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Sydney - Canberra - Melbourne high speed train options

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Abstract

The paper reviews upgrading proposals to reduce Melbourne – Sydney freight train transit times from the Australian Rail Track Corporation National Track Audit and from an Australian Research Council project with the University of Wollongong and the Rail Infrastructure Corporation. This project included computer simulation by Samrom of trains moving over the existing 940 km Dynon - Chullora track. These results show that the running time for a standard superfreighter with 2600 tonnes trailing load hauled by two 4000 HP locomotives moving over the existing track will nearly 12 hours but the same train moving over an upgraded route with three major deviations would take about 10 hours, with a fuel saving of about 10 per cent. Coupled with a spur to North Canberra, the upgraded track could allow, with modest powered tilt trains, 2.5 hour Sydney - Canberra, 6.5 hour Sydney - Melbourne and 4.5 hour Canberra - Melbourne train services.

The provision of relatively high speed regional and inter-capital passenger services can be effectively achieved in tandem with faster and more cost effective freight trains through judicious modernisation of main line alignments. Replacement of the worst of the 100 year and older alignments with straighter and faster routes in general will shorten distances, increase track capacity, and reduce both track owner and above rail operator costs.

This paper has drawn attention to the capacity of well designed re-alignments to reduce times and has identified some the aspects operating cost reductions. The Network Audit Report has shown that faster and more reliable freight transit times can result in significant reversal of market share loss, further enhancing the benefits of improving the main line alignments. Externality gains associated with modal shift from road to rail represent significant community cost reductions. Under a rational land transport policy base, these would have a significant impact on the direction of government infrastructure spending.

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Introduction

Australia's inter-capital non-bulk land freight market was estimated by the Bureau of Transport Economics (BTE - 1999) at about 40.6 billion tonne kilometres (btkm) in 1994-95, of which 26.0 btkm was held by road and 14.6 btkm held by rail. This BTE report also notes that in 1979-80 road and rail had about equal modal shares (at approximately 11 btkm each); also, based on recent trends, that the road share would continue to grow at the expense of rail, and by 2019-20 road would have grown to 90 btkm and rail would have grown to only 26 btkm.

The inter-capital rail freight market was also given particular attention by a series of inquiries during the 1990s, including those by the former Inter-State Commission (1990), the National Transport Planning Taskforce (1995), the House of Representatives Standing Committee on Communication, Transport, and Microeconomic Reform (the Neville Committee - 1998), the Rail Projects Taskforce convened by the Prime Minister (1999), and the Productivity Commission (1999).

The Australian Rail Track Corporation (ARTC, 2001) that was formed by the Federal Government and commenced operations on 1 July 1998 released a National Track Audit in May 2001, and the Neville Committee (2001) issued a further report on rail that month. A common theme of these Federal Government inquiries, and the ARTC Track Audit, is the major finding that for rail to effectively compete with road for intercity freight, it is necessary to improve speed-weight performance on all rail corridors.

This Track Audit noted that, in 2000, some 8.4 million tonnes of interstate intermodal freight moved by road on the Melbourne - Sydney corridor, and about 1 million tonnes by rail. The Track Audit data also indicates that for six interstate corridors, the Melbourne - Sydney corridor had the largest intercity land freight tonnages, with rail having the smallest modal share. In addition, the Track Audit considered that investment at an optimised level would divert 1.04 million tonnes to rail, and investment at an S2 level would lift rail's modal share from a present low level of 11 per cent to 26 per cent. The extent of track upgrading required to meet market requirements in order to lift modal shares is outlined. This follows a brief discussion of the poor condition of the present track.

The Sydney - Melbourne track

A rail link between Sydney and Melbourne was completed in 1883, albeit with a change of gauge at Albury. Most of the NSW track was constructed under the direction of Mr John Whitton with a ruling grade of 1 in 40 with reasonable alignment. A series of deviations and duplication work in the 1910s allowed for easier ruling grades for north bound trains, but at the expense of additional track length, and the introduction of numerous tight radius curves. By way of example, the section between Goulburn and Yass was extended in length from 84.6 kilometres to 93.1 kilometres as a result of duplication and deviations.

The "new" alignment had a total of 39 curves of radius 400 metres (20 chains) or less (with 7 curves as tight as 280 metres). On the other hand, the Whitton alignment it replaced had a ruling curvature of 400 metre radius applying at only 7 curves. Indeed, M – Train simulation (Laird and Adorni-Braccesi, 1993) showed that a modern superfreighter moving over the 19th Century alignment would give transit time savings of 12 per cent and fuel savings of 12 per cent when compared with the present track.

