TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

netwiss

Passenger-friendly and operationally efficient rail-vehicle interiors

Dr. Bernhard Rüger,
Vienna University of Technology,
Research Centre for Railway Engineering
and
netwiss OG

www.railwayengineering.info

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?

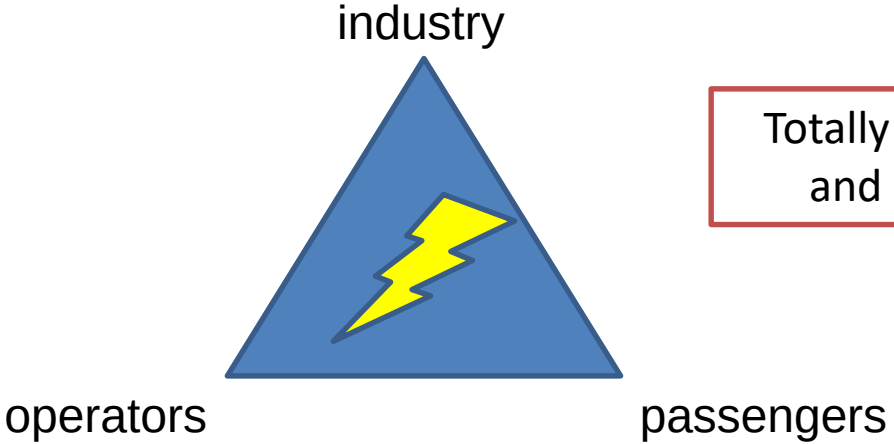
Ultimate ambition: Having an **efficient rail system**!

→ The railway is a holistic system!

→ Optimizing single parts is inefficient!

Efficient rail vehicles – different points of view

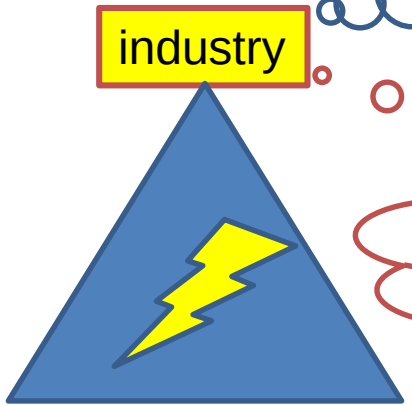
Area of conflict



Totally **different** needs and expectations!

Efficient rail vehicles – diff

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 – differe

Area of conflict

industry

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

operators

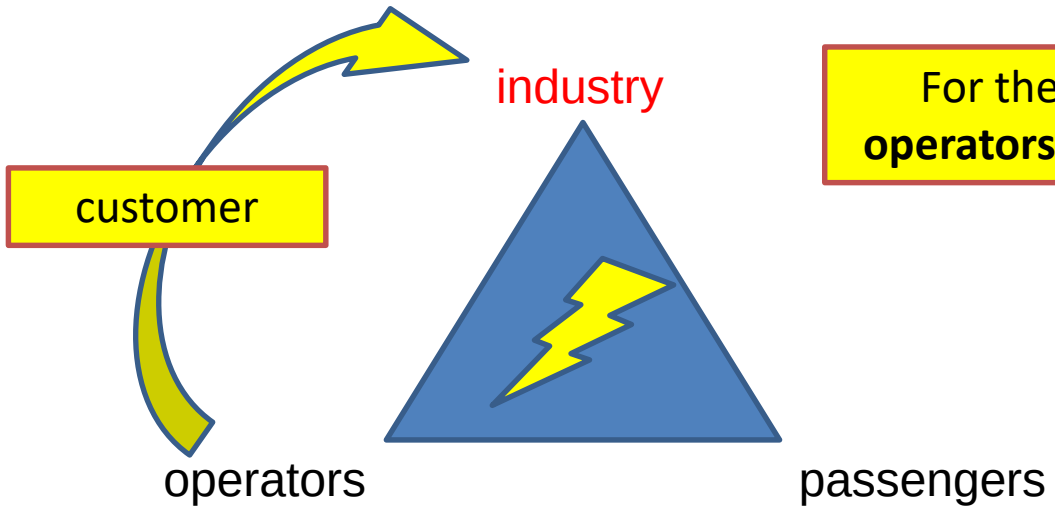
passengers

Source of photo: http://de.academic.ru/dic.nsf/dewiki/2408634

E different points of view

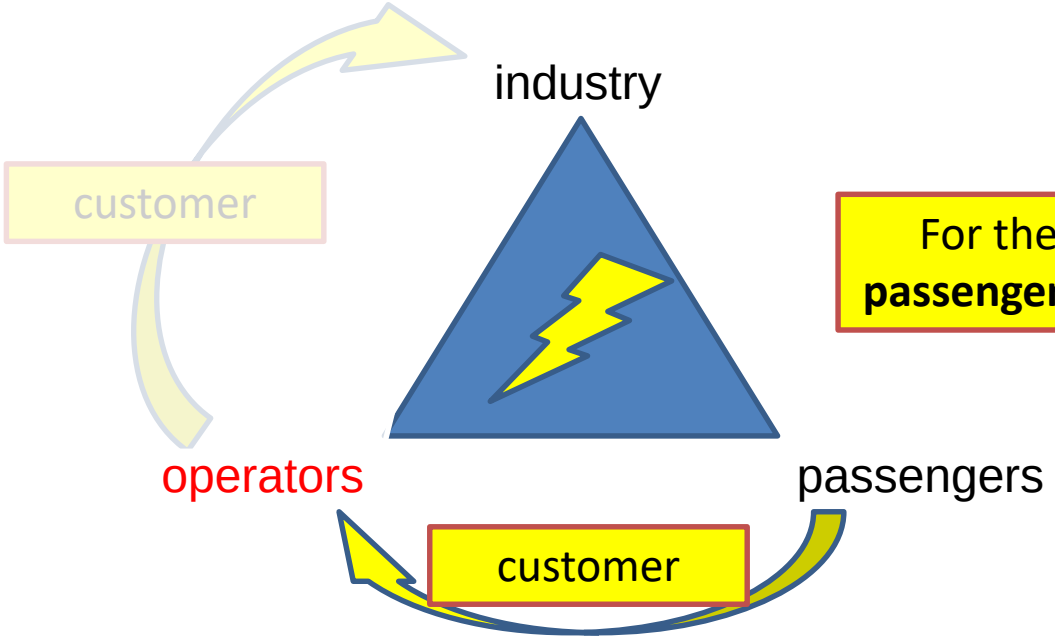
Source of photo: https://www.welt.de/reise/article9699522/Mit-dem-Steh-Sitz-wird-s-im-Flugzeug-noch-enger.html

Who is the customer?



