&I Committee Minutes, 16 May 1980
[101] Gourvish, *British Rail 1974-97*, (p.221)

By January 1982 the APT programme was in disarray. Although the train's problems had been reported in various railway periodicals for some time the general public was relatively oblivious to the growing crisis and continued in their long-established pursuit of confusing the APT with the HST.[103] British Rail's Press Office had been trying to create separate identities for the two trains in the public's mind with little success, until they received some unsolicited help from the Fleet Street tabloids, which started to compare the APT very unfavourably with the HST. For example, as early as 1975, calls were made by the Press to axe the APT and press ahead with the 'proved' HST.[104] Such comments continued until the APT was launched publicly, with one editorial letter calling for resources to be concentrated on the HST and halting the millions being spent on the APT.[105] However, compared with the offensive following the disastrous first run of the APT, comments like those mentioned previous came few and far between. Certainly, it was not until December 1981 that the media intervened to its full effect with the APT Project, and the public's attack began.

Any good publicity the APT might have gained on its foundational passenger run to Glasgow on December 7th 1981 was certainly ruined by the terrible return journey and all its technical problems. This was reported fully on the television news bulletins the following day, as well as in the national press. *The Daily Mail* led with 'The Super Train Hits Trouble,'[106] whilst *The Times*' headline screamed 'British Rail's New Train Tops

[102] P. Dunn, 'APT: Apt For The Eighties?' *RAIL*, 532 (2006), pp.44-45
[103] Williams, *APT*, p.98
[104] *The Times*, August 14 1975, 'Economies Threaten Advanced Train'
[105] *The Times*, (David Thomas), June 30 1980, 'Concordes Of The Rails'
[106] *The Daily Mail*, December 8 1981, 'The Super Train Hits Trouble'

100mph (Later It Limped Home).'[107] From then on things got much worse. On the second day of service the train broke down after developing a fault in the breaking system, caused by travelling at high speed in freezing conditions. Moisture had gathered in the air pressure system of the brakes and turned to ice.[108] Why anyone would choose to launch a train in the harsh conditions of winter, particularly that of 1981 is a mystery and this was something that the media was quick to criticise.[109]

The Advanced Passenger Train was also a major target for the satirists. The *Morning Star* printed a cartoon on its front page depicting the APT as the 'Advanced Labour Party,' with Labour leader, Michael Foot, in the driving seat. The caption read: 'Whoops! Can't have it tilting too far to the left.'[110] The APT also received the *Private Eye* treatment, with a picture of the train splashed across its front page and a caption reading: 'The APT arriving at Platform 4 is fifteen years late.'[111] Certainly, the APT had gone from a relatively unknown piece of British engineering to a severely-criticised piece of technology. Front-page photographs of one APT being towed away by an old diesel unit only helped to convince the public, and the British Rail management, that the Advanced Passenger Train simply wasn't reliable.[112] From then on every little mishap received the full glare of publicity, until British Rail gained itself some breathing space by withdrawing the train from service just before Christmas of that year. Certainly, the mainstream media had a tendency to criticise the railways in the 1970s and 1980s. If they

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[107] *The Times*, December 8 1981, 'British Rails' New Train Tops 100mph, (Later It Limped Home)'
[108] G. Tibballis, *Business Blunders: Dirty Dealing And Financial Failure In The World Of Big Business* (London: Robinson Publishing Ltd, 1999), p.202
[109] O. Nock, *Two Miles A Minute* (2nd edn, Cambridge: Patrick Stephens, 1983), p.175
[110] *Morning Star*, December 10 1981
[111] *Private Eye*, 18th December 1981, No. 522

weren't 'berating impregnable pork pies … they were moaning about late trains or poor rolling stock.'[113] Clearly the railways were an easy target and a subject that could antagonise the wider population. The Press, now wide-awake to a good story (which, at its heart, bore an attack on the capabilities of British Rail) started to ask the predictable questions; 'why has the project taken so long' and 'do we really need the APT?'[114] The answers they came up with did little to shed light on the situation, as they relied heavily on the British Rail press handouts, which had anticipated most of these questions.

