TIMETABLELING AND OUR RAILWAY’S FUTURE

Jonathan Tyler has worked in the railway industry for over fifty years and is passionately committed to enhancing public transport. He has recently specialised in making the case for a strategic, integrated timetable for Britain’s railway and in this paper he outlines how robust timetabling could contribute to increasing network capacity and route utilisation. He demonstrates clearly that it is essential for the PWI and its members to interact with industry colleagues if we are to achieve optimum success for our endeavours.

APPROACHES TO TIMETABLELING

Traditional Timetables

Railway timetabling has always been somewhat esoteric. Technical literature has focussed on the engineering disciplines and few articles exist about the techniques of timetable planning. Popular images are of locomotives and heroic crews, iconic bridges, responsible signalmen and track gangs maintaining the line at night. Occasionally there is a description of men poring over mysterious lines on paper graphs but the factors they are grappling with are never adequately explained. I will argue in this article that timetabling, though it is imperfectly understood, now lies at the heart of a debate about the purpose and future of our railway. And that it is one in which permanent way engineers have a professional interest.

Traditionally timetables were constructed train by train through continual negotiation and compromise. Passenger and goods managers had a sense of the markets they were trying to satisfy, although high resource costs may not have been recognised. Where routes were congested solutions such as the centralised control introduced by the Midland Railway could ameliorate the problem and ultimately new construction, particularly quadrupling, would be resorted to.

The first systematic implementation of a service offered at the same minutes past every hour throughout the day occurred in The Netherlands and on our Southern Railway in the 1930s. In the former the concept became central to post-war reconstruction, with the added ingredient that services were locked together at key interchanges which were often specifically designed for that purpose. In Britain broadly-patterned services spread as each route was modernised, but without a sense of building a coordinated network. Privatisation might have been less feasible had that existed.

Integrated Timetables

In Switzerland timetables with little pattern held sway and the railway was losing market share until in 1982 some young engineers, going back to first principles, identified three critical points. They noted the huge improvement in both the service and the utilisation of resources that regularity could yield, the marketing appeal of standard patterns and the value too of an integrated network. Moreover, they understood the arithmetical rules that would facilitate the new methodology. Thus was born the Taktfahrplan, or rhythmical timetable. It was an instant commercial success.

This philosophy has spread across Europe, notably to the German regions and often with Swiss advice. The Dutch, who had conceived the ideas pragmatically, adopted its full rigour in a recast of the national timetable in 2006. And now the French, who have mixed a market-led scheme for TGV services with seemingly random timings of relatively infrequent trains on historic routes, are preparing for a country-wide horaire cadencé in 2011.

Two aspects of these developments are important.

First, where such timetabling, incorporating structured and reliable connections and often complementary public transport modes too, is established then it is certainly palatable that a well-defined pattern sustained through the day builds, over time, strong public awareness of the availability, convenience and permanence of the railway’s offer.

Second, the very process of planning imposes disciplined analyses of policies, priorities and consequences. Numerous modest issues may arise. For example, where inserting an extra station on a branch would threaten connections at the junction the solution might be faster running through passing loops, while the disadvantages of a non-standard frequency may be highlighted. There will also be issues at the network scale, as famously in the Swiss Bahn 2000 project.

Here plans for high speed on the principal east-west axis were challenged by the Cantons that would not benefit from the plan. Instead, with the help of a distinctive participatory form of government, the Taktfahrplan was reinforced with additional nodes, higher frequencies and a renewed emphasis on the connectivity of the network.

To achieve this, infrastructure works included a new-build section designed for 200 km/h running and extensive upgrading - providing plenty of work for permanent way engineers.

The fundamental point is that the desired timetable was specified first and the works were then designed to realise it; obviously with iterative stages to test what could be justified. The new plan, introduced in an overnight transformation in 2004, again boosted steadily rising traffic. The next round, with a horizon of 2030, is already agreed in detail.

European Union Policy

The momentum toward the general adoption of integrated timetables is being hampered by the transport policy of the European Union (EU).

This policy is rooted in four dominant ideas, namely:
- that establishing an open market across the continent depends on efficient transport,
- that competition is a powerful means of securing economic efficiency,
- that state railway monopolies were demonstrably inefficient,
- that it is desirable for environmental reasons to reverse the railways’ loss of modal share.

