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Planning for affordable transit infrastructure and service expansion: two European case studies

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Abstract

Public transport use in Melbourne and Sydney was stagnant or in decline for many decades. Recently, more positive trends have emerged. These new demands challenge current service planning paradigms. Public transport in both cities faces an alleged ‘capacity crisis’, with planning agencies arguing that huge infrastructure investments are essential for further patronage growth.

This paper provides case studies of two well-established planning processes from German-speaking Europe that offer the potential in the Australian urban context for the development of more affordable plans for infrastructure expansion and improved efficiency in the use of existing operating budgets.

The first case study is the planning framework used by the Swiss Federal Railways since 1990 in the *Rail 2000* and *Rail 2030* programs. Known by its practitioners as a ‘planning triangle’, this framework uses an iterative process to identify the cheapest infrastructure investment required to deliver a desired level of service.

The second case study explores the process used to maximise returns from expenditure on high-quality bus services in the City of Munich over 10 years from 2002. Called *TopBus*, this project of the Munich municipal public transport operator (MVG) has seen a progressive increase in investment in service-kilometres. Increases in revenue have exceeded the costs of this investment. This has been achieved through the iterative development of a network of high-quality bus services providing effective links between key interchanges.

Together the case studies allow us to begin to articulate a new paradigm to frame understandings of requirements for public transport planning in Australian cities.

This work is part of an on-going ARC Discovery Project that is seeking new ways to meet the challenge of continuing growth in demand for public transport in Melbourne and Sydney.

1. Introduction

Public transport use in Melbourne and Sydney was stagnant or in decline for many decades, but in recent years positive trends have emerged (Mees and Groenhart 2012). Citizens and governments are increasingly voicing support for expansion of urban public transport systems. There are many reasons for this focus. These include problems of road congestion or train crowding; the international attention created by staging a major sporting or cultural event; or a desire to open a corridor or locality to more intense development. This new environment is setting new challenges for planners and testing current service development paradigms.

All too often, the political and technical debate on the complex planning questions that surround the revitalisation of public transport is reduced to conflict over a single, costly piece of infrastructure. Even within the sphere of transport planning, the task of delivering new urban public transport is obviously more complex than just designing and delivering new track and stations. Other essential components include the creation of efficient and effective service operating patterns, and appropriate choice of rolling stock. These matters get scant attention when a single infrastructure ‘solution’ dominates political and technical debate.

Large infrastructure investment is hard to come by, and it must be used in ways that will optimise patterns of service supply and allow for the greatest efficiency in the use of future operational budgets. To do this, the ideal patterns of supply must be clearly stated and the case for new investment closely linked to the intended supply outcomes. This is clearly not the case in Australia: the intended timetables and service operating patterns for the Melbourne Regional Rail Link, a project with a cost of $A5 billion, had still not been publicly announced in May 2013, a year after construction began.

This paper extends our previous contributions to the debate on the merits of the various infrastructure mega-projects currently under construction or vying for Federal funding (Mees 2010a). It provides case studies of two planning processes for transit infrastructure and service design from German-speaking Europe that offer the potential, in the Australian urban context, for the development of more affordable plans for infrastructure expansion and improved efficiency in the use of existing operating budgets.

The first case study is the planning framework used by the Swiss Federal Railways since 1990 in the *Rail 2000* and *Rail 2030* programs. Known by its practitioners as a ‘planning triangle’, this framework uses an iterative process to identify the cheapest infrastructure investment required to deliver a desired level of service.

The second case study explores the process used to maximise returns from expenditure on high-quality bus services in the City of Munich over 10 years from 2002. Called *TopBus*, this project of the Munich municipal public transport operator (MVG) has seen a progressive increase in investment in service-kilometres. Increases in revenue have exceeded the costs of this investment. This has been achieved through the iterative development of a network of high-quality bus services providing effective links between key interchanges.

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2. Why German-speaking Europe? Why these examples?

The urban public transport systems of German-speaking Europe are recognised as exemplars in their levels of patronage and their relative economic efficiency (Buehler and Pucher 2011; Stone 2011). Typically, European urban regions have a historic, densely-settled, central core, but their public transport systems are also relatively successful across large areas of urban development that are as new as the suburbs of Melbourne and Sydney (Buehler et al. 2009). In Germany and Austria, the central areas of almost all major cities lay in ruins after World War II, and, outside the inner core, residential densities are not significantly higher than in the Australian cities. Moreover, the automobile industry is very strong – estimated at 20% of GDP in Germany – adding a further potential disincentive for public transport expansion.

So, the practice of planning and operation that underpins these achievements should be of great interest to public transport planning professionals in Australia.

