by Dr Bernhard Rüger and DI Doris Tuna

design

# all aboard


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Busier than usual: Swiss and Czech football fans at Basel's main station

## A recent research study has revealed how much railcar design can influence station stopover time. Here are four ways to tighten your timetable

Getting on or off a train is not as straightforward as it may seem. Passengers experience various difficulties both in boarding and alighting. The net result for the train operators is longer-than-necessary station stopover times with a knock-on effect on service punctuality and operating efficiency. For instance, on local stopping services, stopover time can amount to 11% of the total journey time. Inefficiencies may be caused by a variety of factors, including the placement and design of the entrance/exit doors and the design of the railcar interior. Unfavourable interior configurations contribute to queues of passengers attempting to board.

Vienna Technical University's Institute for Railways Engineering, Traffic Economics and Ropeways carried out a research project to quantify the influence of the railcar interior design on station stopover time. Data was collected from

A major factor affecting the time needed for passengers to board is the railcar design

ABOVE: Specialist carriages help avoid luggage problems. This is the bicycle carriage on the InterCity double-deck train IC2000
RIGHT: Skiers and snowboarders create their own luggage issues

13,000 observations of passenger exchange processes at German, Austrian and Swiss railway stations with almost every railcar type in use today being analysed. According to the research, optimising railcar interiors to allow more efficient boarding and alighting has the potential to reduce stopover time by two-thirds.

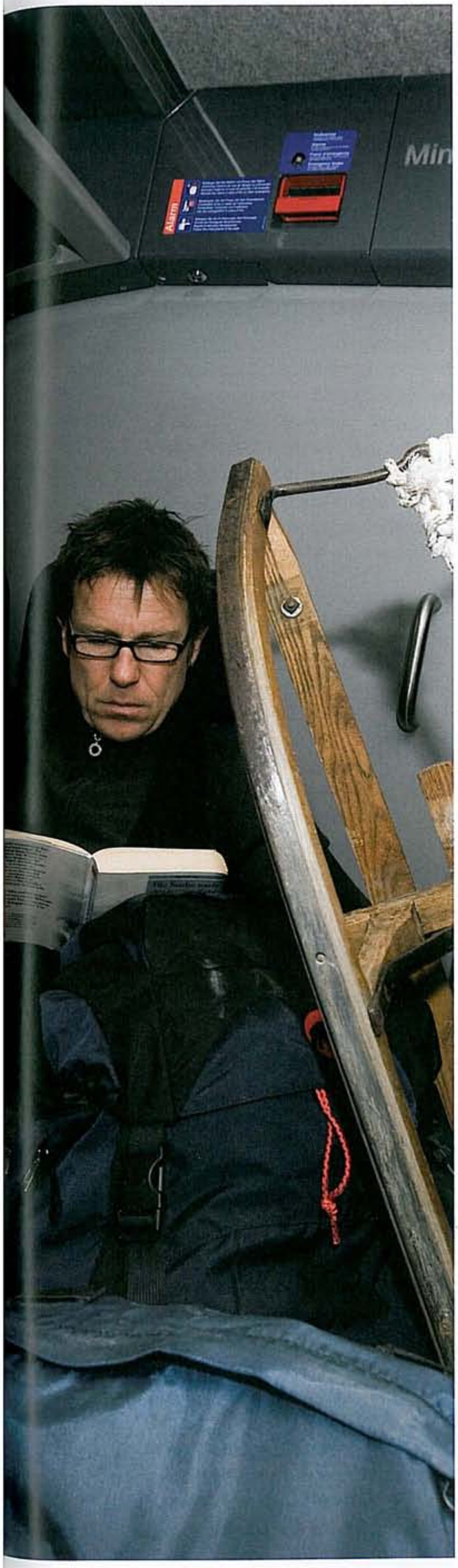
### Exchange rate

Passenger exchange can be divided into two parts, alighting and boarding. Alighting passengers do not have as many restrictions as boarding passengers, and they can prepare their luggage before arriving at the station so they can alight very quickly, so the total time needed is almost linear.