Apart from completion of the Bethungra spiral in 1946, there was no further notable easing of grades. Except for the introduction of "transition curves", there has been no improvement in alignment by easing tight radius curves. In fact, there are no fewer than 542 curves from Glenlee to Albury (as measured from data in SRA Computer files) - literally a curve for every kilometre of track, affecting 40 per cent of the length of track. Of these curves, 348 have a radius of less than 800 metres, affecting about 24 per cent of the length of Glenlee - Albury track, and imposing speed restrictions for freight train operations. This increases train transit time and adds to fuel use.

There are some 17 km of track between Glenlee and Albury with grades steeper than 1 in 66 on curves of radius less than 800 metres, and about 182 kilometres of track that have either a grade steeper than 1 in 66, and/or curvature tighter than 800 metres (Laird and Adorni-Braccesi, 1994). The sections of track that are both steeper than 1 in 66 and have curvature tighter than 800 metres - which may be called 'red sectors' - are located between Goulburn and Junee, with 5.5 km between Goulburn and Yass, 4.4 km between Yass and Harden, and 7.1 km between Harden and Junee. The track alignment on the Southern NSW and Victorian sections of track is better

Over the years, there has been much work done by various agencies to propose improvements in the Sydney - Melbourne rail track alignment. A list of no fewer than 22 studies (updated from Laird, Newman et al 2001) follows. This list excludes the numerous studies undertaken between 1984 and 1991 for the Very Fast Train (VFT) proposal, the later Speedrail proposal, and the East Coast Very High Speed Train Study undertaken by Arup -TMG (2001b).

1975 Bureau of Transport Economics
1977 Public Transport Commission Sydney - Canberra High Speed Train
1980 Elrail report re Sydney - Melbourne Electrification
1981 Institution of Engineers, Australia Bicentennial Rail High Speed
1981 Hogan, M. Grade Improvements along the Main Southern Railway Line
1988 State Rail Authority Study re Main South Line
1989 High Speed Rail Engineers (HSRE) Fast Freight Train
1990 State Rail Authority Study re Curve Straightening on Main South
1991 National Rail Freight Initiative and Jacana Study
1993 Energy Research and Development Corporation (ERDC)
1993 National Rail Corporation: Railway Infrastructure Plan
1993 Bureau of Transport and Communications Economics (BTE)
1995 National Transport Planning Task Force
1994 Examination of the "Wentworth Route" for State Rail
1995 BTCE Report for the NTPT

1995 Sydney - Canberra Rail Corridor: Infrastructure Study (for SRA and DOT)
1995 Bureau of Industry Economics, International Benchmarking, Rail Freight
1998 Maunsell report on Operational Standards
1998 Neville Committee inquiry and report
1998 New South Wales Public Works Committee inquiry into tilt trains
1998 Booz.Allen and Hamilton, report re interstate rail track capital program
2002 ARTC National Track Audit

All studies found the need for some track upgrading. For example, Hogan (1981) found *"...most conclusively that it is economical to carry out a regrading of the line..."* between Goulburn to Junee. A further example of track investment options was given by the BTE (1993) that includes upgraded terminals, dedicated track for freight trains to Enfield, longer crossing loops (with 1500 metres now being installed), increased height clearances, and, upgraded track alignment to increase speed and reduce fuel use. Although some improvements have been made, as noted by the ARTC Track Audit, many other improvements are still awaited. These include replacement of the 1880 bridge over the Murrumbidgee River at Wagga with its 20 km/h speed restriction, and replacement of outmoded safeworking systems between Harden and Wallendbeen. It is of note that the recent Australian Infrastructure Report Card (Institution of Engineers, Australia, 2001, p24) gave the Melbourne - Sydney - Brisbane interstate line a poor F rating because of *"...steam age alignments and inadequate signalling and communciations systems".*

The ERDC project (Laird and Adorni-Braccesi, 1993) found that the poor track alignment between Sydney and Albury was a serious barrier to efficient and competitive rail freight operations. This report recommended consideration be given to upgrading the Sydney - Melbourne mainline railway by a series of deviations and minor track upgrading to ease clearances, curvature and ruling grades. Such rail upgrading, and an increase of rail's modal share of line haul freight to 50 per cent on this major corridor was found by a consultant to the ERDC project, Dr J. Thampapillai of Macquarie University, to be cost effective with a benefit cost ratio of about 1.1 as compared with 0.95 for the existing road freight dominated option.