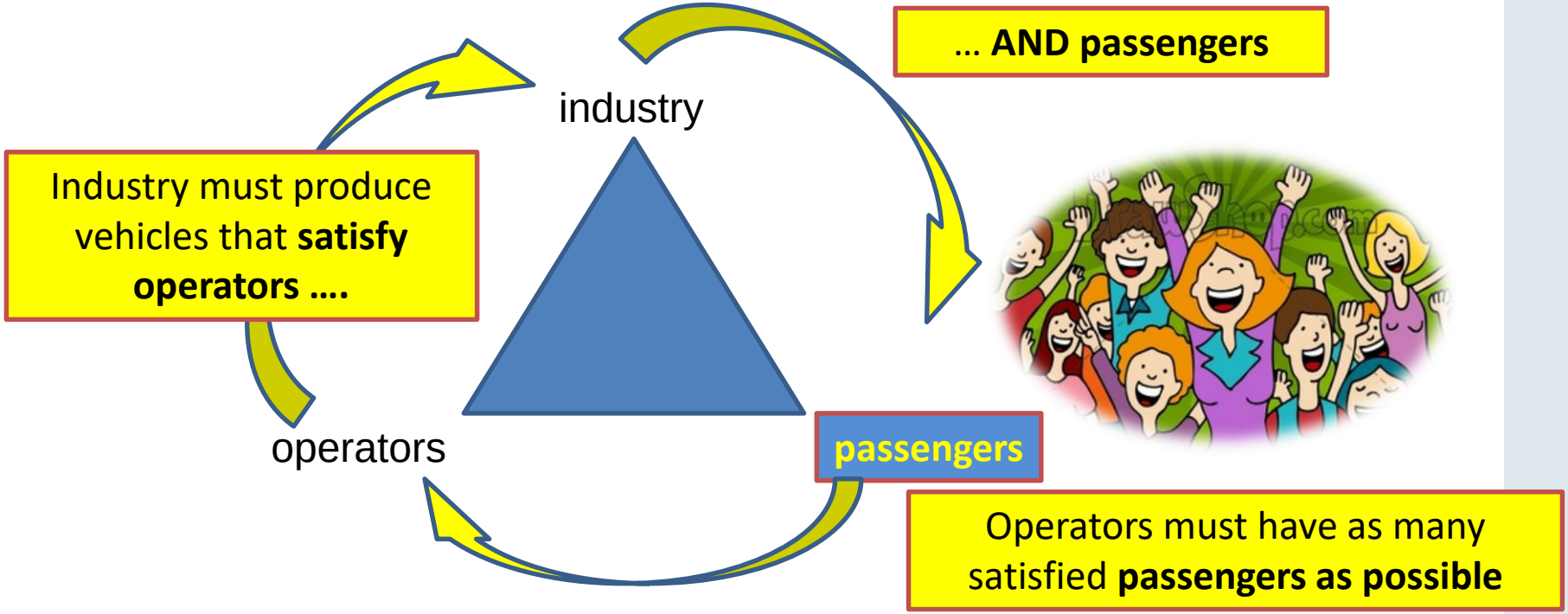
For the industry → **operators are customers**

Who is the customer?



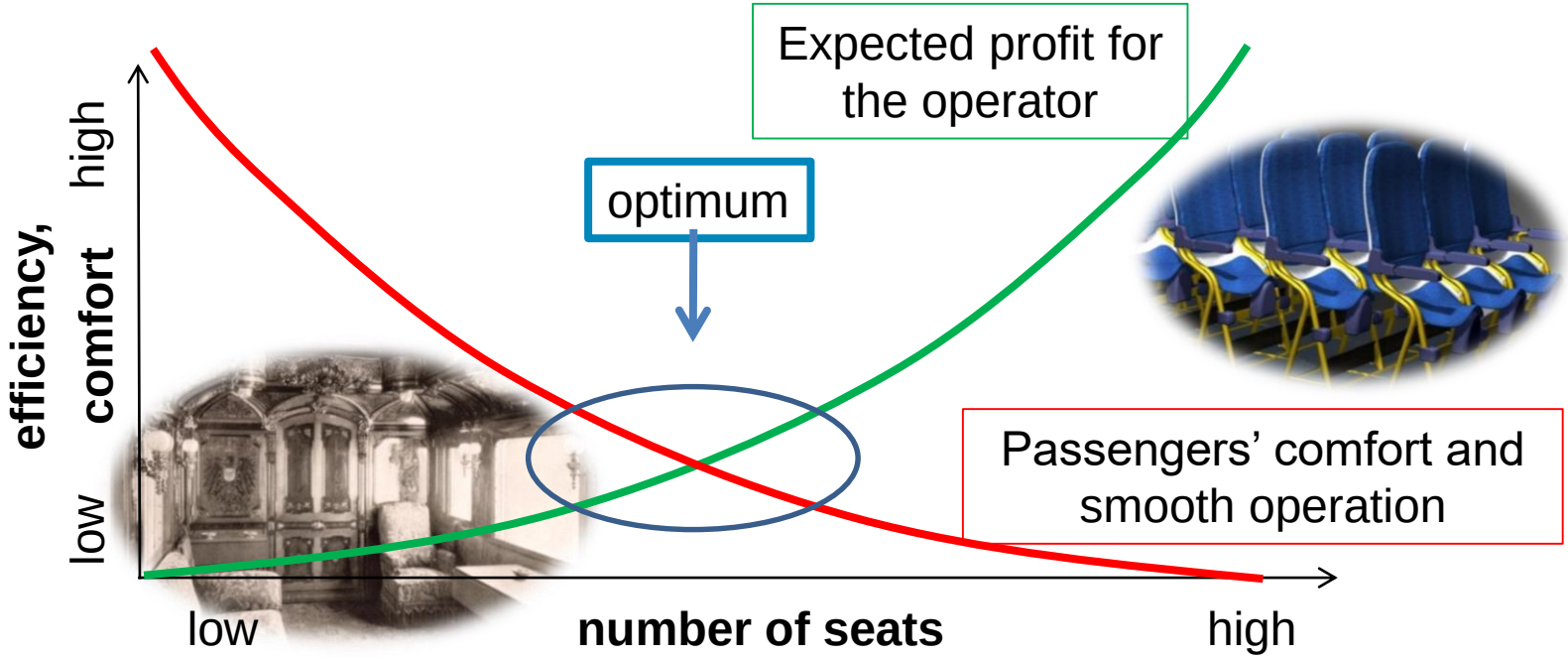
For the operators → **passengers are customers**

Realise profit?