A major factor affecting the time needed for passengers to board is the railcar design. To evaluate the boarding process, the railcar was divided into two zones: the door, including consideration of the door width, the steps and the entrance area; and the interior and seats. The zones each have different factors influencing the time passengers require to pass through them. The assumption was adopted that both the single door and the entrance zone can accommodate 10 people.

The main parameters under consideration were the passengers' agility, their luggage and possible obstructions. If more than 10 passengers are boarding, the interior is the most relevant factor – poorly designed interiors prevent quick boarding and result in a queue forming very quickly. The stopover time is also directly related to the number of steps on the railcar, the step-ratio and the width of the entrance door.

The profile of the passengers also affects stopover time.




## SUMMARY OF THE RESEARCH

All factors discussed here need to be taken into consideration to reduce stopover time. The railcar entrance area, retention area and the interior layout must be designed to enable quick and efficient passenger movement.

Specific research conclusions include, firstly, that steps should be avoided if possible and, if unavoidable, there should be a two-step maximum. Secondly, doors should be more than 90cm wide and, ideally the horizontal gap should be less than 10cm. The aisle width should be a minimum of 60cm, 70-90cm would be better. Thirdly, luggage storage should be distributed appropriately along the coach, and not restricted to just the end or middle. Finally, it would be advisable to use compartments or back-to-back seating more frequently.

If these conclusions are taken into account for the design of new railcars, passengers will experience easier and more pleasant journeys, and operators would find that there would be less time expended during station stopovers. As a result, they could optimise timetables and offer a faster and more efficient service.

### Level best

Passengers prefer a level entrance/exit without any steps, barriers or obstacles. In most cases, however, there is a horizontal gap between the railcar and the platform, forcing passengers to concentrate more and expend more energy. Children and older people need more time, because they are smaller or less agile.

In general, the number of steps and the ratio and the number of pieces of luggage involved are the most important factors. However, if there is a level entrance or just one step of not more than 20cm, the research revealed little difference in individual passenger behaviour.

These conclusions were drawn from an analysis of the IC 2000, a double-decker railcar in service with the Swiss National Railways. If the IC 2000 stops at a platform 38cm high it needs one step up into the railcar or, if the platform is 55cm high, no steps are needed to access the railcar. The 140cm door width enables passengers to get on and off, side by side, optimising stopover time and resulting in it being less than 70% of the stopover time of common RIC railcars. In terms of RIC railcars, the Deutsche Bahn ICE offers the best solution, as stopping at a 76cm-high platform results in a flat step-ratio and its railcar has a 90cm-wide door, allowing adequate access width.

Major factors affecting passenger boarding are passenger age, the number of pieces of luggage they carry and, of course, the presence of any disabled passengers. The research divided passengers into three main groups according to age: children 10 and under; people aged 11-64; and adults aged 65 and over. Passengers' luggage was categorised into 'less obstructive', 'one big piece of luggage' or 'more than one piece of big luggage'.

### Open-door policy

A major influence on the passenger exchange is the arrangement of the doors. Many railcars have the doors at the end, so every door has to serve half the railcar in one direction. This means that some passengers have to go a long way to find their seat. The time needed grows with every passenger in an over-linear way, resulting in a dramatic increase in stopover time.

A positive effect can be observed with concepts where the passenger flow divides after boarding. This is possible in double-decker coaches, or when doors are arranged at the quarter points of the coach length. The second solution divides the coach into four parts reducing passenger exchange time.

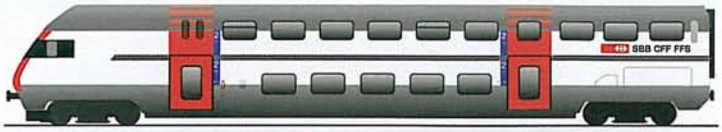
There is a major problem in railcars with only one door, as can be seen on the control coach of the ICE-T or the Fiat Pendolino railcars. Even though the control railcar of the ICE-T could be served by the second coach, passengers do not use it in this way. The research clearly shows that the majority of passengers use the door leading to the coach where they want to sit. Railcars with only one door need special analysis.