However, one must realise that Thatcherite Britain was fragmenting by late 1981. Race-related urban violence was rife in major urban centres and UK unemployment rates had topped three million.[115] Britain was at crisis point in her domestic affairs and it seemed only logical that the Press would want to drive the Advanced Passenger Train to a premature death, as it represented yet another failure in post-war Great Britain. Furthermore, the years 1979 to 1981 were in many ways a 'phoney war' period in the relations between Margaret Thatcher's right-wing conservatism and the nationalised industries. Therefore, the exact manner in which the public sector was to be 'rolled back' remained unclear for some time.[116] With the Advanced Passenger Train Project being built by British Rail, a nationalised industry, it was essentially public money that was funding the train. Therefore, anger was increased, as many felt that the millions invested in the APT could be spent in other areas, which would benefit Britain's population more

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[112] C. Gardiner www.bbc.co.uk/northyorkshire/travel, 'To Tilt Or Not To Tilt – Part 1' (3 December 2005)
[113] Dunn, 'APT: Apt For The Eighties?' p.45
[114] Williams, *APT*, p.99
[115] www.bbc.co.uk/onthisday, '1982: UK Unemployment Tops Three Million' (10 September 2005)
[116] Gourvish, *British Rail 1974-97*, p.100

directly and in the immediate short-term. As has already been discussed, successful innovations are those which arise from or are able to create a commercial or social demand.[117] Clearly, the media had persuaded the British public that, in light of pressing domestic issues, the APT was no longer viable in the climate of 1981. Dr. Alan Wickens put it rather succinctly when he stated that "by the time the technical difficulties had been addressed, the goalposts had shifted and the momentum was lost."[118] The technology may have been improved, but clearly, the government, the media and the public were not to be swayed.

When the Advanced Passenger Train finally entered public service in 1984, the launch was not given the pomp and circumstance like that in December 1981.[119] Simply, the three full rakes entered service quietly as relief trains on the WCML. Of course, this was intentional, as British Rail and the Conservative government feared another attack from the Press. Regardless, the media response second time around was much more favourable than previously. On August 9th of that year *The Times* ran a story with the headline: 'Applause As Tilting Train Leaves The Past Behind.'[120] However, comment from British Rail, in order to cover their tracks further, was to highlight the APT still very much as an experimental train.

Perhaps it was down to the fact that British Rail were still reluctant to announce the APT as a fully-operational aspect of their network after years of development, that the

[117] Potter and Roy, *Design And Innovation*, p.63
[118] Interview: Dr. Alan Wickens, 10 April 1989, quoted in, Gourvish, *British Rail 1974-97*, (p.91)
[119] *The Guardian*, July 13th 2001, 'Wonder Train Shunted Off Into History'

vehicle's days were numbered. For, in December 1984, following a record-breaking run, the APT was withdrawn from passenger service, never to return. The damage had already been done; both the government and the media had lost faith in Britain's revolutionary train, seeing it as an unnecessary waste of money and time. Yet, once again, irony comes in to play. Perhaps, if it were not for their negative attitude toward the APT, then it may not have been the failure they predicted and, later, described. Instead, the last remaining vehicle now lays to rest at a museum in Crewe; a melancholy shadow of what it promised to the nation, and a lesson to all those involved.

[120] *The Times*, (Michael Bally) August 9 1984, 'Applause As Tilting Train Leaves The Past Behind'

Conclusion

And so we end where this dissertation began; Britain's Advanced Passenger Train becomes a museum relic, shunted alongside other locomotives, which had served for over fifty years across the railway network. For, despite nearly two decades of research and development, the APT served for less than a year as a commercial passenger carrier. It is certainly remarkable to note how close the APT came to be a success. For example, if a full fleet of APT-Ps had been built, as was originally proposed, the same approach may have been used as with the HST; whereby, high maintenance of the rolling stock was used to buy reliability. Or if the initial reorganisation of the CM & EE came some two years later than it initially did, this dissertation may have been examining the failure of the HST as opposed to that of the APT. It is remarkable to note how close the boundaries between 'success' and 'failure' are.

However, one cannot regard the APT as a total failure. Without the technical know-how gained during its research and development neither, the HST nor its successor, the Inter-City 225, would have been possible. Certainly, the technology pioneered by the APT has recently returned to the West Coast Main Line in the guise of Virgin's *Pendolino* trains. However, the Fiat Company, who modified the research carried out by British Rail for the APT, created this new fleet of tilting locomotives in Italy. It seems ironic that Britain is today essentially buying back technology it created. For, one must not forget that during its brief life as a passenger carrier, the APT was the most technologically advanced train in the world. Undoubtedly, the APT experience helped

British Rail learn many valuable lessons about how to organise and manage an innovative project. This is clearly evident by the changed approach to fast train development, as well as by the growing practice of decentralising innovative projects to the Regions and using the Railway Technical Centre as a central source of scientific and technical support. Interestingly, this ethos also filtered down into the various companies when British Rail was privatised.