Source of illustration: http://weclipart.com/happy+people+clipart

Realise profit – area of conflict....



symbolic drawing

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

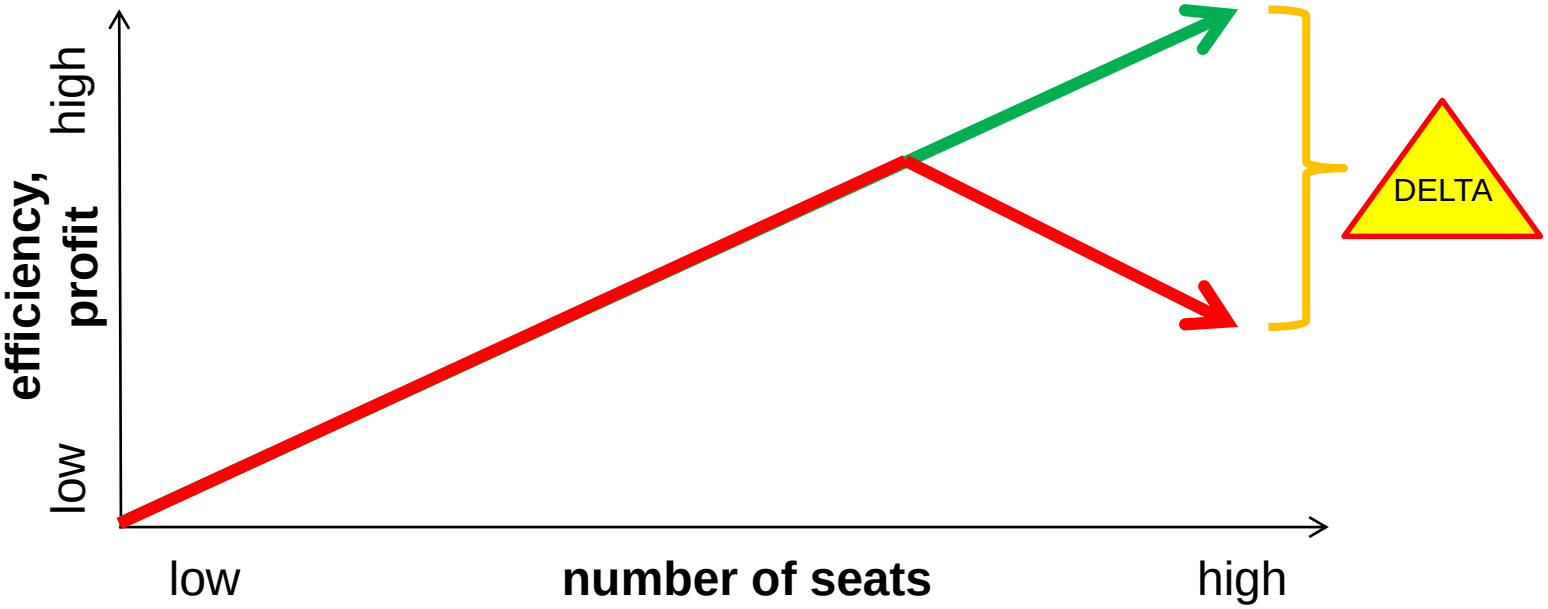
Short dwell time: Shortest possible passenger change-over time

Usual approach: Implementation of as many seats as possible!

→ **Highest expected revenue!**

Reality is at antipodes!

Efficiency – Operator’s expectations vs. reality



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!**

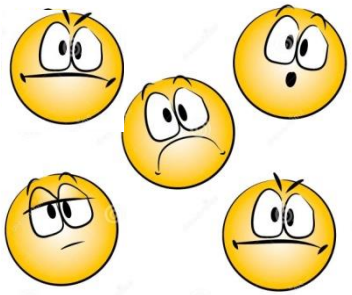
→ Then the **operation** will also be **efficient!**

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!

example illustration

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

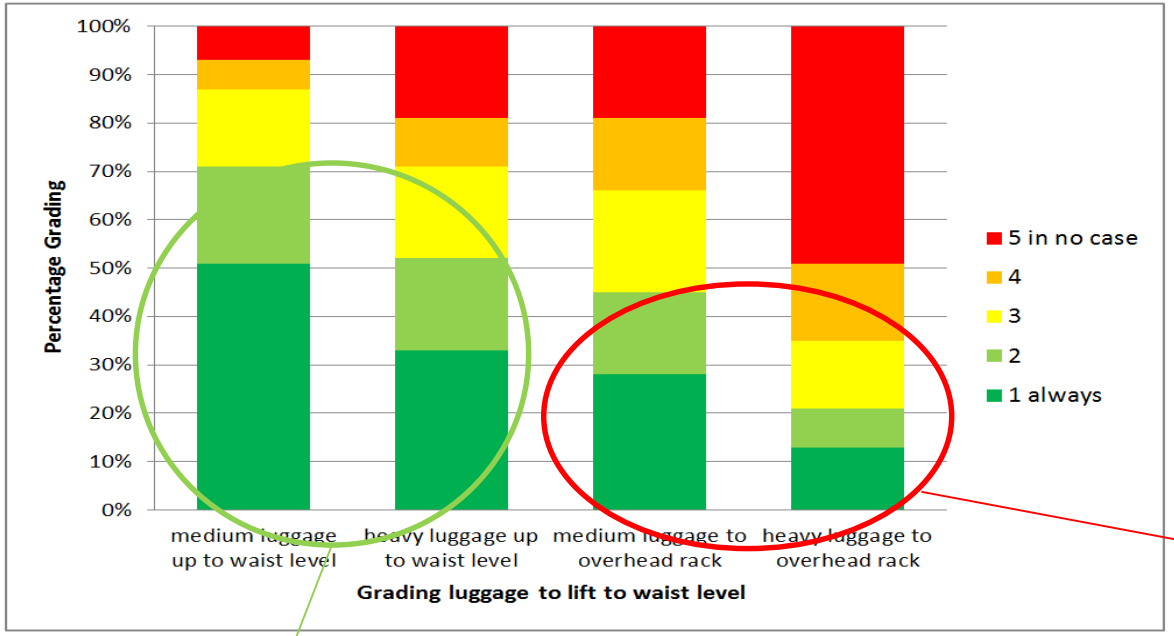
Focus of further presentation

- 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!