European success has been ascribed to a particular institutional framework – the ‘transport alliance’ or *Verkehrsverbund* (Buehler et al. 2009; Mees 2010b). These alliances, first established in the 1960s, engender cooperation between operators of different modes within a regional public transport networks (Knieps 2009). However, it may not be realistic to expect that better public transport can be achieved simply by transplanting the institutional framework of the ‘transport alliance’ from one place to another.

Such an approach was attempted as part of efforts to re-build the transit systems of cities in Eastern Europe in the years following the collapse of the Soviet Union. However, as Stead et al show in their review of a number of attempts at policy transfer from West to East, it was operational and planning techniques, processes and methodologies, rather than institutional frameworks, that were more amenable to successful transfer (2010).

Unfortunately, the techniques, processes and methodologies of public transport planning and operations in German-speaking Europe are not well documented, even in the German literature. The profession is largely craft-based. Experienced practitioners say that the basis of their work is a dense body of knowledge kept by individuals and organisations.

Through a Commonwealth Endeavour Fellowship in 2012, John Stone was able to spend five months based at the Technical University Munich. In this time, he undertook interviews with professionals and academics in eleven cities in German-speaking Europe. The purpose of this work was to gain insights into the political and institutional context in which the ‘dense body’ of public transport planning practice is conducted, and to make links from which future research and exchange can be developed. Material from these interviews forms that basis for the case studies that follow. Further analysis of the interview material was made possible through the ARC Discovery Project: *DP 110104738 - New paradigms for urban public transport planning in Australia*.

These case studies are a first step to articulate some of the techniques and methodologies that underpin European public transport success. The Swiss example illustrates the centrality of the desired service outcomes (in German, the *Verkehrsangebot*, or ‘transport offer’) in planning for major infrastructure investments, and shows the wide gulf that exists between this and current Australian activity. The example of bus planning in Munich could be more easily adapted by Australian agencies, and its focus on gaining maximum efficiency from expenditure on inner and middle-suburban bus operations is immediately relevant for our major cities.

3. Case studies

3.1 Conceptualising ‘best-practice’ in determining public transport infrastructure investment requirements

The place of Switzerland as an international exemplar in the performance of its urban and regional public transport systems makes its planning processes worthy of scrutiny. The Swiss appear to have achieved their enviable outcomes not by doing better at what others are doing. Instead, their planning processes run contrary to those applied in many other jurisdictions across the world.

The Swiss experience is not that of a country with comparatively huge budgets at its disposal for passenger rail projects. Resources of both finance and land for these projects were hotly contested, and, in fact, it was this contention that drove planners to develop new approaches to maximise the impact of the resources available to them. The budgets for the infrastructure considered here are comparable to the expenditure available to Australian public transport planners.

In the typical approach to determining public transport infrastructure requirements, planners identify the choke points that are evident in day-to-day operations as train numbers increase, and then develop solutions in reaction to this congestion. This means that investment decisions are informed by the current configuration of the system and by problems, compounded over time, arising from previous planning decisions. Under this approach, there is little incentive for long-term evaluation of the value of infrastructure investments, nor of their interactions and consistency. In addition, there is little scope for questioning the network’s existing operating rules, and so it is usual for timetables and service patterns to be modified only marginally following the commissioning of new infrastructure.

In this traditional approach, infrastructure planning is often separated from service planning, for which the standard goal is the minimisation of the number of services required to transport the expected number of passengers. This leads to scheduling characterised by wide variations, both spatially and temporally, in frequency across the system.

3.1.1 Swiss rail planning: Bahn 2000 and Bahn 2030

On the Swiss national railways and in some urban regions infrastructure planning takes a different course. Future infrastructure requirements are determined by the intended timetable. Track, signalling and rolling stock upgrades are specified to achieve train operating speeds that are “as fast as necessary”, rather than as fast as possible (Stalder 2007, p. 73).

This atypical approach was introduced in the late 1980s during planning for a large investment and service improvement program known as *Bahn 2000*. In a reversal of the traditional logic of service provision, timetable planning began from the premise that passengers would like to be able to make flexible use of the overall system. Consequently, the system is set up to offer the best possible frequency between all possible destinations. This is achieved by a system of hub-and-spoke connections in which arrival and departure times are organised symmetrically around an hourly periodicity. (For example, passenger trains from Geneva arrive in Bern every hour at the minute 56 and 26 and depart at the minute 04 and 34, i.e. 56 + 04 = 60; 26 + 34 = 60 (Stalder).)

