Railway Interiors International, November 2006

ON THE RACK

Bernhard Rüger, **from Austria's TU-Wien, outlines the findings of a recent study into better arrangements for luggage racks**

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ATTEMPTS ARE OFTEN made to increase the number of seats in railway carriages to increase the capacity. The consequence, however, of maximising seat numbers is that only the overhead racks are available for storing luggage. This fact has proved important, as shown by an extensive study by the Institute for Railway Engineering at the TU-Wien. The study took place on long distance trains across Austria, and dealt with passenger behaviour under a variety of conditions.

Two things were discovered. Firstly, travellers dislike having to lift their luggage up to the overhead rack and so are prepared to put up with considerable inconvenience to other passengers and themselves in order to avoid this. Secondly, passengers always want to be able to see their luggage.

If these two basic principles are disregarded when a train is being designed, then serious disadvantages arise for the passengers and operator during daily use, leading not only to increased dissatisfaction but also a drop in efficiency.

Human behaviour

If at all possible, passengers try to avoid lifting medium sized and large pieces of luggage. The consequence is that areas on the floor are used to deposit luggage. If there are no suitable areas, such as sufficient room between the seats or individual racks on the floor, then other areas like spare seats or the entrance area are used.

As a rule, the displacement of the free seats is done in such a way that they can only be made free at great expense, and so are unusable.

As well as the passengers having to sacrifice comfort, this has the result that the maximum possible utilisation rate of the seats in the carriage is lowered to 70 to 80%. At least 20% of the seats are unusable and this means that more passengers have to stand up, despite the fact that there are theoretically free seats available.

Luggage, which is left in the aisle and near the entrances, stops those passengers who wish to move about on the train. This problem gets worse when the moving passengers have luggage as well. A further difficulty is when aisles are too narrow to accommodate movement when luggage is present. With a width of less than 60cm, passengers find it far more difficult to move about. When people are boarding, these circumstances quickly lead to queues – a situation aggravated by there not being enough free seats.

All change

The queue which is caused by these design flaws in the interior, as well as narrow entrances and often the large numbers of steps to be negotiated (sometimes up to five) when people are getting on and off, leads to increased passenger changeover times at stations at peak travel times. The delay of a train increases by a few minutes at every station. Depending on the distance, this can add up to delays of up to one hour. These delays affect approaching and following trains and even timetable arrangements for a whole day.

Unsuitably placed luggage blocks the various emergency exits, which represents a high risk to safety. The emergency exits are further restricted by aisles which are too narrow. The usual layout of the doors at both ends of the carriage has a similarly disadvantageous effect, as the emergency exits for people who sit in the middle of the wagon are a long way off.

Suitable ways of optimising potential can be drawn from the study of passenger behaviour and can lead to a marked improvement in the faults mentioned. The two main critical points refer to passengers getting on, and the seating arrangements in general.

The position of the doors on newly built trains should be reconsidered. If the two entrances are put at the respective quarter points instead of at the end of the carriages, the flow of passengers can be better spread, which leads to a tangible reduction in the queues. In order to speed up passengers getting on, the entrance doors must have a minimum width of 90 cm.

Step on it

Of equal importance is the number of steps from the platform to the interior of the train. Depending on the luggage that is carried, negotiating four steps takes two to three times longer than two steps before the next passenger can follow. A passenger with a heavy case takes on average 12 seconds to negotiate four steps. The same passenger needs on average five seconds to negotiate two steps. A gentler gradient in the angle of the steps also contributes to a reduction in changeover times.

When getting on to an ICE train with a door width of 90cm and a step ratio (height/depth) of 21:23cm, a passenger needs on average 15 to 20% less time than when getting into a RIC-carriage with a door width of 80cm and a ratio of 23:20cm.

In order to avoid queues, the immediate entrance area inside the train must fulfil the function of taking on and distributing passengers. It is therefore necessary that this area is not too narrow. Passengers with luggage must be able to pause there. As a further consequence, the width for access between the seats must be at least 60cm to not restrict the passenger too much.

The seat/rack ratio

The maximum number of seats should not be dictated by the wishes of the operator, which will likely want to offer as many seats as possible per carriage. The basis for the maximum sensible number of seats is set by passengers and their behaviour under various conditions.

Most passengers have luggage with them, especially on trains which serve airports or holiday destinations. However, the amount of luggage on business journeys should not be underestimated. On average, passenger destinations on long distance trains in Austria consist of: 12% holiday journeys, 15% longer private journeys, 38% short journeys and the rest are business trips of one or more days.

