Selecting the Route

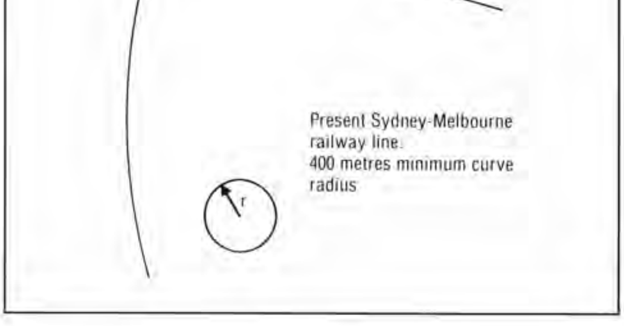
One of the questions asked most often about Australia's Very Fast Train is: "Why do you need a new line — why not upgrade the present line between Sydney and Melbourne?"

That's a reasonable question to ask. In fact, when CSIRO scientists were first investigating the prospects for a faster train service between Canberra and Sydney late in 1983, they did not assume that a completely different alignment[1] would be needed. But they were soon to discover that alignment was the key to higher speeds, and that the New South Wales State Rail Authority's recently-introduced XPTs were capable of much higher speeds than they were reaching. This realization was borne out later in the VFT project with the help of a powerful computer program. It showed that if one of the latest French high-speed trains were run on the Sydney-Melbourne railway line in competition with an XPT, the difference in their transit times would be quite small.[2] Great advances in speed could not be made without a much straighter line than the present one.

The limitations of the present line

The sharp curves on the present Sydney-Melbourne railway line came about because of the need to keep costs down while still allowing trains to haul useful loads. If the line had been built with gentle gradients, many more earthworks would have been needed: "cuts," involving removal of rock from the tops of hills, and "fills," involving rock piled into embankments in the gullies between. Alternatively, steep gradients would have severely limited the load which trains could have pulled. The sharp curves that resulted from this 19th-century cost/performance trade-off allowed trains to snake around the contours of the land, slowly gaining height with a minimum of earthworks.

Comparison of Ruling Curves: VFT and Conventional Rail



Such compromises were perfectly acceptable in the 19th century. At the time of construction of the line from Melbourne to Sydney — from the 1850s to 1883 — steam trains competed against stage-coaches and small ships. In 1878, there was a 208 km gap between the rail-heads at Albury and Bethungra which had to be traversed by stage-coaches. Train travel over the rest of the route took 20 hours of a total journey of about 60 hours. That was a great improvement on the time by stage-coach alone: coaches took 6½ days, running virtually non-stop in relays. In 1883, when the lines finally met[3] at Albury, the journey time was 19 to 20 hours. Needless to say, the difference in comfort was an enormous improvement on horse-drawn transport.

Nowadays, diesel-hauled trains cover the 960 km of track in 12½ to 13 hours. Their average speeds are 74 to 77 kilometres per hour. Whereas travellers of 100 years ago could afford the time for such journeys, very few people nowadays can do so: the scarce commodity in the late 20th century is time. As a result, trains on the present Sydney-Melbourne railway line are not well patronized.

A new plan

An early conclusion of the CSIRO team, based on research on choices made by travellers in France and Japan, was that if fast rail can produce journey times of not more than three hours, it would be highly competitive with air travel. Consequently, the VFT was specified to travel between Sydney and Melbourne in three hours. To achieve that transit time, the average speed needs to be 290 km/h and the maximum speed 350 km/h.

The key to such high speeds is to have very gentle curves: the tightest had to be no less than 7 kilometres[4] in radius. By contrast, curves on the existing

1 Alignment: the line's actual location on the route. Alignments of existing lines often have tight curves, which must be increased for high-speed running.

2 The French TGV would not, in reality, be able to run on the Sydney-Melbourne line, because the line is not electrified. The computer program analysed more than a dozen variables in XPT and TGV performance and applied them to the characteristics of the line between Junee and Cootamundra (i.e., to each curve, each gradient, each signal etc) to obtain the result of what would have happened if the two trains were able to run on that section of the line.

3 The lines did not actually join, although they were on either side of the same platform — they were of different gauges. At the time, Victoria charged customs duty on 333 categories of goods; only 8 items were duty-free. Customs inspection was carried out on the platform between the two trains. Nowadays, apart from a single standard-gauge (1435 mm) line between Albury and Melbourne, all main line in Victoria is still broad-gauge (1600 mm).

4 A "desirable minimum" of 8.5 kilometres was specified subsequently.

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Depending on terrain, the strip of land required for the VFT may be as narrow as 40 metres in width. Agriculture can proceed undisturbed alongside the railway alignment, as shown in the picture of a TGV in France. – photo SNCF

Sydney-Melbourne railway are often as tight as 400 metres radius: about 18 times sharper. Figure 1 illustrates the difference between these radii.