The assumption that an 'upgraded rail freight system' could win 50 per cent of the Sydney-Melbourne freight market is due to the National Rail Freight Initiative Task Force (1991) and was on the basis of the Sydney - Melbourne rail track being upgraded to 'benchmark' standards. Economic modelling by M M Starrs Pty Ltd (2000) for an Australian Research Council project with the University of Wollongong and the Rail Infrastructure Corporation (noted henceforth as the ARC-RIC project) found that a rail modal share of 50 per cent would be possible with some track upgrading and application of mass - distance charges at a New Zealand level for heavy trucks operating on the Hume Highway.

It is also of note that rail had about 50 per cent of the Sydney-Melbourne freight market in 1970 (BTE, 1990). There are many reasons for the loss of line haul intermodal freight to road over the last three decades including some poor rail system management (largely addressed during the 1990s) and *'...substandard* *national track'* (**still to be addressed**). During this time, there has been significant improvement in the Australian road system and in truck technology. This includes the development of the National Highway System since its formation in 1974 (including the reconstruction of 86 per cent of the Hume Highway at a cost of about $4 billion in 1999 terms (Laird, Newman et al, 2001), and the introduction of B-Doubles during the 1980s. Further reasons for rail losing non-bulk freight to road include low road cost recovery from heavy articulated truck operations, and desirable upgrading of substandard national East Coast rail track still to take place.

The major challenge for rail is to offer line haul freight rates so low as to cover the cost of road pick up and delivery at each end of the rail haul, and to offer service so good that consignors will want to use it. The service factors include reliability, timing of arrival and departure of freight trains, and transit times.

The ARTC Track Audit

The Australian Rail Track Corporation (ARTC) National Track Audit includes a summary and final report with appendices by Booz.Allen & Hamilton (BA&H - 2001), a report on the Melbourne - Sydney and Sydney - Brisbane corridors by Maunsell McIntyre Pty Ltd (2001), and an Arup – TMG (2001a) report on the Inland Route.

In brief, the Track Audit reviewed the Australian Transport Council's speed weight targets, examined minimum market improvements (the S1 scenario), significant track improvements (the S2 "stretch" target scenario), and after economic analysis, recommended optimised investment of $507 million with a combined benefit cost ratio of 3.2. It is notable that BAH did not include the future savings generated from higher track capacity, which would arise from faster transit and shorter distances where routes are re-aligned.

Of the proposed optimal investment, $325 million was recommended for works on the Melbourne - Sydney rail corridor. This included a total of $146 million for Stage 1 of a Sydney Freight Priority Project, $73 million for Main South deviations, $63 million for crossing loops, $30 million for a Southern Control Optimisation Project, and $16 million to replace the 1880 bridge over the Murrumbidgee River. The ARTC Track Audit (2001, summary, p 11) identifies present Melbourne - Sydney terminal to terminal times of 13 hr 30 min. This transit time was expected to be reduced to 10 hrs 30 min on completion of the optimal capital works.

Completion of the optimal capital works was recommended whether or not the proposed Melbourne - Brisbane inland route proceeds. More information about this inland route is given by the Track Audit, the BTE (1990), Arup - TMG (2001a), and Laird et al (2001).

Investment in Melbourne - Sydney track at an S2 level of $908 million was expected to lift the modal share to 26 percent, due to increased reliability (55 to 75 to 95 percent), service availability (50 to 75 to 85 percent), and reduction in transit times (13.5 to 10.5 to 9 hrs). The main S2 projects additional to the optimised scope of works (for freight only) include:

The 'Hoare' Deviation	$300 million
Additional standard gauge capacity in Victoria	$110 million
Additional realignments and grade easing	$97 million
Sydney freight priority Stage 2	$80 million
Sub total	$587 million

The "Hoare" Deviation is noted Maunsell McIntyre Pty Ltd (2001, p65) as a new 93.3 km line between Bowning and Frampton suggested by Mr John Hoare of Concord CE Pty Ltd to the University of Wollongong as part of the ARC-RIC project. This route, at a broadly estimated cost of $300 million, would save 22.6 km in route length, could save 51 minutes for down trains, and compares favourably with a series of major deviations to bring the present Bowning - Cootamundra - Frampton track alignment to modern engineering standards.