Hence, the first ‘package’ of railway reforms in 1991.

These enforced separation of the management of infrastructure from management of operations in order to encourage new entrants to challenge the incumbent railways. This policy was primarily concerned with international freight traffic, and to a lesser extent domestic freight, due to their obvious importance in
respect of the driving ideas, but intervention in the passenger business would clearly follow.

Serious flaws weakened this logic.

First, a pan-European market has undoubtedly yielded some economic benefits, but it promoted long-distance movement of goods, including part-finished products being moved between large-scale processors. The social and environmental impacts are not trivial and it may not be sustainable.

Second, the policy was so much influenced by ideological convictions about the failings of vertically integrated national railways and the virtues of competition that legislators underestimated the extent to which the growth of road freight was attributable to the sheer versatility of the modern lorry. Modal shift in favour of rail thus proved more difficult than expected. The problem was compounded by the EU's persistent failure to address the economic inefficiency of uncompensated external costs that almost certainly disadvantage rail relative to road.

Third, and most critically for timetabling, the policy betrayed a profound misunderstanding of the nature of a railway. The model was partly the free-flowing road where vehicle operators need no permission for access whenever their business requires it. The model was also partly envisaging sea- and air-ports where a provider of infrastructure, typically independent of the users, allocates space on a market basis. It was recognised that railways are different but regulation was to be the minimum possible and to mirror the other modes as far as practicable. The degree of interaction between trains on the railway and the consequential need for coordinated planning were underestimated. This is illustrated by the adoption of the term 'slot', which implies a simple sequence of largely unconnected events at a point, such as ships berthing and aircraft landing, in place of the established railway usage of the term 'path', which describes the time-distance movement of a train amidst other movements, conflicts between which must be planned out.

These flaws have not deterred the EU. Faced with disappointing results in respect of rail's share of international freight and the recalcitrant behaviour of some cities and railroads the rules are being enforced more strongly, cabotage rights in domestic freight markets have been introduced and international passenger services have been opened to any qualified operator. State-supported passenger services must be tendered, although extensive open access has met with opposition.

So, there are two distinct concepts of how use of the railway should be planned. The next section discusses the tension between them that is being played out in Britain – and why it matters. It is certainly more than an arcane issue in European politics or a mere bureaucratic difference.

TIME TABLETING IN BRITAIN

Operational Realities

Chapter one of a textbook on railway operations is likely to explain that the capacity of any section of track is a function of the mix of trains on that track. Permanent way engineers know this as well as anyone since it is their task, along with their civil engineering and signalling colleagues, to provide the track layouts that will optimise the throughput of trains. The factors involved in this include relative speeds, differential rates of acceleration and braking, the capacity and loading of each train, stopping patterns and the facilities available for efficient overtaking. The work of the engineers and timetable planners is then complicated by junctions where train-paths converge and diverge. Conflicting moves must be avoided, too often without the aid of grade-separation.

Enthusiasts for open access have neglected these elementary conditions and constraints. European law requires provision for freight paths, despite there being no unequivocal means of comparing their value with the passenger paths thereby closed off. Similarly, applications by new 'customer-driven' passenger operators, to whom the Office of Rail Regulation (ORR) accords special value, are judged in terms of supposed competition benefits without appraisal of the impact on the network.

When it considers access rights ORR does not commission a detailed timetable with defined paths. It relies on an outline timetable to estimate the available capacity. And once a set of rights has been granted the task of the infrastructure provider is to fit the trains in as best it can, with no particular concern to maximise journey-opportunities.

Such fragmented decision making based on random initiatives, albeit justified by assumptions about the wisdom of the market, is unlikely to deliver optimal use of something as complex, and note the emphasis, as a national railway system.

Policy Issues

The outcome, as the East Coast Main Line demonstrates, is definitely a mediocre passenger timetable. Moreover, the alternative of a more disciplined sequencing of trains is not just a matter of achieving a more efficient railway but part of a wider question about its purpose. Creating an integrated repeating-pattern timetable requires the shape of the services to be carefully formulated if it is to be credible for the communities it serves. The process presents options, including infrastructure and rolling-stock strategies, in a manner that facilitates logical decision-making and thereby renders misconceived projects such as Ashford international less likely.