### Go with the flow

The design of the interior influences the exchange of passengers when more than 10 people get on the train one after another. The main parameters are the entrance size, aisle width, the arrangement of the seats and the luggage storage facilities.

A queue in the entrance area is inevitable if the area is too small, or does not have clearly defined routes to the seats. The entrance area should, therefore, have enough room for at least 10 passengers, but should not be defined on the assumption that the travellers will stand neatly side by side.

Boarding passengers look for a seat as soon as possible, and the aisle width determines their speed of movement away from the entrance area. On long-distance services, the travellers have medium/large-sized luggage. If the aisle width is only 50cm, passenger movement speed will be restricted (luggage is often wider than 50cm), and there are no points at which it is




possible to pass passengers heading in the other direction. So the passenger flow slows and customer satisfaction rates fall. If the aisle width is 60cm, passenger movement will be quicker and more comfortable.

The research showed that with aisle widths of only 50cm, the time it takes passengers to find a seat is 25% more. A good solution is offered in railcars built with compartments, which provide an aisle width of 70-90cm.

## On the rack

Luggage storage is an important issue. Passengers have two main concerns: firstly, they do not want to have to struggle to lift their luggage in a confined space, and secondly, they want to keep an eye on it once it is stowed. Overhead luggage bins mean that the suitcases, trolleys and bags have to be laboriously lifted, a difficult, time-consuming process.

**Many railcars have luggage storage facilities which are either inadequate or unacceptable, and therefore often not used because they are too small or too high and inaccessible. The result is that a lot of passengers store their luggage in the aisle or on the seats, where it constitutes an obstruction.**

Racks in the entrance area are mostly used for extremely big pieces of luggage. Passengers who use them inevitably block the passenger flow while stowing their bags, introducing a potential conflict point. These racks cannot be seen from the seats, and therefore passengers lose visual contact with their belongings during the journey.

Storage compartments located in the railcar itself are often too small, resulting in similar problems and a tailback of passengers.

Luggage racks in the middle of the coach have the advantage of offering passengers visual contact with their luggage but, at the moment of boarding, they have to pass along the whole railcar to get there, often finding racks that are too small for their purpose, resulting in a tailback while a different storage place is found. With their luggage stowed, the next priority is find a seat and they may have to turn around into the oncoming passenger traffic. If, as in most cases, the aisles are too narrow to offer passing points, once again passengers get stuck in a jam.

The optimum solution would be to locate the luggage racks in the quarter points along the length of the railcar. This would ensure that passengers could always sit in a position from which they could keep their luggage in view and, because they would not have far to move to find a seat after stowing their luggage, there would be minimal obstruction of passenger flow. Luggage rack dimensions need to be carefully considered so that they can accommodate the typical load.

## The best seats in the house

Seating on long-distance trains can be divided into three main categories: seats facing in one direction; back-to-back seating; and compartment coaches, although these three categories are sometimes combined within a railcar. Seats facing in one direction suffer from most of the disadvantages described above.

Back-to-back seating offers more luggage storage, distributed along the length of the coach between the backs of the seats. The luggage is close to the passengers' seats, there is no need for passengers to struggle with lifting their luggage onto a high rack, and visual contact is possible. However, in many cases, the space between the seats is sufficient to store only small or medium-sized items. It is necessary to make the space between the back of the seats slightly larger to accommodate big bags or suitcases. An advantage of back-to-back seat configurations is that groups of four seats with a small table offers plenty of passing points for passengers.

In principle, compartment railcars offer a better all-round solution than open-plan railcars. There are unlikely to be problems if a big suitcase is put in the aisle, which is typically wide, and oncoming passenger traffic can be passed with relative ease. If there are passenger-flow blocks, the side aisle/first compartment door has the merit of also serving as a waiting area, and can be regarded as part of the railcar entrance.

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