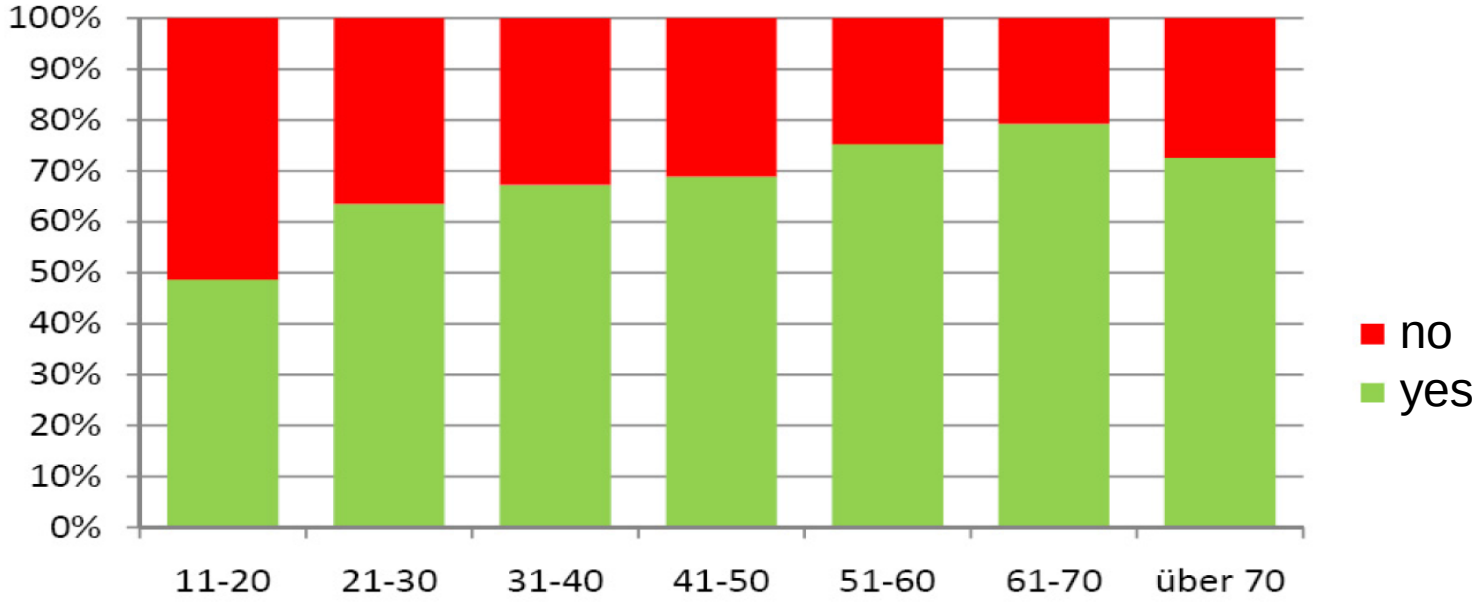
Willingness to lift baggage



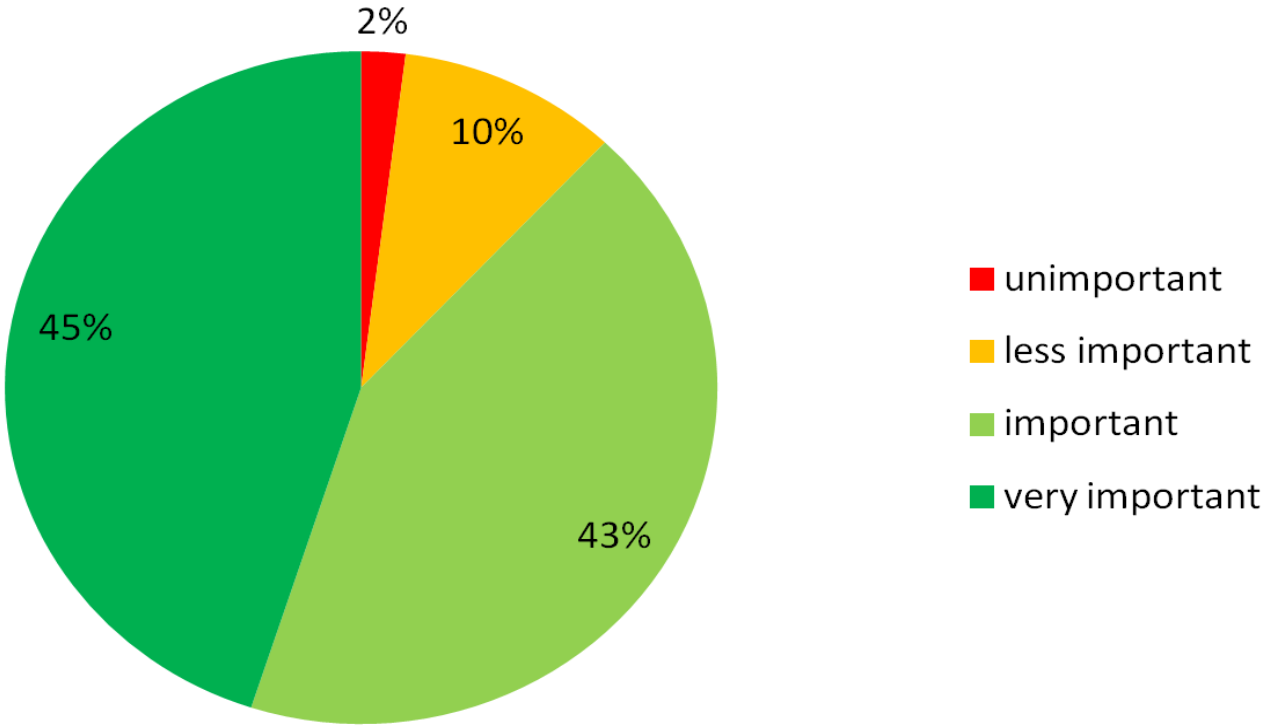
20% (heavy) **to 40%** (medium baggage) are **willing to lift** baggage to the overhead bin