Other major proposals noted in the Maunsell McIntyre report and examined by the ARC-RIC project include the "Wentworth" rail deviation at a cost of $218 million (for single track) reducing route length by 19.6 km, and saving an average of 19 minutes (averaging $12.2 million per minute), and, the "Centennial Deviation" between Goulburn and Yass (that is outlined by Laird and Adorni-Braccesi, 1993, 1994)). The Maunsell McIntyre report, page 52 notes the cost of the Centennial deviation as $255 million, and on page 65 the length is noted as 88.6 km. However, the amount of new construction involved between Breadalbane and Yass is approximately 68 km, which would need a revised cost estimate.

It can be seen that with $72.7 million for rail deviations in the optimal investment package, there is a total of $469.4 million in the S2 package for all rail deviations, realignments and grade easing. The major part of this is for the Hoare Deviation (item 5.21 in the Maunsell report, p 65), of all new construction at 93.3 km in length between Bowning and Frampton. The cost is broadly estimated at $300 million. The Track Audit Summary notes (p26) that *"Capital cost estimates were derived by Ove Arup and were higher than the original pre-feasibility estimates".* In addition, subsequent work for the ARC - RIC project, at the suggestion of Mr G Beasley of RIC, found that it would be more cost effective to construct a major 77 km deviation from Bowning to North Cootamundra (which could be called the Sesquicentennial route) with some realignment between South Cootamundra and Frampton. These options would also benefit freight moving from Sydney to Perth via Parkes.

The S3P option

Construction of the three major deviations (Wentworth, Centennial and Sesquicentennial) with a combined length of new construction at about 195 km, and other track realignment coupled with the other S2 projects is designated in this paper as the S3P option. It would reduce the point to point distance between Campbelltown and Junee by about 47 kilometres.

Computer simulation by Samrom Pty Ltd (2001) for the ARC - RIC project showed that the running time for a standard superfreighter with 2600 tonnes trailing load hauled by two 4000 HP locomotives moving over the existing 940 km Dynon - Chullora track was nearly 12 hours, but that the same train moving over an upgraded route would take about 10 hours. Moreover, the fuel used for this freight task would reduce from about 13, 200 litres to some 11,900 litres, a saving of about 10 per cent. Further analysis shows that about one half of this fuel saving is due to the reduction of point to point distance, and the other half is due to reduced litres per 000 gross tonne km resulting from the improved alignment.

As always, there will be some reservations about proceeding with major rail deviations when transit times can be reduced by other and less costly measures. Transit time reduction strategies as identified by BA&H (2001) are notable in that they complement rather than substitute for carefully crafted re-alignments. However, the three major deviations of total length 195 km are about 21 per cent of the current length of track between Dynon and Chullora. It is of note that the track upgrading between Brisbane and Rockhampton under the Queensland Main Line Electrification and Main Line Upgrade (MLU) projects was about 120 km or 19 per cent of the former 638 km route.

External costs

As part of the ARTC National Interstate Track Audit Booz Allen and Hamilton (BA&H - Appendix A page 24) considered *'...six external cost items of noise pollution, air pollution, greenhouse gas emissions, congestion costs, accident costs, and incremental road damage costs.'* Their estimates reflect the fact that noise, air pollution costs and congestion costs are higher in urban areas than in rural areas and are mainly based on estimates given by the BTE (1999). The BA&H estimates of externalities were used in the ARTC national interstate track audit to calculate the external benefits associated with diverting tonnage from road to rail.

These estimates may well be conservative, and the BA&H greenhouse gas estimates appear to be in error. For example, Laird, Newman et al (2001) notes the average cost of NSW road crashes involving articulated trucks at 0.5 cents per net tonne km, and gives estimates of under-recovery of road system costs from articulated trucks averaging at 1.25 cents per net tonne km. It is appreciated such estimates are assumption sensitive and subject to data limitations. More recent data from the Australian Transport Safety Bureau suggests that the average cost of road crashes involving articulated trucks in

Australia is also 0.5 cents per net tonne km (Laird, 2002). It would be desirable to have an up to date estimate for the average cost of accidents involving rail freight in Australia, and estimates of incremental rail use costs and any rail corridor Community Service Obligation type payments would also be helpful. For greenhouse gas emissions, the Bus Industry Federation (2001) considered that $40 per tonne was an appropriate value although other values could be more appropriate. (By way of example $25 per tonne approximates $NZ30 per tonne as used by Transfund New Zealand for project evaluation as noted by Austroads (2000, p13) which also discusses a range of values). Using the BA &H values, as modified above, we obtain unit external costs, in cents per net tonne km, as follows.