Certainly, the mistake of the APT is nothing compared to those experienced by some contemporary projects such as Concorde; a technically successful aircraft whose specification had little commercial input and whose speed generated insufficient traffic to cover its development costs. Marketing models and information were not sufficiently sophisticated at the time to foresee such problems.[121] Therefore, under the circumstances, it can be said that British Rail did considerably better than most.

However, ultimately, the Advanced Passenger Train was a failure. As has been explained, radical innovation, whilst offering the prospect of various benefits, is inherently risky. It seems that there is a threshold regarding how many innovations an advanced vehicle can contain. With the APT, British Rail implemented too many for available technologies to deal with, thus creating a train that was unworkable and far from complete when it was initially launched. Launched hastily by an anxious government, who wanted quick returns on their investment, the poor performance of the APT was highlighted across the country through the print media.

It is also important to point out that the way in which innovation is addressed is

[121] Potter and Roy, *Design And Innovation*, p.53

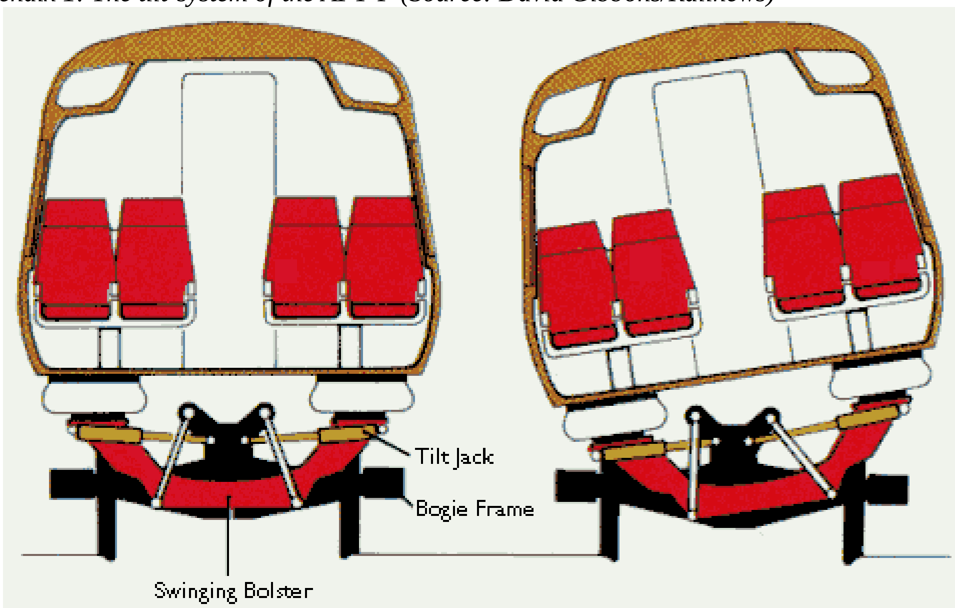
also crucial to the success of an innovative project. The engineers of the APT approached the train as they had done previous projects, using the traditional ‘cut-and-try’ method. Certainly inadequate for radical technological innovation, a more scientific approach would have complimented the initial design process appropriately. However, the poor engineering involved in the project was part of a much larger problem; that being the shortfall of the management hierarchy. It was weak at the best of times in favouring the APT Project over other developments. Also, the Advanced Passenger Train was organised within a structure which was totally alien to the way in which the Chief Mechanical and Electrical Engineer’s Department at British Rail Research was run at that time. Once again, the APT represented an innovative project operating under the constraints of an archaic system.

Above all, though, the failure of the Advanced Passenger Train can be blamed on its technological problems. Tilt system failures, poor quality breaking and an oversight on other design features meant that the APT would never become the ‘advanced’ train initially proposed. British Rail had set out to create a train like never before, which would overcome the difficulties of an archaic railway network. Yet, by forfeiting major design specifications and compromising to save money, the APT became a shadow of what it originally promised. Virtually all the chief aspects of the train had to be innovated at the same time and this way beyond the capabilities of British Rail and its staff during its two decades of development.