Up to one meter: willingness to lift is higher

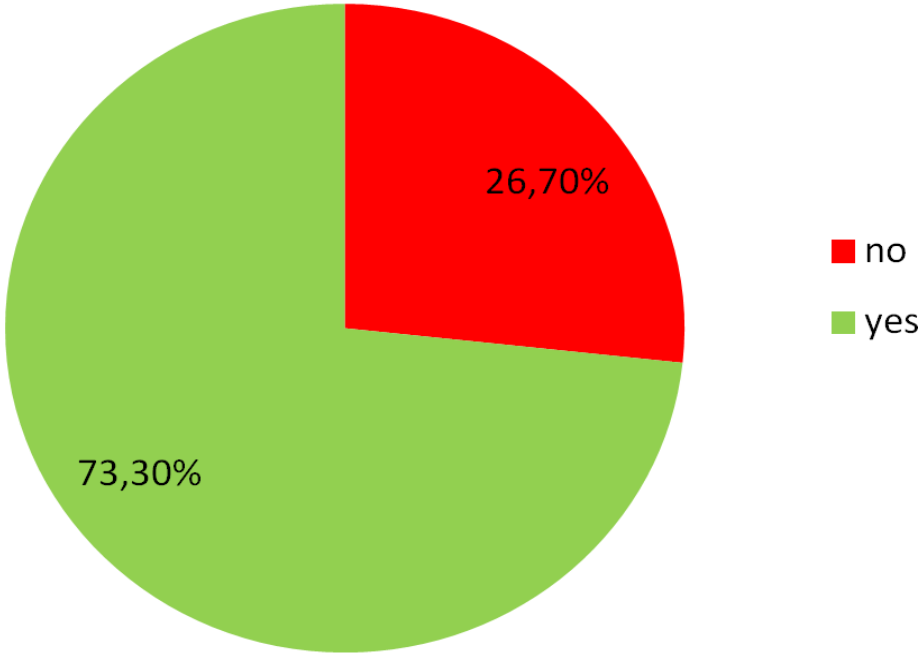
Willingness to **store baggage** **disruptively** (on floor, seats, in the aisle etc.) **to avoid lifting?**



Importance of visual contact



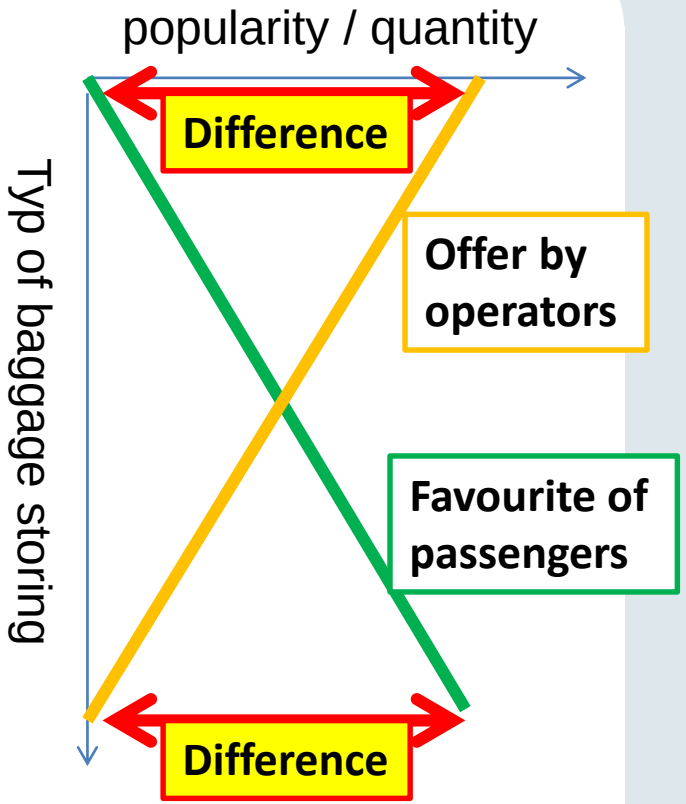
Willingness to **store baggage** **disruptively** (on floor, seats, in the aisle etc.) **to guarantee visual contact?**