	Road	Rail
Rural	2.073	0.140
Metro	2.276	0.174

The net reduction of external costs was found to be $15.70 per tonne of freight moved from road line haul to rail line haul. This estimate also used a road distance of 840 km, an upgraded rail distance of 893 km, urban hauls of 50 km for each line haul mode, plus an average 25 km urban road pick up and delivery for each rail line haul

The ARC-RIC project found that assuming Melbourne - Sydney intermodal tonnages at 8.4 million tonnes in the year 2000, with a 4 per cent per annum growth rate, major track upgrading and rail gaining a 50 per cent modal share would lead to annual diesel savings of about 28 million litres by 2020. This is compared with no track upgrading and rail retaining a 14 per cent modal share, and translates to about 75,000 tonnes of carbon dioxide per annum. Other assumptions include rail having an energy efficiency of 2.7 Megajoules (MJ) per ntkm on existing track and 3 MJ per ntkm on upgraded track, along with 77 MJ for road pick up and delivery when rail line haul is used, and line haul road having an energy efficiency of 1 MJ per ntkm (with 38.6 MJ per litre of diesel).

The T line

In 1981, the National Committee on Railway Engineering of the Institute of Engineers, Australia (now the Railway Technical Society of Australasia) published a "Bicentennial High Speed Rail Proposal" report. This report outlined the option of a "T - Line" which includes a new railway from Breadalbane to Yass with a spur to North Canberra. The "T - Line" envisaged a ruling curvature of 1200 metres to allow for 160 km/hr train operation.

The benefits included faster rail freight services and a potential 3 hour Sydney - Canberra XPT service and a 6.5 hour Melbourne - Canberra XPT service. It is now worth revisiting the "T - Line" but with the use of tilt trains instead of XPTs.

The "T - Line" location, when viewed travelling south west from Goulburn, leaves the existing railway near Breadalbane, and crosses the Cullerin Range at a saddle. This saddle is at an altitude of about 740 metres and is now used for the new Cullerin Range freeway deviation completed in 1993 and for electrical transmission lines. After crossing this saddle, the line would then take the higher ground to join the existing railway at the Mundoonen Range. A spur line of about 40 km would start in the vicinity of Mt Dixon to North Canberra. The "T - Line" option is a combination of the Centennial deviation and the spur line to North Canberra.

Use of the "T - Line" would also have advantages over the present line through Queanbeyan for the movement of freight (mostly liquid fuel) between Sydney and Canberra.

Tilt trains

Tilt trains are widely used in Europe and Japan where traffic densities do not warrant the construction of new high track for trains such as the TGV or Shinkansen. Following the Queensland Main Line Upgrade in the mid 1990s for faster and heavier freight trains, Queensland Rail has operated since 1998 a successful Brisbane - Rockhampton electric tilt train service. By March 2002, this service had carried its one millionth passenger, and along with securing strong patronage growth had brought many regional benefits. Queensland Rail in 2003 is due to commence a diesel tilt train service to Cairns. Also, in 2003, a new Prospector is due to enter service between Perth and Prospector whilst the Victorian Government in 2001 awarded a contract to construct 29 high speed train sets. NSW intercity rail passengers will rely on 20 year old XPTs, albeit with new motors, for some years to come.

Coupled with the Wentworth and Sesquicentennial deviations, and other minor track straightening, SimTrain showed that the “T – line” could allow, with modest powered tilt trains with a maximum speed of 200 km/h, the introduction of 2.5 hour Sydney - Canberra, 6.5 hour Sydney - Melbourne and 4.5 hour Canberra - Melbourne train services. The same trains on the upgraded track would take 1.75 hours between Canberra and Wagga Wagga.

Conclusions

The provision of relatively high speed regional and inter-capital passenger services can be effectively achieved in tandem with faster and more cost effective freight trains through judicious modernization of main line alignments. Replacement of the worst of the 80 year and older alignments with straighter and faster routes in general will shorten distances, increase track capacity, and reduce both track owner and above rail operator costs.

This paper has drawn attention to the capacity of well designed re-alignments to reduce times and train operating costs. The Network Audit Report has shown that faster and more reliable freight transit times can result in significant reversal of market share loss, further enhancing the benefits of improving the main line alignments. Externality gains associated with modal shift from road to rail represent significant community cost savings. Under a rational land transport policy, these would have a significant impact on the direction of government infrastructure spending.

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