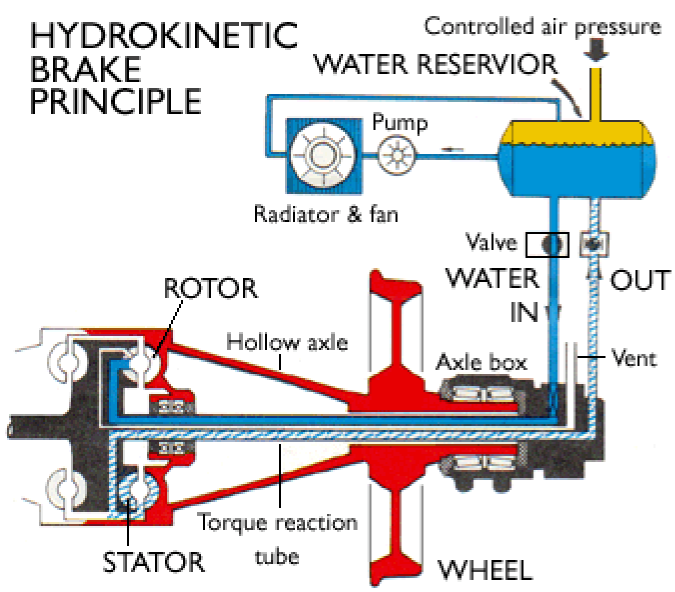
The APT was born out of a need to bring speed to a network which was not designed with speed in mind. Yet, by the time the APT finally came to fruition, commercial needs had changed; speed was simply no longer a key issue. However, more importantly, design flaws and glitches meant that the APT was unable to offer the speed it initially promised. Therefore, the APT lacked a truly innovative nature, underlying its failure above anything else. After years of trials and tribulations on the part of British Rail, ultimately they had simply created a limited passenger train. And, what was advanced about that?

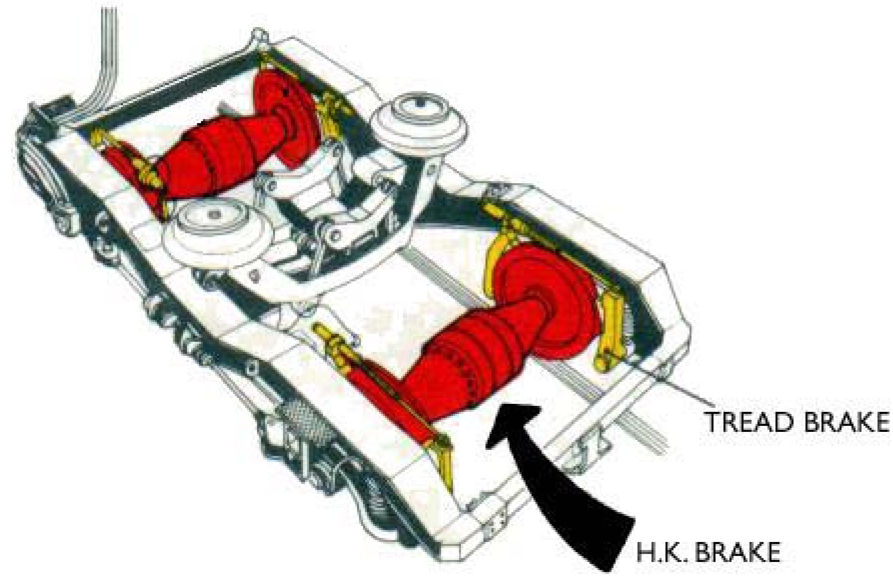
Appendix

Appendix 1: The tilt-system of the APT-P (Source: David Gibbons/Railnews)

