Passenger-friendly and operationally efficient rail-vehicle interiors

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Inition

- Vienna University of Technology (Research Centre for Railway Engineering), in cooperation with netwiss, has more than **15 years of experience** in rail-vehicle **interiors**.

- Aim of all projects:

  Finding of the **optimum** between passengers’ ↔ operators’ **needs** and expectations
What do we want?

**Ultimate ambition:** Having an **efficient rail system**!
→ The railway is a holistic system!
→ Optimizing single parts is inefficient!
Efficient rail vehicles – different points of view

Area of conflict

industry

operators

passengers

Totally different needs and expectations!
Efficient rail vehicles – different points of view

Area of conflict

Realise profit by selling a lot of trains
Best profit: selling ready-made concepts

Source of photo: http://www.railwaypro.com/wp/innotrans-2010-background-for-the-future-of-mobility/
Efficient rail vehicles – different points of view

Area of conflict

Maximum possible space and comfort „Travelling in one’s own palace car“

operators

industry

passengers

Source of photo: http://de.academic.ru/dic.nsf/dewiki/2408634
Efficient rail vehicles – different points of view

Realise profit by selling a lot of tickets
Having a maximum possible number of seats

operators

passengers

Source of photo: https://www.welt.de/reise/article9699522/Mit-dem-Steh-Sitz-wird-s-im-Flugzeug-noch-enger.html
Who is the customer?

For the industry ➔ operators are customers
Who is the customer?

For the operators → passengers are customers

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Realise profit?

Industry must produce vehicles that **satisfy operators** ....

Operators must have as many satisfied **passengers as possible**

... AND passengers
Realise profit – area of conflict....

Expected profit for the operator

symbolic drawing

Passengers’ comfort and smooth operation

Source: https://www.welt.de/reise/article9699522/Mit-dem-Steh-Sitz-wird-s-im-Flugzeug-noch-enger.html
Source of photo: http://de.academic.ru/dic.nsf/dewiki/2408634
Efficiency – Operator’s point of view

**High occupancy rate:** All “seats” shall be sold

**Short dwell time:** Shortest possible passenger change-over time

**Usual approach:** Implementation of as many seats as possible!

→ Highest expected revenue!

**Reality is at antipodes!**
Efficiency – Operator’s expectations vs. reality

Graph showing the relationship between efficiency, profit, and number of seats.
Efficient rail system - interiors

• A lot of things are important!

• Very important – knowledge about passengers’:
  • needs and expectations
  • experiences
  • actual behaviour in their environment

Only if the rail-vehicle interiors meet the passengers’ needs in all phases can they be efficient!
Focus

The **focus** must be on the **passenger**!
→ Then the **operation** will also be **efficient**!

Source of illustration: http://weclipart.com/happy+people+clipart
Today‘s reality

**Industry designs** rail vehicles and **expects** that **passengers** will use them in line with industry’s thinking.

→ Very often **basic passenger needs are denied** which creates behaviour in passengers that best fits their needs but causes a lot of operational problems.

Source of pictures: https://de.dreamstime.com
Efficient design

The entire rail vehicle must be designed around the “needs and behaviours” of passengers to have a chance of being efficient!

Source of pictures: http://weclipart.com/happy+people+clipart
https://www.ferienbahnhof-reichenbach.de/index.php/ferienwohnungen/grundriss
What does that mean?

There are a lot of passenger **needs and expectations**: e.g. Interiors for efficient time use (e.g. working)

Referring to **operational efficiency** - Main influence: **Baggage**!

If the vehicle interiors are only based on seat-maximisation, the result will be:

- **Much longer dwell time**
- **Lower occupancy rate**
Methods of our research projects

• Passenger behaviour analyses
  • Actual behaviour of about *200,000 passengers* in trains (Who is sitting where? Where is baggage stored? Where are the immediate problems? Which seats are preferred? etc.)
  • Exact measurement of passenger change-over *time requirement* of more than *20,000 passengers*
    → In more than *60 different types* of vehicles in Europe

• Passenger needs and expectations – questionnaire
  • More than *35,000 passengers* EU-wide
Methods of our research projects