This timetable scheme was used to determine future infrastructure requirements. Since the 1980s, an integrated and iterative procedure linking timetable design and infrastructure budgets has evolved so that the demands of users are now central to planning and operational processes. This unified timetable and infrastructure planning encompasses all of the complex mixed traffic using the Swiss railways – international, national and regional passenger trains as well as national and international freight. For national and regional passenger operations, he result is the ‘service offer’, called the *Verkehrsangebot* in German, which is made by the railways to existing and potential customers. It is instructive that there is no comparable term in common usage among English-speaking rail planners.

While elements of the *Bahn 2000* passenger timetable were implemented in 1999 and 2001, a major step-change took place in December 2004. This was made possible by the completion of an infrastructure program that cut journey times between the largest cities to just under 60 minutes. With consistent departures every hour or half-hour throughout the day and coordinated bus services, a simple, stable and attractive ‘service offer’ could be made.

This infrastructure came at a cost of €4 billion. Half this amount went on a 45km stretch of new track from Bern to Olten that permitted speeds of 200 km/h and two-minute headways. A further €1.4 billion was allocated to a variety of smaller capacity enhancements: a task that was simplified because the regular timetables meant that crossing of trains always occurred at the same place and the same minutes of a full hour, minimising the need for track duplication outside these key points. The remaining funds were used to adapt the network to new rolling stock (Stalder 2007).

Rail passenger and freight volumes have grown ahead of projections since the 1990s (SBB Annual reports). Passenger numbers are predicted to rise by just under 60% on 2009 levels by 2030, although at peak times and in certain hotspots this increase could be as much as 100%. Public and political support for rail investment has continued.

A national initiative to limit road freight passing through Switzerland in 1994 gave impetus to construction of two massive Alpine ‘base tunnels’ that will form the core of the international New Rail Link. At the national and regional level, the original timetable ambitions *Bahn 2000* are being fulfilled through a program known as ZEB (*Zukünftige Entwicklung Bahninfrastruktur* – ‘future development of rail infrastructure’) or *Bahn 2030*. Federal expenditure for a €5.4 billion work program has already been approved and more is in the pipeline in a robust but orderly process of public debate, political consensus-building, budget allocation, and refinement of technical specifications (Wyss and Halder 2009).

This program includes:

- speed increases;
- measures to increase the number of services through projects to 'disentangle' traffic flows and expand the network (flyovers, underpasses, additional tracks);
- increasing the number of services by reducing headways;
- power supply improvements;
- noise reduction measures.

The planning focus remains the simple and stable 'service offer'. SBB staff, in 2012, know the timetable that they or their successors will operate in 2030.

The stable and attractive timetable for regional service provides the backbone for rail services in the Canton Zurich where the performance of public transport outstrips any other urban region in Europe. S-Bahn services providing access to intermediate stations coordinate and interleave with the SBB regional offerings; buses and trams complete a sparse but almost universal network (Mees 2010b; Stone et al. 2012). Regional planners at the ZVV and in the operating companies share with the SBB the planning approach described above. In fact, it was pioneered here in the 1990s and continues to evolve through efforts to concentrate passengers into services with coordinated schedules "as early as possible in the journey chain" (Prof. Ulrich Weidmann, ETH, Zurich, pers. comm.)

3.1.2 Swiss rail planning: institutionalising new methods

Clearly, Swiss planners recognise considerable benefits in their idiosyncratic approach:

> The resulting infrastructure tends not to correspond to the conventional image of a state-of-the-art network topology, but it is more cost-efficient and … a very effective way of bringing service to the customer base (Laube and Mahadevan 2008).

These authors also say that the strategic approach of first defining future commercial objectives in terms of the desired 'service offer', and then shaping the infrastructure to this purpose, avoids:

> putting in place short- or medium-term upgrades that would be less useful in the future, and ensures efficient use of infrastructure, and thus satisfactory returns on investments.

Wyss and Halder also remark on the way that the process encourages efficiency:

> Numerous minor upgrades to the network are planned in order to achieve an optimum effect. The planning team [tends to] avoid larger, and therefore more expensive, expansions (such as completely new high-speed routes or tunnels) as far as possible, in light of its limited room for financial manoeuvre .

As we have noted, the Swiss political system, with its high level of citizen engagement, imposes significant rigour on budget allocations, and so the processes for planning of the future 'service offer' are sophisticated.

Inside the SBB, the shift in approach required to put the *Bahn 2000* & *2030* concepts into practice has been characterised as a "transformation from an industrial producer into a service provider" (Laube and Mahadevan 2008):

> Incremental steps of realisation are developed backwards iteratively if necessary by optimising the possible schedule as a function of the available infrastructure and rolling stock. This technique is known as the 'Planning Triangle' inside SBB. [It]

> guarantees a close fit of resources and service provision at most stages – a critical factor when activating large investments.