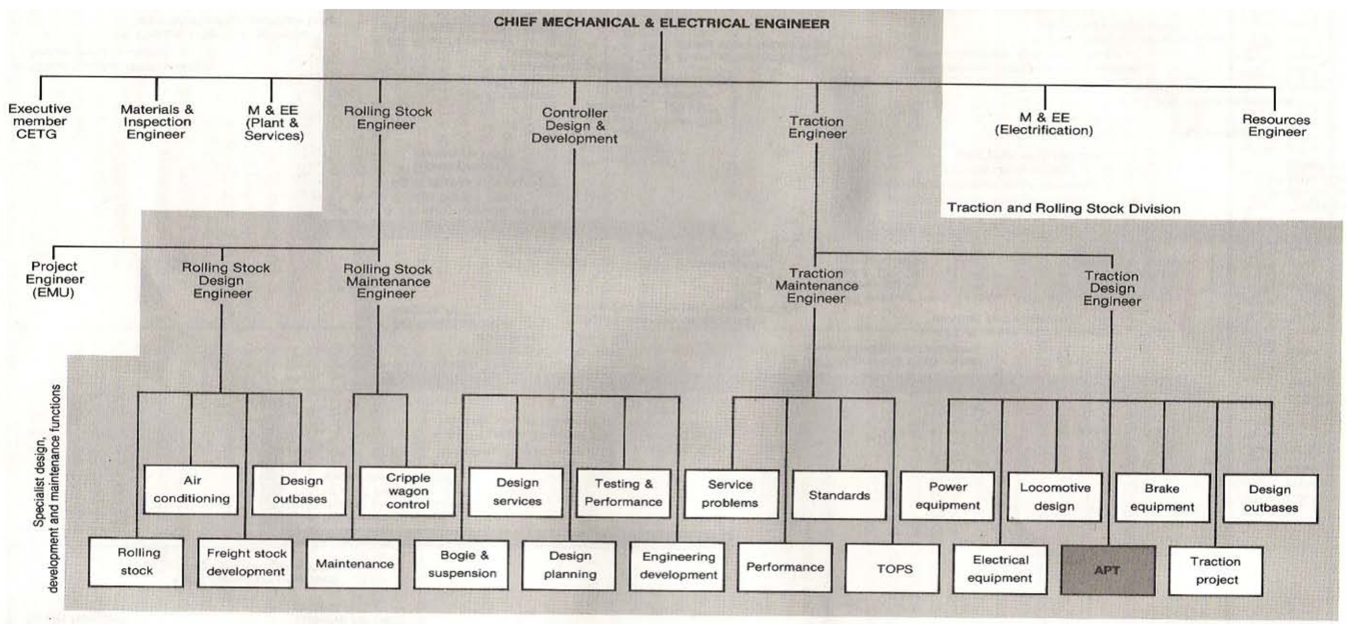


Appendix 2: The hydrokinetic and tread brakes principle (Source: David Gibbons/Railnews)

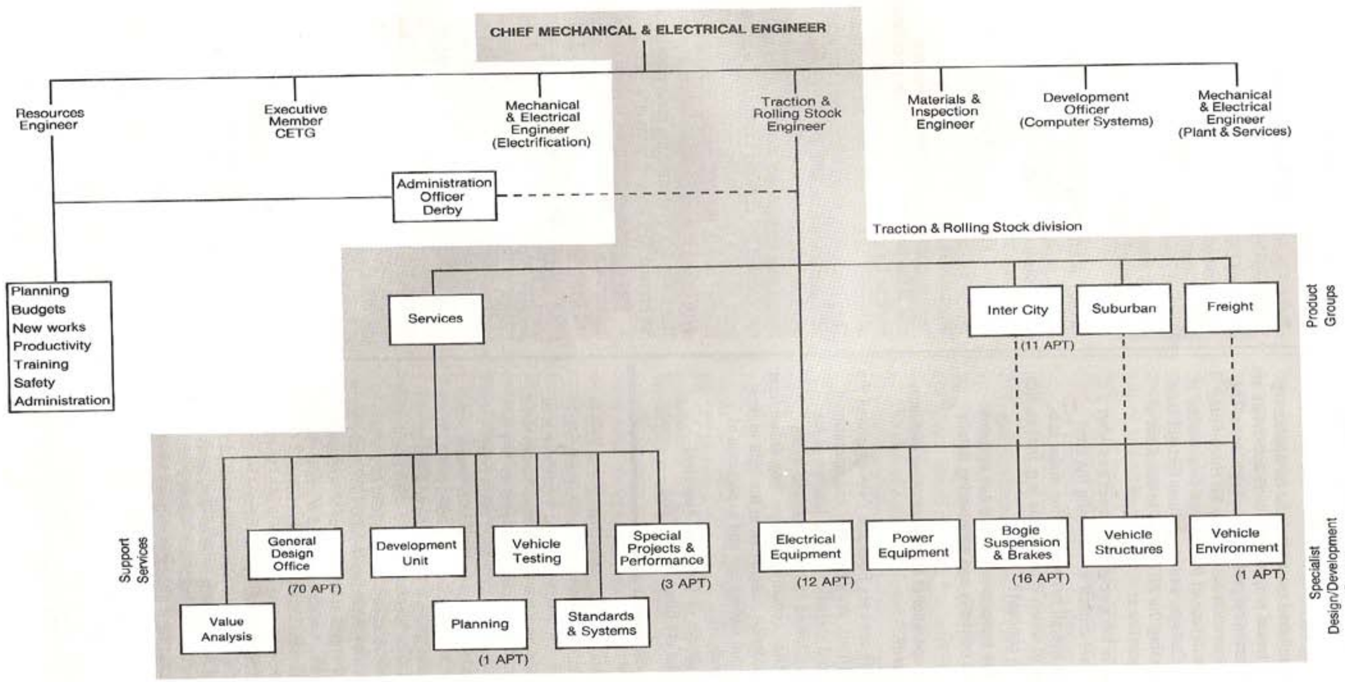




Appendix 3: The CM & EE Department as organized on 'functional' lines in 1977 (Source: British Rail)



Appendix 4: The CM & EE Department following the July 1980 reorganisation (Source: British Rail).



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