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

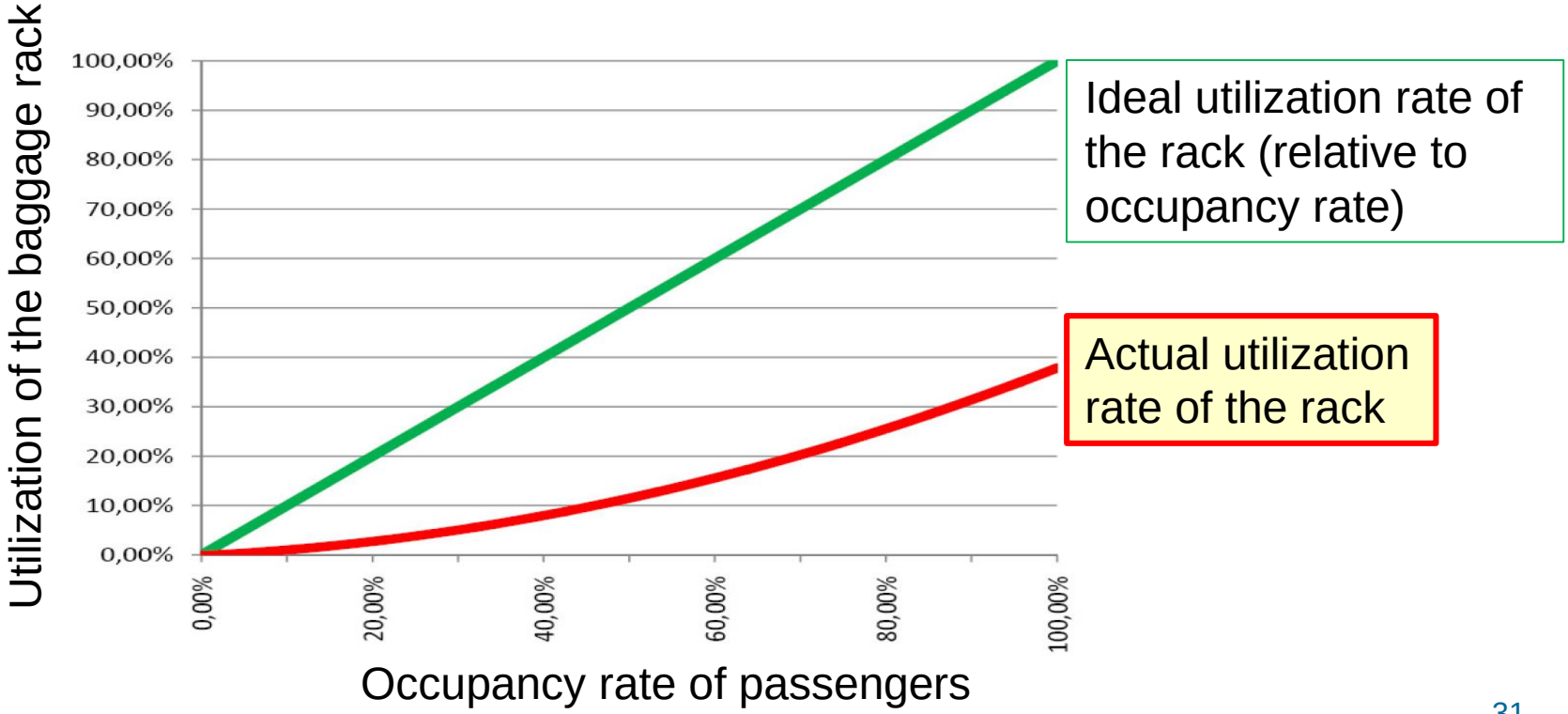
High request



Baggage racks

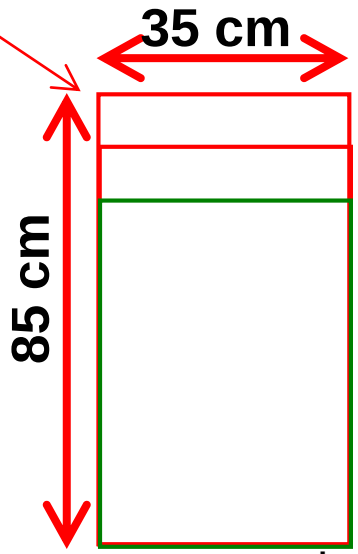
- Are liked by the passengers
- Main problems:
  - **Location** – at the end of the vehicle or in the entrance area
    → NO visual contact
  - **Dimensions** of the rack often do not match today‘s baggage
    → inefficient