The ‘Planning Triangle’ is further elaborated by Wyss and Halder:

> In the conceptual phase, SBB evaluates the needs of railway companies in both the passenger and freight sectors, as well as those of cantonal representatives and other interested parties. As part of a timetable study, SBB’s experts calculate the feasibility and necessity of network infrastructure adjustments. The building and technical aspects of these then form the subject of a separate feasibility study, as well as a cost estimate. SBB then makes a final decision on how to implement the phases of any project based on business and economic criteria.

For the future, the SBB and associated agencies understand that they must optimise the performance of their existing systems beyond their already enviable standards. They are seeking to further embed the focus on customer needs in operational processes and move away from the industrial production model (Laube and Mahadevan 2008; Stalder 2007). To do this, they are supporting the academic development of new conceptualisations of operational tasks and planning processes, and adapting this more abstract research to new practices appropriate to the organisational culture of the SBB. It also requires careful attention to changing the mindset of staff at all levels.

Some of the tasks that are addressed in this continuing process of invention and adaptation include:

- Shorter calculation times for scheduling problems and optimising train paths in real time (Caimi et al. 2011).

- Integrating the tasks of the infrastructure provider and train operating company through procedures known as ‘co-production’ that get relevant information to drivers and then have drivers respond appropriately. This allows tighter on-time running targets for normal operations (as low as 15 seconds) and faster responses to disruption.

- Re-framing internal measures of success away from ‘industrial’ concepts like punctual trains to user expectations of an ‘enjoyable ride to my destination within the needs of my daily schedule’. This is leading to the development of real-time communications with passengers to provide alternative paths in the event of service disruptions.

3.2 Case study 2: Optimising bus operations in inner Munich

This case study examines a project of the MVG, called ‘Topbus’, which contributed to the improvement in both operational efficiency and rates of trip-making in the decade from 2000. This was achieved through a reorganisation of the layout and operating parameters of its bus routes that began in 2002 and has delivered a new bus network in successive stages. Refinements and extensions of this network are continuing. Similar projects, built around the creation of ‘tram-like’ bus services linking key nodes, have also been implemented in other large German cities, most notable Hamburg, where comparable successes have been recorded.

The Munich urban region has a population of around 2.5 million people in suburbs and towns spread over an area of 5,500 km^2 (2.5 times the size of the old Melbourne Statistical District). Rates of public transport use are more than twice as high as those found in the urbanised areas of Melbourne and Sydney. In 2009/10, 204 annual per capita unlinked trips were made in Munich compared to 116 in Melbourne and 119 in Sydney (data from operators' Annual Reports and other government papers, see Stone 2011). This result was achieved with per capita public transport service supply (measured in bus, tram and train-kilometres) at levels that are marginally lower than those found in Melbourne and Sydney. Over the decade from

2000, per capita trip-making in Munich has grown by 9 per cent while service supply fell by 3 per cent.

As in almost all urban regions in German-speaking Europe, public transport planning across Munich region is coordinated by a small ‘transit alliance’, or Verkehrsverbund, which ensures that the service offerings of the many operators form a single network from the users’ perspective. The strongest member of this alliance is the Münchner Verkehrsgesellschaft (MVG). The MVG is a corporation owned by the City of Munich. It operates bus, tram and underground light rail (U-Bahn) services in the 310 km^2 City. In this area, roughly two-thirds the size of Melbourne’s Zone 1, the 1.4 million residents of the City, together with workers, shoppers and other visitors from the wider urban region, make 500 million trips annually.

Before 2002, buses served a poorly defined, secondary role supporting the city’s tram and U-Bahn lines. At this time, a fleet of 480 buses provided services of 420 route-km on 76 separate lines. This service had grown in piecemeal fashion over many years and comprised a combination of radial and tangential services with varying frequencies and operating hours with numerous route duplications (MVG staff, research interview).

The new network was designed to take into account extensions to the City’s U-Bahn and tram systems; service improvements on the suburban heavy rail (S-Bahn) network operated by a subsidiary of the national railway company (Deutsche Bahn); changes to the road network, and the need to serve new patterns of residential and commercial development.