• Calculation model
  • Input:
    • Number of passengers
    • Distribution of passenger data (age, sex etc.)
    • Distribution of travel purpose
    • Exact vehicle interior’s layout
  • Output:
    • Exact dwell time
    • Baggage distribution (number, types)
    • Baggage storing (which baggage is stored where?)
    • Which seats are taken, which are blocked?
    • Possible actual occupancy rate
    • Efficiency of the vehicle design
Requirements – train operators

- Short **dwell time** – quick passenger change over
- High **occupancy rate**
- Maximum **revenue**
- **Satisfied** passengers
Requirements – passengers

- **Easy access**
  - if not, boarding time will increase

- **No lifting** of baggage

- **Having baggage close** *(visual contact)*
  - if there is no suitable storage, passengers store baggage close to them on the floor, in the aisle, on or in front of seats etc.

- **Many different comfort needs**
  - Adjustable seats; possibilities to sleep; enough space for working (tables, trays etc.); WIFI; individualized heating, cooling and air conditioning, lightning and much more
Focus of further presentation

- Passenger needs and resulting behaviour against operational effects for train operator

- No focus on the different comfort needs
  - Most of the comfort needs are not really observed in most trains.
  - Big effect on satisfaction and dissatisfaction!
  - For efficiency satisfied passengers and so the best possible attention to comfort needs is required!
Baggage – two dogmas

- Passengers try to avoid lifting baggage
- Passengers want to have visual contact to their baggage!
Willingness to lift baggage

20% (heavy) to 40% (medium baggage) are willing to lift baggage to the overhead bin.

Up to one meter: willingness to lift is higher.
Willingness to store baggage disruptively (on floor, seats, in the aisle etc.) to avoid lifting?
Importance of visual contact

- Very important: 45%
- Important: 43%
- Less important: 10%
- Unimportant: 2%
Willingness to **store baggage disruptively** (on floor, seats, in the aisle etc.) to **guarantee visual contact**?
Offer of baggage storage

- **Overhead bins**
  - Frequently the only offer
  - Not liked by passengers

- **Baggage racks**
  - Sometimes offered, especially in new coaches
  - Liked by passengers

- **Between seat backrests**
  - Hardly offered
  - Very well liked by passengers

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Baggage racks

- Are liked by the passengers

- Main problems:
  - **Location** – at the end of the vehicle or in the entrance area
    → NO visual contact
  - **Dimensions** of the rack often do not match today’s baggage
    → inefficient
Effect of racks close the entrance

Utilization of the baggage rack

Occupancy rate of passengers

Ideal utilization rate of the rack (relative to occupancy rate)

Actual utilization rate of the rack
Knowledge about baggage – size required

Example

trolley upright

- < 35 cm
- < 65 cm
- < 85 cm

cross-section

- 35 cm
- 85 cm

large 75%
medium
small

maximum 95%

large 75%
medium
small
baggage racks – dimensions - effects

not efficient
Between seat backrests

- Very well liked by the passengers!
  - Easy storing, no lifting, close to passengers

- Main problems:
  - **Space** between the seat backrests does not match today‘s baggage (especially larger items‘)
    - inefficient
Space between seats – today’s examples

- 0 large suitcase
- 0 trolley upright
- 1 small suitcase
- 1 medium carpetbag

0 cm
Overall effect of the vehicle interiors

Arrangement of

• Seats
• Baggage storage

→ has a big influence on:

• Occupancy rate
• Dwell time

Following slides provide examples for better understanding:
Row seating – only overhead bin

Baggage in aisle, on seats – blocked seats
Oncoming passengers
Overhead bins

Tailback after only a few passengers, long time requirement
Row seating + baggage rack close to entrance

No visual contact

Tailback after only a few passengers, long time requirement
Vis-a-vis seating

Baggage storing between the seats

- enough space required
  - Very fast and easy storing
row seating – time requirement

- Seats standing neatly in a row
- Opposite seats
- Compartment coaches
- Opposite seats in an IC2000

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<th>Actual time [sec]</th>
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<td>Opposite</td>
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<tr>
<td>IC2000</td>
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row seating
Seat arrangements

- Seats standing neatly in a row
- Opposite seats
- Compartment coaches
- Opposite seats in an IC2000

Graph showing the ideal and actual times for different seating arrangements.

- **Row seating**
- **Vis-a-vis seating**
Dwell time – different concepts

Row seating (no racks)
Mixed seat concept (rack close to entrance)
Mixed seat concept (rack away from entrance)

Today’s situation

Dwell time needs double to three times longer!