Effect of racks close the entrance



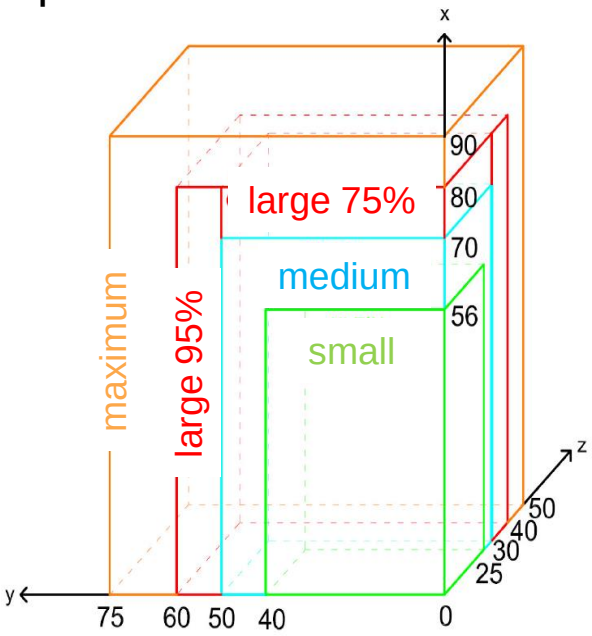
Knowledge about baggage – size required

trolley upright

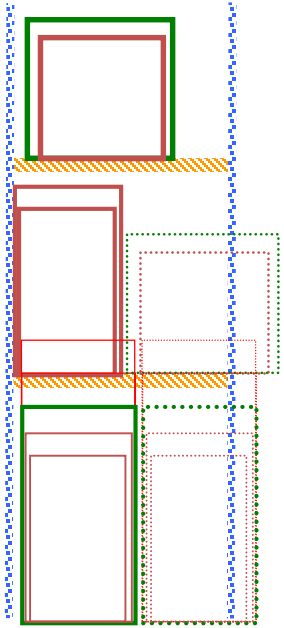


cross-section

Example



baggage racks – dimesions - effects

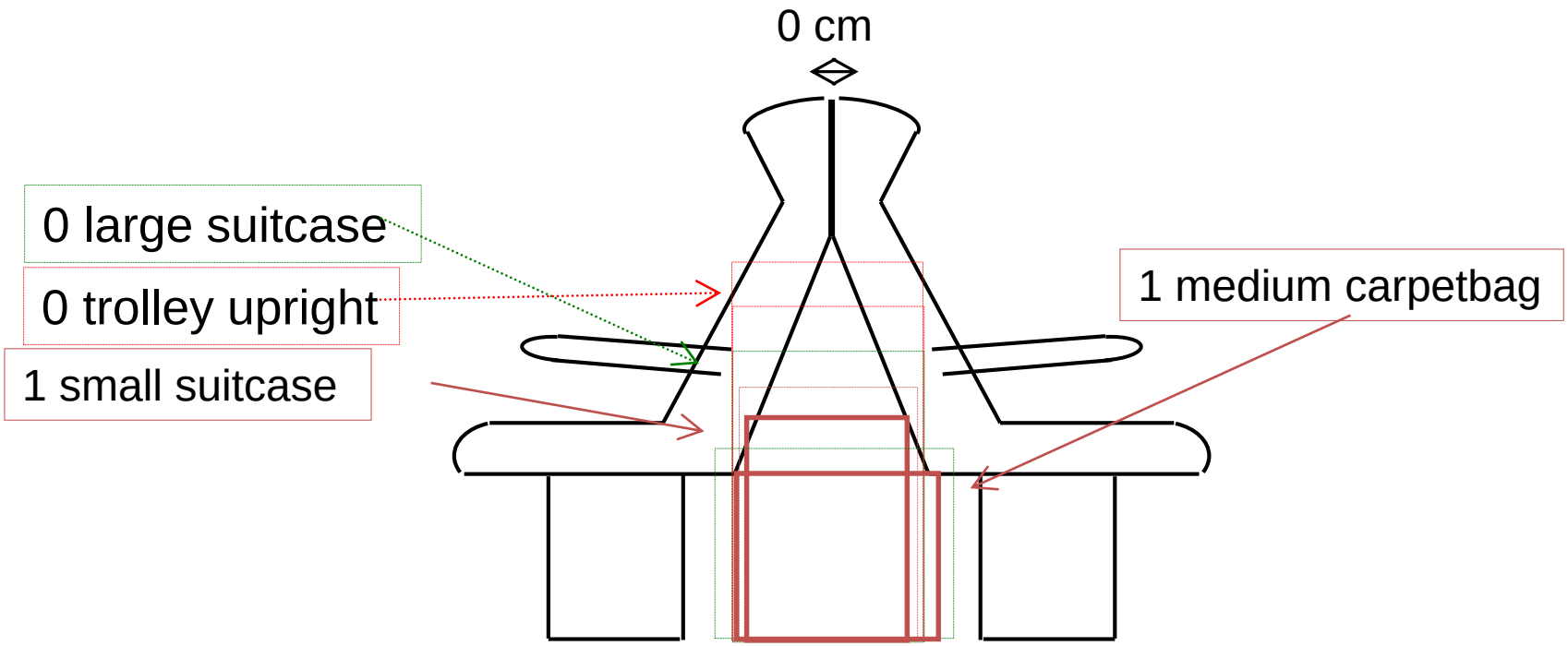


not efficient

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



Overall effect of the vehicle interiors

Arrangement of

- Seats
- Baggage storage

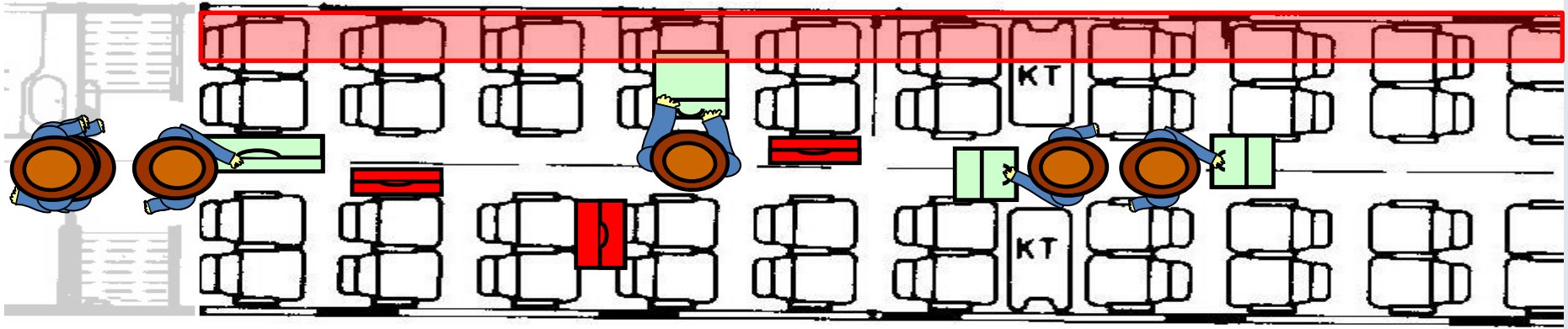
→ has a big influence on:

- Occupancy rate
- Dwell time

Following slides provide examples for better understanding:

Row seating – only overhead bin

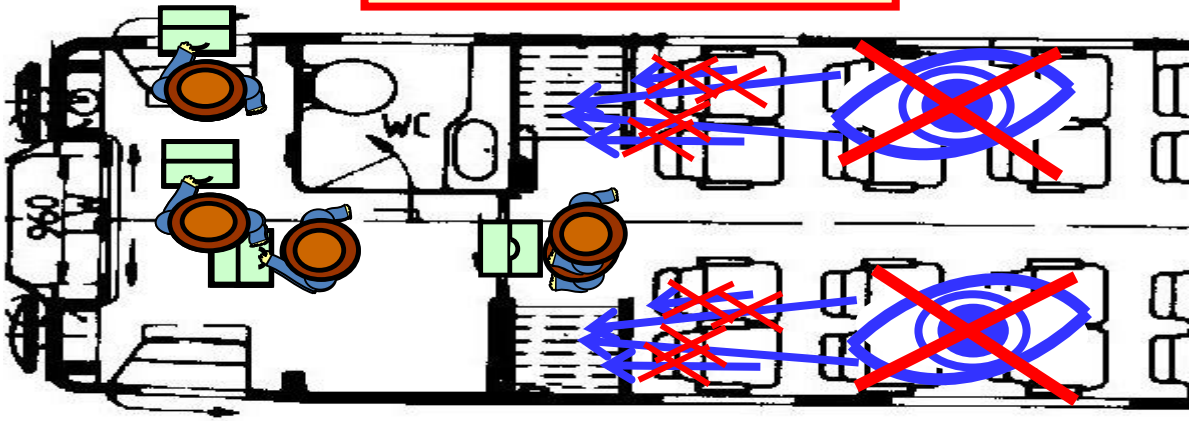
Baggage in aisle, on seats – blocked seats
Oncoming passengers
Overhead bins