From the user's perspective the major features of the new bus network are:

- Creation of new connections, especially with longer tangential bus lines;
- Harmonisation of timetables to uniform headways (because of short headways this works well in all directions between bus, tram and U-Bahn, but longer headways on S-Bahn services mean that good connections are only possible in one direction;
- Creation of bus-bus interchanges at seven nodes;
- Differentiation of bus services into three ‘products’:
  - *Metrobus*: the premium ‘product’ typically operating at 10 minute headways for most of the day and connecting major destinations to other transit services. The intention is to replicate as closely as possible the service quality of the tram network. Some bus-to-tram conversions have already been achieved and more are planned.
  - *Stadtbus/Bus*: the standard services, also typically on 10- and 20-minute headways and connecting to other modes. These lines are not included in the stylised transit network maps, but on the large and somewhat complicated physical map.
  - *TaxiBus*: ‘on-demand’ services offered across the urban region to and from outlying S- Bahn and U-Bahn stations.
- Introduction of a new line number system that groups lines by service quality and location;
- Guaranteed connections (via electronic communication between vehicles) between tram and bus services at 27 nodes.

(Maps of current bus routes can be found on the MVV website http://www.mvv-muenchen.de/en/network-stations/network-maps/index.htm, although simple and effective cartography is not a strength of the Munich system!)

3.2.1 Patronage and financial performance

Measures of the performance of the new bus network are available are taken from data supplied by MVG staff during the research interviews and from media releases from the MVG (for example www.bahninfo.de/artikel/8991/mvg-seit-fuenf-jahren-zufrieden-mit-topbus/).

From 2004 to 2009, the re-organised network was created using roughly the same number of bus-kilometres as had been used in previous schedules. However, significant efficiencies, gained largely through a process described as 'optimised block scheduling', meant that the new services required fewer buses. The annual cost of operating the new network was reduced by €5 million (a 14 per cent saving).

By 2011, some of these operating savings had been re-invested in an increase in bus-kilometres. More frequent peak hour services were delivered using only 390 buses, compared with the 480 that had been required prior to 2004. Moreover, the use of larger, articulated buses meant that the peak service offer also provided a greater number of seats.

With an average annual cost of €300,000 per bus (including capital, maintenance, fuel, drivers and overhead), the cost of bus services was €3 million p.a. cheaper than in 2004.

Passenger numbers have risen continuously since 2004. After many years of declining patronage, the MVG recorded 171 million passengers in 2008 (a growth of 7 per cent or 15 million passengers), and by 2011, boardings had reached 185 million.[1]

The MVG planners observed that new routes took up to two years to be 'found' by new passengers. Almost all routes performed within expectations and some much better: one route, on which frequency was doubled, achieved the same loadings per bus within two years.

3.2.2 The design process

Design of the bus renewal project took two years.

Planning for the new network involved limited use of modelling or simulations, instead MVG staff described the process as "eye-balling it" based on their own experience and input from workshops and community consultations. They noted that an important element in the process was a willingness by MVG staff to discuss new ideas from outside formal channels: "these new ideas challenged our dogmas and changed outcomes".

For Australian practitioners, who have faced fierce community opposition to even the smallest changes to bus schedules, the process of workshops and consultations undertaken by the MVG should be of great interest.

The planning team from the MVG bus operations group included a former bus driver, a former tram driver; an architect (with 10 years planning experience), and a new graduate. Also part of the process, from within the MVG, were planners who had strong connections with the 25 local 'boroughs' that make up the municipality of Munich. Unusually when compared to Australia, the MVG has an internal structure that encourages planners to remain in a 'regional office' for long periods in their careers. A single planner maintains links

[1] Patronage on buses is measured using automatic passenger counters (20% of fleet have these counters). Every line, time slot and season is covered by moving the 'counter-buses' around network. These automated counts are supplemented by surveys in which passengers are counted in vehicles and at key stops, and are asked about transfers.

with local councillors and community representatives in four or five boroughs over many years, thus facilitating a two-way exchange of information that is very much to the advantage of the MVG when it is attempting to make changes to its service.

The MVG team assembled for the consultations included skilled moderators from outside the bus operations group. In addition, external consultants were engaged to design a series of workshops, roundtables, neighbourhood conferences and hearings that brought local organisations and individuals into the process. In parallel with this public process, the proposals were subject to internal peer review from other branches of the MVG and the state transport ministry, and review by bus drivers MVG and private bus companies.

4. Conclusion: Moving Australian public transport planning towards a greater focus on the user

These case studies show that it is possible to use relatively simple but rigorous planning processes to improve the effectiveness and efficiency of the expenditure of the public funds available for urban public transport. The key difference between the transport planning methodologies described in these case studies and much of the practice currently undertaken in Australian cities is the attention given to producing service patterns that meet the needs of a large range of potential users.

The challenge for Australian practitioners is to learn more about European practice and to find ways to adapt European techniques and processes to Australian conditions, remembering the comments of the Munich planners who found that a willingness to be open to new ideas “challenged our dogmas and changed outcomes”.

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