Here are some examples of issues that need to be addressed.

Standard hours versus entrepreneurial proposals

A rigorous 'standard hour' timetable is defined by the consistency of timings throughout the day (and preferably on every day of the week) and by its judicious pattern of inter-connection between the component services. Flexibility is discouraged: introduce variations and, apart from probable degradation of other paths, the marketing benefits of regularity will be eroded.

Yet it is not as inflexible as critics suggest because frequencies can be reduced at less busy times without jeopardising network cohesion and clever planning can make space for additional peak trains without disrupting the underlying pattern. Nonetheless, its publ appeal in terms of memorability and convenience must be demonstrated, as again the claimed skills of entrepreneurs attuned to the subtler and ever-varying vagaries of consumers.

There has been too little study of this important question. The Swiss know where they stand. The Taktfahrplan is now embedded not only in their transport policy but also in Swiss life; an important national psyche too. Some wonder that this plan, together with a loyal encouragement fares policy, has created an unsustainable mobility. By contrast, Britain seems singularly reluctant to engage with comparative research, including behaviour studies to evaluate travelers' perceptions, a too often advances complacent defences of a dis-integrated approach.

Through trains

Naturally, everyone would like a single-stay journey from A to B. After all, that is what everyone expect from their cars. The question is: how best to organise a railway to minimise the deterrent effect of the fact that most A and B connections cannot be made directly, but require changes at regular through services. C stratagem is to run occasional such services although it is likely to be difficult to path them.

This affords the more time-sensitive segments of the market what they most want, but it does not help those who need to travel other times or who wish for flexibility, expect if connections poorly complement the three services.

The alternative, as demonstrated in mainland European examples, is to decide routes on which through services are justified and to provide for those journeys with unavoidable change by means of well-structured timetable that optimises connections and is supported by good information and excellent real-time management interchanges.

Once again Britain exhibits much Franchised operators have tried and withdrawn occasional services, while it favours operators who make a great virtue of...
A Voyager train on a CrossCountry service threads its way through Birmingham New Street station on the afternoon of March 20th 2010. The need to accommodate trains like this, with a complicated pattern of connecting services, regularly through such complex junctions is a challenge to all involved in the railway industry.

Photograph by Ted Hamer

providing direct links. No one is charged with dispassionate analysis, so we do not know whether the open-access companies are identifying the busiest unserved flows, as distinct from being opportunistic, or what the merits of the typical European practice might be if applied to Britain. Meanwhile, confidence in interchange arrangements is eroded by excessive emphasis on the performance statistics. Not holding a forward train may often be the right decision but dogmatic rules have led to unconcern about connections.

Growth, modal share and the environment

A timetable expresses the priorities of its compilers. The present British inter-urban timetable emphasises journeys to and from London. The Swiss timetable ensures a good service between any pair of places. The London-centrivity is justified by the conurbation’s overwhelming scale in the national economy, in tourism and in social life and by the particular advantage of rail in accessing the heart of a perpetually-congested area. Yet it is perhaps time to challenge simplistic assumptions.

First, profit-seeking companies inevitably focus their marketing on already-strong ‘products’, but the result, as witnessed by promotional activities and fares practices, is to stimulate new trips as much as to capture trips from car and air. That is perfectly legitimate but it may not be compatible with national policy to protect the environment by reducing energy use and excessive mobility.

Second, if rail transport really is environmentally more sustainable than other modes then the principal goal should be to increase its modal share from its present modest level of 7% of all passenger-kilometres. Statistics on shares are not routinely collected at the sub-national level. This is itself a reflection of the Government’s patchy commitment to real change. Rail is thought to hold more than half the market on prime London flows and of course a leading role in commuting to central London but only tiny shares on most other flows.

A large share is quite difficult to increase, since the people not using rail are the ones who have the stronger reasons not to. Conversely, where the share is small opportunities for market-capture abound. Competitive circumstances mean that London shares will always exceed the non-London shares but the gap between more than 50% and less than 10% is difficult to justify (the two segments are estimated to be of roughly equal size for journeys of over 80km).