Each traveller averages 0.8 pieces of luggage. This can consist of big or medium sized cases, travel bags or rucksacks. Each passenger also averages 0.7 pieces of hand luggage – smaller cases, travel bags and rucksacks.

The area needed to deposit luggage will be demonstrated on a new, fictitious train. We are dealing with a second-class open saloon coach with some face-to-face seating and some seating in rows. The seat grid pattern is about 92 cm. Making full use of the seating arrangements, a maximum of 88 seats can be built in the compartment and in this case there is no space to deposit luggage near the floor and only overhead racks are available for depositing luggage.

Incorporating passenger behaviour to this train, then depending on the distribution of the destinations, 20 to 30% of the seats are unusable, since they are blocked off by luggage. Even if all passengers

> "The luggage racks must not be situated in the immediate vicinity of the entrance areas at both ends of the carriage"

were prepared to lift their luggage and stow it in the overhead racks, there would not be enough luggage space on those days with an increased number of holidaymakers.

Since there are many passengers who are not prepared (or able) to lift up their heavy luggage, then only the light pieces of luggage and clothing are lifted up and the heavy stuff stays on the floor, or in front of the seat. Accordingly, in this compartment only 70 of the 88 seats would be available. On holidays there would be even less.

The degree of efficiency to be expected is 94% on holidays down to 89%. The upper limit for seats to be built in, in order to get around 100% efficiency, is about 80 in this type of carriage on an average travel day. In this case four luggage racks can be built and on the basis of the analysis of passenger behaviour, one can predict a possible seating efficiency of 100%.

So, by giving up eight of the 88 seats, there will be 10 more seats available! This increases the efficiency, and with this the economy, and also passenger comfort and customer satisfaction.

Arrange a re-rack

The luggage racks must not be situated in the immediate vicinity of the entrance areas at both ends of the carriage. Passengers only accept these racks grudgingly even though they offer storage space on the floor. The reason lies in the fact that the passengers always want to keep an eye on their luggage.

In normal trains (with doors at each end of the compartment) it is best to arrange the luggage racks in the quarter points of the carriage opposite each other, whereas to get optimum efficiency they should be placed next to each other. This arrangement guarantees the best possible flow of passengers who are getting on and in this way reduces the queues.

The final choice of number and size of luggage racks depends on the respective conditions like the distribution of the destinations. As a general rule the installation of 4 luggage racks each with an inside width of at least 100cm has proven to be most advantageous. One must be aware that the bottom rack, which is mainly meant for large and heavy pieces of luggage, is at least 75cm height. Above this are 2 racks arranged with an interior height of 55cm and 45cm and here the smaller upper rack is suitable for travel bags and rucksacks.