Clearly, the alignment of the present Sydney-Melbourne line was irrelevant to the VFT's alignment. It would be necessary to build a totally new alignment for the VFT in the high-speed section of the line outside the Sydney and Melbourne suburbs.

Early in the project, Dr Wild's team decided that, since they had to start from scratch, it made sense to have the line serve the national capital: Canberra lies on a straight line drawn between Melbourne and Sydney.

With the fundamental question of minimum curve radius determined, it was decided that the general philosophy for selecting the route would be:

- to build the line as straight as possible between Sydney and Canberra and between Canberra and Melbourne, but
- to avoid passing directly through intermediate towns so as to cause a minimum of disturbance to them — stations serving towns en route would generally lie a few kilometres out of town.

The detailed process

The first step in selecting the VFT's route was to study maps with a scale of 1 in 100,000 (1 cm to the km) to define a general corridor with desirable topographical[5] and environmental characteristics. The next was to fly along the corridor and take stereo photographs[6] along its length. A number of surveyed ground marks then related these photographs to the national coordinate grid system. From the photographs, a strip corridor — on average about one kilometre wide — was mapped to form a "digital terrain model." Established in a computer, it is a representation of the shape of the ground — the topography — and includes roads, railways, buildings, fences, dams, power lines and so on. Because the terrain model is in digital form, maps of the corridor can be produced to any scale. For the VFT alignment a scale of 1 to 25 000 was chosen.

There is a particular advantage to using a digital terrain model in a computer to analyse the various options for the alignment: it is very flexible in testing out different routes in the corridor of interest. Rather than taking only one set of measurements as in traditional surveys, a large array of reference points is used. By including features like property boundaries, roads and dams, questions such as "Can we avoid these farms? Can we intrude less on the run-off area for this dam?" can be answered.

This method of route selection is very different from the traditional way of selecting routes for railways and roads: a route would be fixed in the drawing office, surveyors would take field measurements, and engineers would calculate the volume of earth to be removed for cuts and fills. Decisions stopped there, with almost no prospect of varying the route as a result of local knowledge — except by starting the process all over again. The whole process was enormously slow, cumbersome and costly.

Under the process used by the VFT, once a tentative route is selected, the corridor is examined for critical sites, such as:

- environmentally sensitive areas — e.g. national parks and localized wooded areas of the kind that provide important natural habitats for animals,
- socially sensitive areas — e.g. houses, buildings, existing roads, railways, power lines, historical sites, aboriginal artifacts,
- topographical, geological and hydrological features to be avoided, and
- bridge sites that would have the lowest potential

5 Topography: the definition of the physical features of a locality, i.e. the shape of the land.

6 Stereoscopic photography is a process of taking two photographs of the same object, from different viewpoints. When seen through stereoscopic viewers, the photographs give a three-dimensional view of the object photographed; they have much the same "depth" that we see when looking at the actual scene. That is because the process duplicates our everyday experience, in which our eyes view things from slightly different positions. They are much better, therefore, for helping to make decisions about the alignment — especially when used with modern computer-based digital terrain imaging equipment.

to disrupt water courses and to cause siltation and erosion.

An alignment is then calculated with the aid of the digital terrain model which:

- avoids, as far as possible, environmentally and socially sensitive sites and adverse topographical, geological and hydrological features;
- passes through the most favourable bridge sites;
- has a minimum horizontal radius of 8.5 kilometres wherever possible;
- takes account of the need for overpasses and underpasses for both humans (roads) and animals; and
- subject to a maximum vertical curvature of 22.2 kilometres and a maximum grade of 3.5 percent, minimizes earthworks — keeping down not only costs, but also disruption to the countryside by cuttings and embankments.

The alignment nominated in this way becomes part of the body of the VFT Feasibility Study report, which is to be made available for public comment before the final approval process is undertaken.

The men and women responsible for the detailed process of selecting the route are dedicated to finding the most acceptable route from all points of view: social, environmental, hydrological, structural, etc. From their experience, they are acutely aware of the high degree of concern held by people living in selected corridors and by those who have particular environmental and cultural interests at heart. The VFT Joint Venture is committed, of its own initiative, to extensive public and individual consultation. That said, it must be acknowledged that the need to restrict curves to a minimum radius of 8.5 kilometres will, at some locations, pre-empt all desirable conditions being satisfied simultaneously. The aim of the VFT Joint Venture is to select alignments in which such conflict is at a minimum; to make adjustments to alignments as sensitively as possible; and to take special measures to resolve particular problems — each on an individual basis.

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