Government and industry should be assessing the potential gains from a concerted narrowing of the prevailing disparities between the London and on non-London service offers. The latter are attracting welcome attention through projects such as the Manchester Hub but it is difficult to discern a comprehensive approach grounded in a timetable vision.

Provision for freight

Securing paths for freight trains is both rooted in EU legislation and supported by popular clamour for more freight to be carried by rail.
Here too the assumptions need challenging. In order to secure ready access to rail infrastructure managers must set aside capacity for growth in freight traffic, and they cannot contractually commit to passenger paths for more than one year in case adjustments should be needed to accommodate future freight. On capacity-scarce routes this distorts planning of the passenger timetable and it is not obvious that either the decision-mechanisms or understanding of the socio-economic trade-offs are adequate for the scale of the repercussions.

Nor is the environmental case for rail at all certain. The many studies of the relative merits of road and rail have not conclusively demonstrated that it is universally valid. There are a great many variables. However, even if on balance it is better to carry freight by rail rather than by road, then the question still stands of whether the traffic itself is environmentally sound. Coal is suspect because of its involvement in CO₂ emissions and the intercontinental movement of containers is a function of manufacturing, trade and consumption models that are ecologically unsustainable and socially arguable, while the long-distance haulage of bottled water is simply irresponsible.

A wider reappraisal is called for. Extravagant forecasts of rapid expansion in container traffic should be matched by a sober review of the implications for the freight market of the profound debate about sustainable futures and alternatives to "turbo-capitalism". A precursor is the slowing down of container ships in response to falling demand and high fuel prices. Perhaps the shortest possible transit time for container trains is going to be a less significant imperative. It may be that by reference to sustainability measures an excellent passenger service is the absolute priority with freight only admitted to the railway to the extent that it does not interfere with the passenger timetable.

The Process

As remarked at the outset of this paper, time-tabling is insufficiently understood. The legal framework now encasing it has reduced awareness still further, despite the consequences for the public interest. It is, for example, often said that the Department for Transport (DfT) plans the timetable. This is usually in illustration of the thesis that such micro-management is the bane of the lives of Train Operating Companies (TOCs). DfT does no such thing. For each franchise it specifies a pattern of service in terms of frequency and calling points and it may give some indication of preferred times. It does not specify the exact paths of trains, and indeed it cannot legally do so for that is the responsibility of Network Rail (NR).

Access to the track is determined by operating companies, including the open-access and freight businesses, applying for rights to ORR. These are granted or refused according to whether Network Rail can demonstrate that capacity exists. It is only when all the access rights have been assembled that NR starts knitting them together in detail. This procedure may comply with the theory and law of an infrastructure resource subject to regulated access.

Nonetheless it has substantial weaknesses.
- The disconnect between ORR's grants and NR's timetabling can complicate production of an acceptable timetable, let alone one of decent quality. Indeed the Secretary of State, commenting on the ECML saga, has stated that "too significant a proportion of the capacity has been allocated to open-access operators, making it difficult to timetable trains for the franchised operator that will deliver the accelerated journey times ... that we seek without damaging the frequencies to the intermediate stations on the route".
- Independently generated specifications for paths are most unlikely to achieve optimal use of capacity. It is strange, given the constant message of growth and congestion, that no parallel tests are being made of the improvement that a centrally-planned timetable might yield. The matter is compounded by the fact that ORR and NR think in trains, whereas capacity is also a function of their size. It does not seem sensible to be accepting so many short trains.
- Sequential awarding of franchises constrains each new round of planning by fixing contracted paths that cannot be adjusted other than by complex renegotiation.
- EU rules prevent NR from agreeing to adhere to standard-hour timings.
- These features make irritating, and sometimes damaging, minor variations pervasive; while excessive pathing allowances can often dissipate the gains from expensive track improvements.
- No one is responsible for the service as a whole. NR has no explicit duty to secure sensible relationships between services and the TOCs seem remarkably unconcerned about designing a connected network. The result is a railway that is preoccupied with performance but does not measure whether the service itself is a good one. Now that performance is greatly improved attention should be paid to assessing how well the timetable provides for a wide range of journeys. For all the talk of market sensitivity TOCs display little sign of doing what lies beyond their own narrow interests.