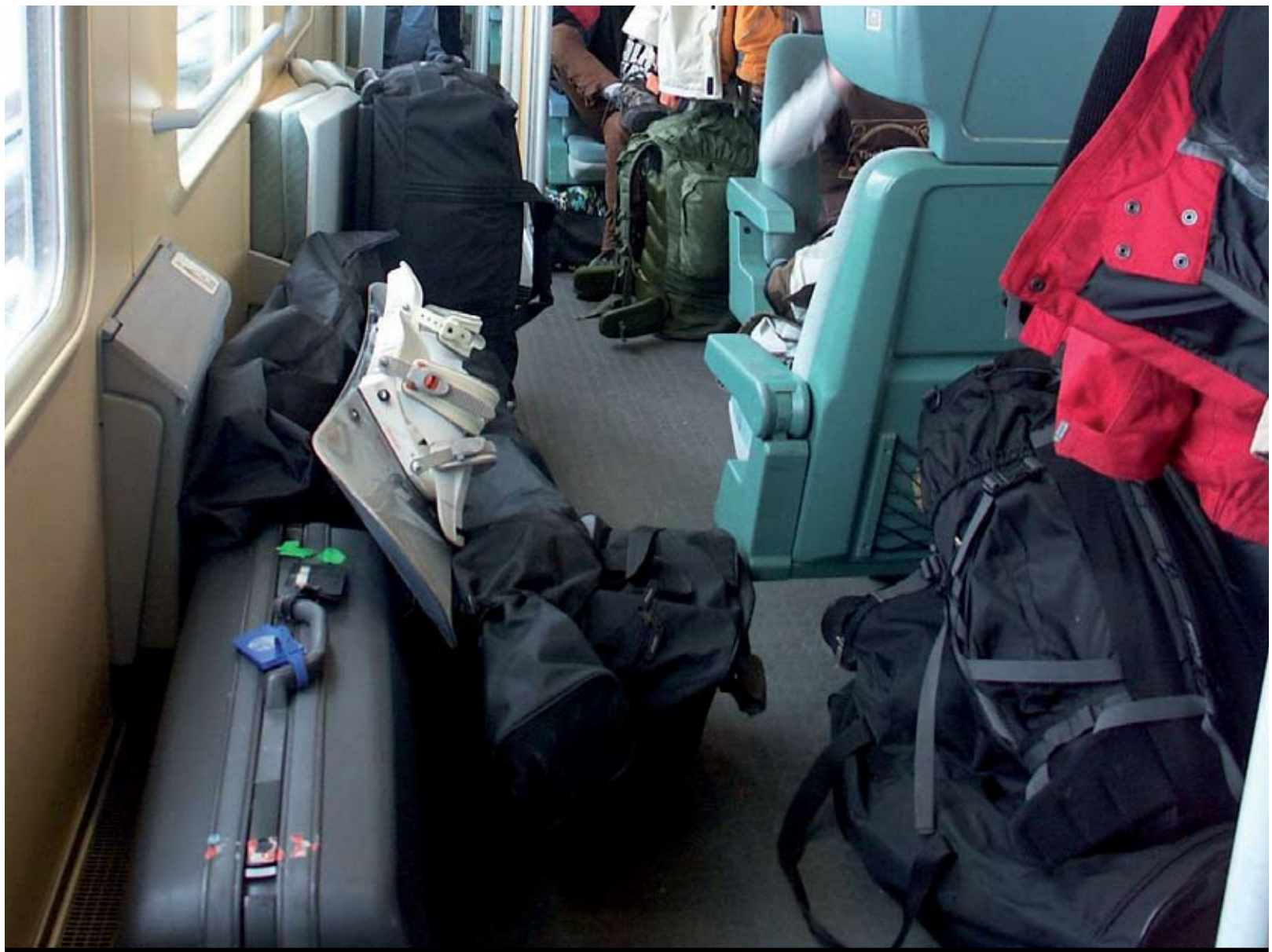
If the minimum measurements are not met, the racks cannot be used efficiently. When building the racks one must take care to have them sloping backwards so that the luggage does not fall down.

Since the backrests have a certain angle, one can use the space that is left between the two seats for storing luggage. Passengers like these areas and gladly make use of them. One must not make the mistake of placing headrests next to each other – the space left is much too small and cannot be used. The seating arrangement is only efficient if there is space left, measuring from the floor, to a height of 60cm and a width of 35cm.

If the side fittings do not go down to the floor then the load is carried through to the back area, and the angle of the seats can be used for a broader area on the floor to store luggage.

The studies have shown that if the ideas used in this article are used to their full potential, then rail services can be optimised and managed more efficiently in many areas. *END*

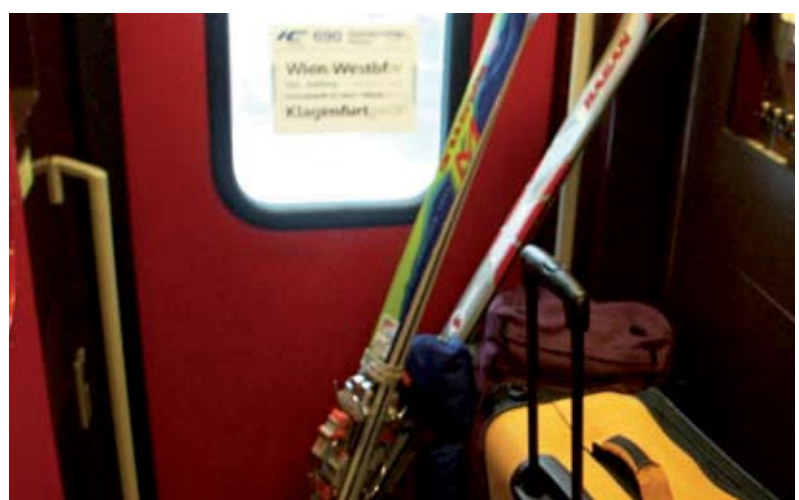
Find out more about the project (and meet the author) at 10.50 on 28 November in Köln, Germany at the Railway Interiors Expo Open Technology Forum.



Luggage needs to be safely stowed out of harm's way. Haphazard arrangements like this only cause passengers and staff problems

> "So, by giving up 8 of the 88 seats, there will be 10 more seats available! "

Closely positioned seats do not leave much space for luggage



Blocking exits could be fatal if an evacuation was required