Boarding time, approximately 30 passengers

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Available seats – occupancy rate

Example 26.4m wagon

<table>
<thead>
<tr>
<th>Number of seats in wagon</th>
<th>Number of usable seats</th>
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<tr>
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<td>82</td>
<td>80</td>
</tr>
</tbody>
</table>

Fewer available seats!

Peak!

Even more seats
Operator’s wishes versus reality

- Operators wishes:
  - Best possible efficiency
    - Short dwell time
    - High occupancy rate
    - High revenue (as many passengers as possible)
  - Today’s approach
    - Maximizing number of seats (as the airline industry does!)

- Practice:
  - Much longer dwell time (train stop time up to 5 minutes)
  - Lower occupancy rate (maximum 80%)
  - Dissatisfied passengers
Solutions

- Reducing number of seats:
  - Reduction of approx. 10% of the seats
  - Using space for well-designed baggage storage
  - Mixed interiors concepts

→ On most days 100% occupancy rate is possible
→ Dwell time can be reduced

- Further concepts such as changing of the door locations or waggon body types leads to even more benefit
Requirement for designing

For redesigning or designing new vehicles:

- Passengers’ *behaviour* must be taken into consideration from the beginning
- Also passengers’ *needs* and *expectations*
- Exact *calculation* of the optimum number of the seats
  - Knowledge of passengers (main travel purpose etc.)
  - Knowledge of baggage distribution
- **Start** the vehicle designing *from inside* (the interiors must be fixed first)
  - the *waggon body must match the interiors*, not the other way around!
Usual way of designing

1) Waggon body is designed
2) Window divider is fixed
3) Seat divider and seats are fixed
4) Remaining space is for baggage (often overhead)
Usual way of designing

1) Waggon body is designed
2) Window divider is fixed
3) Seat divider and seats are fixed
4) Remaining space is for baggage (often overhead)

seats
existing : available
88 : 70
Possible improvement

Everything is fixed, just some seats can be removed and replaced by racks
Possible improvement

Everything is fixed, just some seats can be removed and replaced by racks

existing : available
84 : 75
Possible improvement

Everything is fixed, just some seats can be removed and replaced by racks.
Possible improvement

Everything is fixed, just some seats can be removed and replaced by racks.
Possible improvement – boarding time

- Type A
- Type B
- Type C
- Type D
- Type E
- Type F

fictive example

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Still suboptimal

Long way from entrance to rack
Visual contact from a few but not from all seats
Rack width is based on seat divider
What to consider exactly - examples

- Passengers do not want to lift baggage → **racks** or between seats
- Knowledge of actual size of baggage items → for storage every cm counts and how passengers use baggage storage
  - Baggage has **three dimensions**, not only one volume

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What to consider exactly - examples

- Visual contact → close to passengers
- Passenger flow

→ Good baggage storage distribution in the waggon
What to consider exactly - examples

- Visual contact → close to passengers
- Passenger flow

→ Good baggage storage distribution in the waggon
Baggage racks must have an efficient width and must not be restricted by the seat divider.

- Usual: Rack second, then seats.
- Efficient: Rack first, then seats.
Design from inside

- Baggage racks must have an efficient width and must not be restricted by the seat divider → plan the racks first
- Good distribution
  - much better visual contact
  - much better passenger flow
More to think about

- Waggon body in general
- Entrance situation
- Passenger needs and expectations → requirements for efficient time use and comfort
- Innovative baggage storage solutions → every cm counts
Conclusion

- Start designing from inside
- Less is more (fewer seats, more efficiency)
- There is no panacea at all - Each area of operation needs an exact calculation of expected baggage items (e.g. Commuters vs. air passengers)
- The passengers’ needs and expectations must be taken into consideration!
Operators benefit

- Shorter dwell time realisable
- Higher defacto occupancy rate is possible

→ Higher passenger satisfaction
→ Higher operator’s efficiency
Consulting references

Evaluation of the interiors concept regarding

- efficient baggage storage
- highest possible occupancy rate
- low dwell time

- DB (German Rail)
- SBB (Swiss Rail)
- ÖBB (Austrian Rail)
- Bombardier
Thank you for your attention!

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