In theory an infrastructure manager who cannot accommodate all the paths demanded should instigate a review of the route with the aim of identifying means of providing additional capacity. This has spawned attempts to construct arithmetic equations to measure utilisation. They are unconvincing because they ignore the fundamental fact that the capacity of a mixed-traffic railway is determined by the manner, rational or otherwise, in which trains are sequenced. In practice the arrangements for relieving congestion have rarely been implemented and economic conundrums remain regarding efficient allocation of the cost of new networks between various parties.

Two further points need making.

First, no other European country has adopted Britain's ultra-liberalised form of access-planning. In The Netherlands the state-owned holder of the main passenger concession, the freight operators and the infrastructure company agreed a complete recast that left little room for open access. The integrity of the core network of passenger services was paramount. In Switzerland, which adopts EU law, it is even more strongly protected while the precious Alpine paths for freight are built into the plan and effectively auctioned. And in France the infrastructure manager is insisting on a nations plan to better order the use of capacity.

Second, while the tension between franchise and open-access operators arises from provisions in the Railways Act 1993, it is curious that ORR has not been challenged on it interpretation of its duties. It is indeed require to promote competition but it must also contribute to developing integrated transport and to sustainability, promote the shorter possible journey times and facilitate journey which involve more than one operator. It is manifestly not properly balancing these duties.

THE EAST COAST MAIN LINE

Defining Standards

It might be thought that a substantial refreshment of the timetable for Britain's premier main line would be guided by precisely define standards. These might include the frequency and speeds appropriate to each type of flow, its scope of through services and some idea of its hierarchic importance of the associated line. No such standards exist. Instead we have coarse specifications and inter-compared manoeuvring, with no expression of connectivity goals across the network.

Targets for fast timings between the principal cities and London are set, but no equivalent exists for other place-pairs. Arranging complement through trains with one-changer services at intermediate times is not on the agenda, even though it makes good use of the existing train-kilometres and despite the importance of maximising the attraction of the railway to a clientele accustomed to unbound flexibility of the private car. Similarly, interchanges are not planned with any coherent framework.

All these elements are systematically managed in the timetabling process that has acquired acknowledged excellence in a number of European countries. And here is too a clear example of British insularity. Brisk connection would not happen by accident. They are achieved because their designers have understood the significance of symmetry, as explained in.
appendix. Without it, wait times for each flow are randomly determined, and regularity will replicate the good and the bad every hour. It is difficult to fathom why this is still not appreciated and why instead so much weight is attached to the less important feature of round-number departure times from a handful of principal stations.

A Very Brief History

Plans for a revision of the timetable were initiated by the first franchisee, GNER, and later absorbed into the broader workstream of the Route Utilisation Strategy (RUS) that started in 2005 yet was not completed until 2008. Astonishingly, this did not incorporate any significant timetabling studies. This seems to have been because of fears that they would compromise Network Rail's legal position and highlight the capacity effects of the open-access trains. ORR was approving in a separate process. Once the RUS was 'established' ORR invited expressions of interest in running trains on the ECML, but it took a year to resolve the many conflicting claims for paths, even in principle.

Then NR spent months devising a workable timetable, albeit via several unacceptable drafts. This was approved by the ORR in February 2010. The delay has caused implementation to be postponed by five months to May 2011. Although numerous details remain unsettled, consultancies are underway, but the constraints are such that it is impossible to do other than tinker with the plan.

A Timetable Unworthy of the Route

The East Coast public-relations machine brands the new timetable *Eureka*. This is bizarre. Boasting that the task has taken ten years is hardly a tribute to the dynamism of the industry and it glosses over the fact that a not-intrinsically-difficult task has become so for the reasons advanced in this paper. Moreover the accentuate-the-positive publicity is misleading.

- Journeys will be faster between key centres and London, which is good, but the gains are slight and services for some non-London pairs such as York-Doncaster-Sheffield will deteriorate. No complete analysis has been published, only a selective focus on London.
- The Secretary of State's late intervention to impose a fast business service between Edinburgh and London displays an uncharacteristic lack of understanding on his part and will likely fail.
- The extra seats are mostly only available at off-peak times.
- The new Lincoln service is of doubtful value, its opportunity costs are high and it only came about because of quirks in the planning process.
- No services from York and north thereof will call at Stevenage. Moreover, the alternative connectional arrangements are dreadful and involve no less than four TOCs.
- Anomalies abound because of the strange stopping patterns imposed on open-access operators by ORR's convoluted balancing of generated and abstracted revenue.
- Talk of the total number of trains obscures the bunching that diminishes real frequency and wastes train-kilometres.
- Assertions about good connections are selective, since many others are poor. Disregard for symmetry often means brisk interchange in one direction and a long wait in the other.
- Many apparently timetabled connections fall foul of the interchange-time rubrics and the railway is singularly careless in handling these circumstances in journey-planners.
- The staff running the 'consultation bus' did not understand these issues and were unable to answer questions about operators other than East Coast. This risks an explosion of criticism when the full facts become known.

The present author has applied the Swiss principles and methodology to the design of an ECML timetable, employing Swiss software. The project showed that substantially better services could be offered for the generality of journeys without compromising high standards for the top flows. There are indications that the revenue and social gains would be considerable. Yet it cannot be formally evaluated because it falls outside the existing regulatory process.

Where Now? - An Alternative Proposal

The critique of the existing process, the weaknesses in current timetables and the examples from Europe all make a prima facie justification for investigating truly integrated timetabling. This would require the DfT to specify franchise in considerably extended detail but the gain would be greater coherence, properly-organised connections and a renewed sense of a national network.

Practice abroad indicates that in itself this would not fail foul of EU law; although there is plainly a case for reviewing its more baneful effects. Provision for open access would be subject to some constraint within the overall plan, although tests suggest better results for all the players. The idea could be taken further. Both the franchise model and open access could be replaced by market-bidding to operate segments of the timetable. This would need controlling to prevent fragmentation but it would enable operators to do what they are supposedly good at, namely the day-to-day delivery of customer service. London Buses have shown the way.

The Longer Term

The railway is awash with plans for development. It is an exciting time, but one feature is missing. There is no vision for the timetable that Britain will need in, say, 2030. Its characteristics will depend on trends that are difficult to forecast but one can venture that ecological pressures will require public transport to play a growing role, even if mobility as a whole is curtailed. That means services that are reasonably fast, though not necessarily super-fast, and suitably frequent and provide an even standard across the country. Designing and adopting such a scheme could spark the popular imagination by unifying all the infrastructure projects into a single plan. The timetable does matter after all.
TAKT-Britain
an integrated cyclic timetable for Britain's railway

- green: principal inter-city services
- magenta: other London inter-urban services
- red: regional services
- blue: suburban and local services

all services hourly, except where line is dashed

Additional peak trains:
06:07 EDBR > LNDN 18 23, 17 38 LNDN > EDBR 21 54, calling BWFY, NCLT, YORK
07:11 SKPH > LNDN 06 03, 08 08 LNDN > SKPH 09 52
calling KGLY, SLY, LEDS, WKF
06:50 HULL > LNDN 09 23, 08 38 LNDN > HULL 21 05
calling BIGH, SLIB, WOF

work in progress

Passenger Transport Networks
York 20 Sep 08
Appendix: the fundamentals of integrated standard-pattern timetables

An integrated timetable depends on applying six fundamental principles.

- The most important nodes of the network for interchange must be identified.
- All services should have the same symmetry, i.e. timings in the two directions should be a mirror-image of each other balanced around the ‘zero minute’.
- Services should arrive at the principal nodes just before the hour (and half-hour), in a sequence from the least to the most significant, and depart in the reverse sequence.
- Timetables should be consistent throughout the day and every day.
- Investment should be directed at bringing key nodes into the xx.00 and 30 scheme through inter-node running times of about 28 and 58 minutes and 60 / 30 / 15 / 7½ minute intervals. However, running times should be no faster than this if the aim is maximal connectivity.
- Perfection cannot be achieved in a real network. The task of timetablers and engineers is to devise (and improve on) the best compromise, often in the face of multiple constraints.

These principles are illustrated in the two figures.

Figure 1: the ideal pattern at a key node

Figure 2: the consequences of disregarding the mirror-image principle

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