Tailback after only a few passengers, long time requirement

Row seating + baggage rack close to entrance

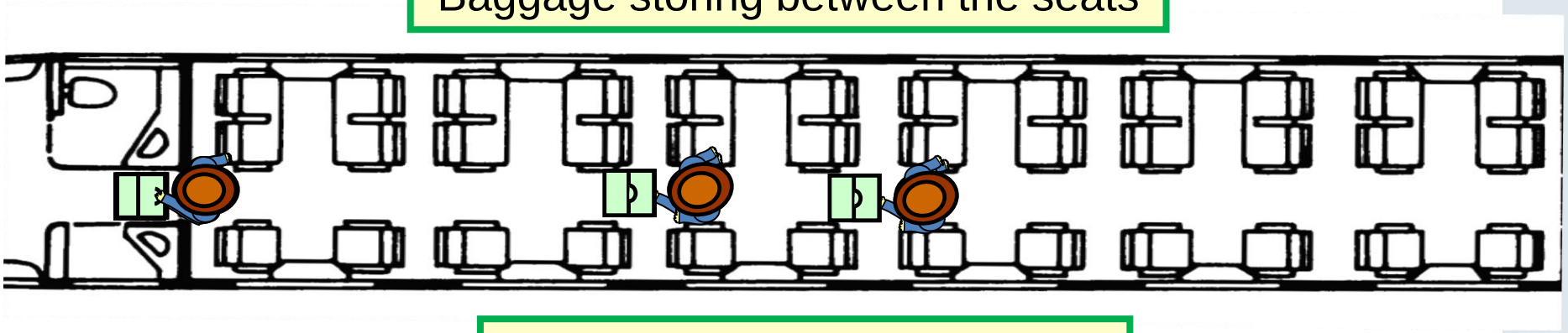
No visual contact



Tailback after only a few passengers, long time requirement

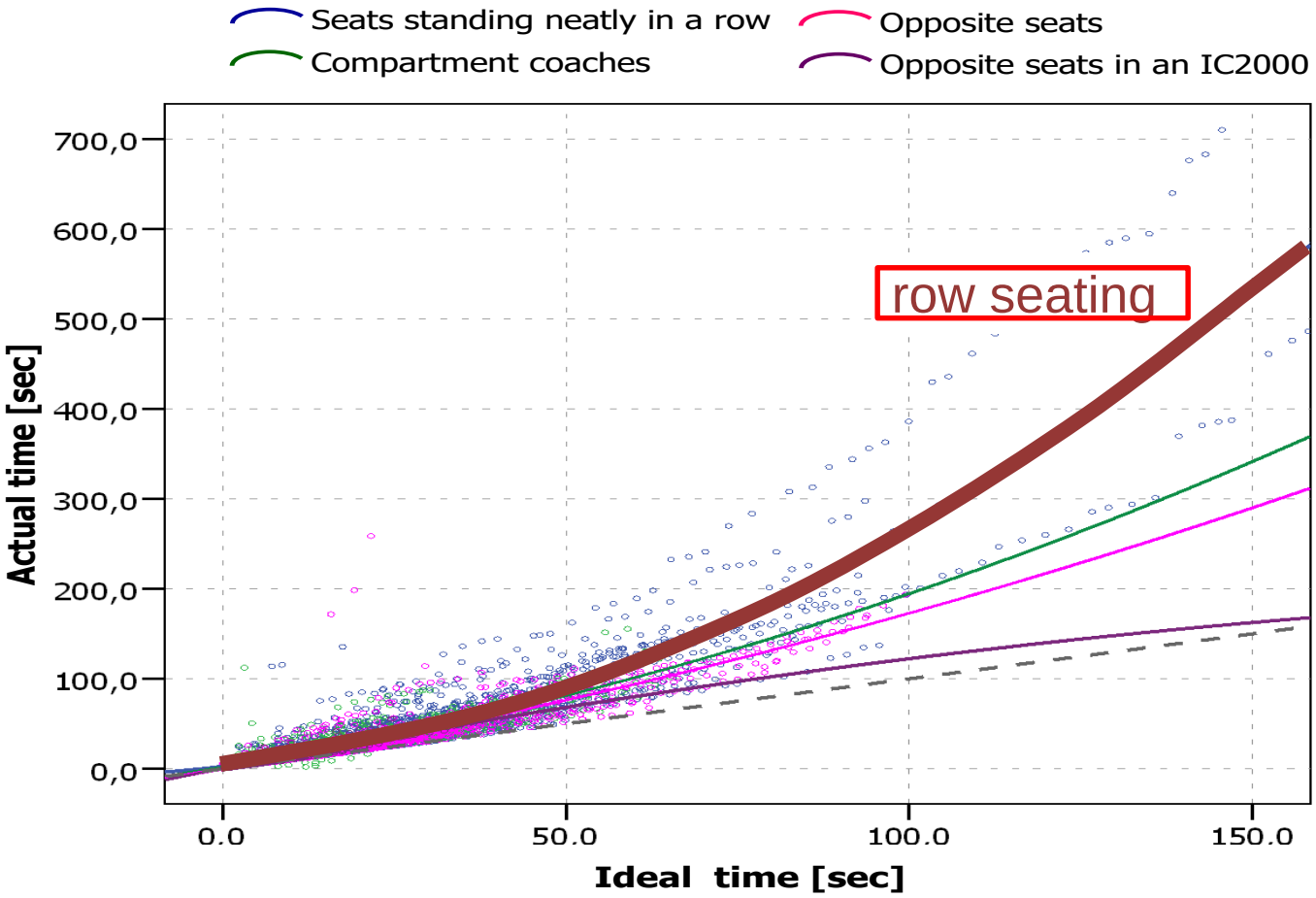
Vis-a-vis seating

Baggage storing between the seats

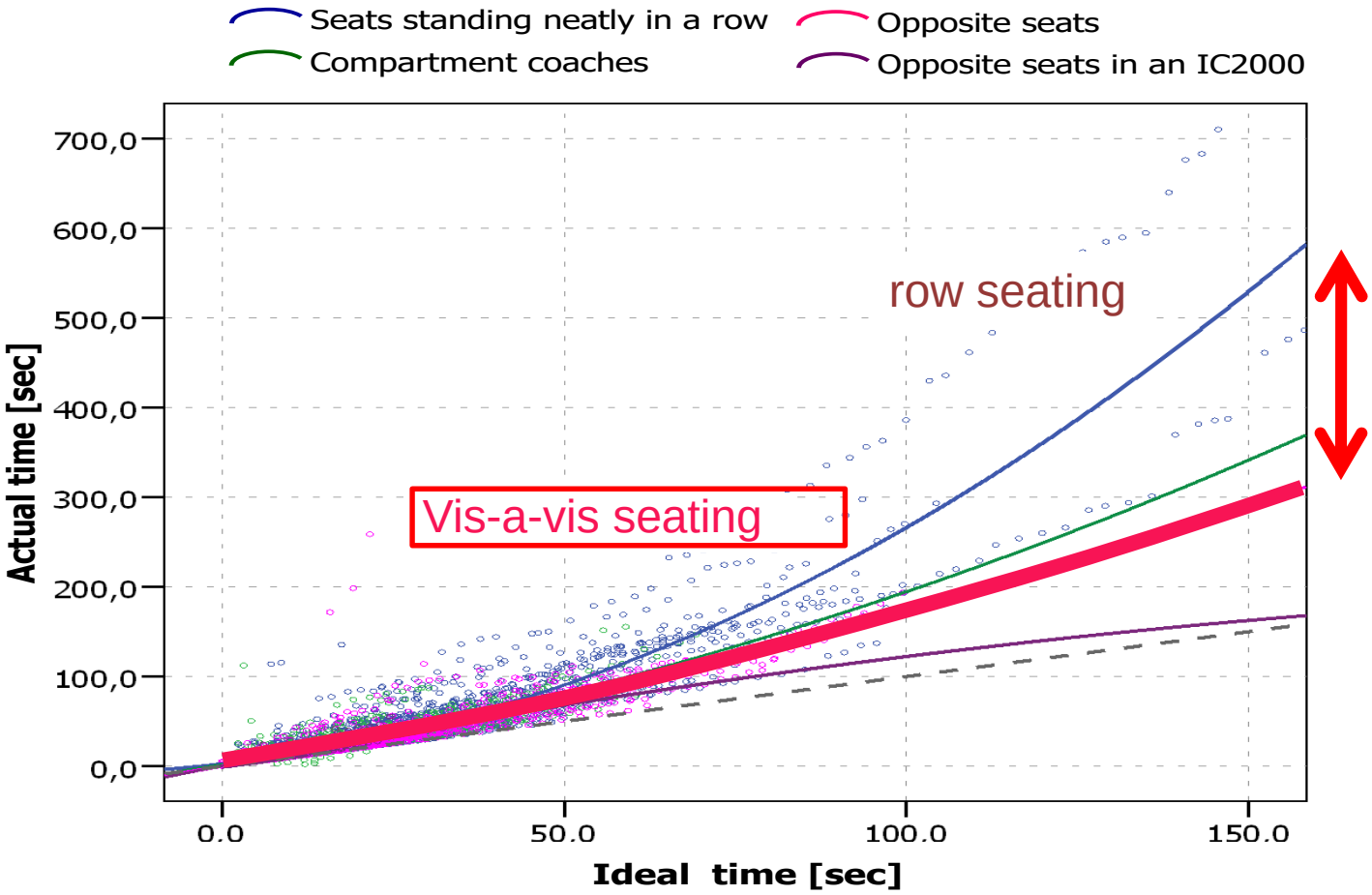


enough space required
→ Very fast and easy storing

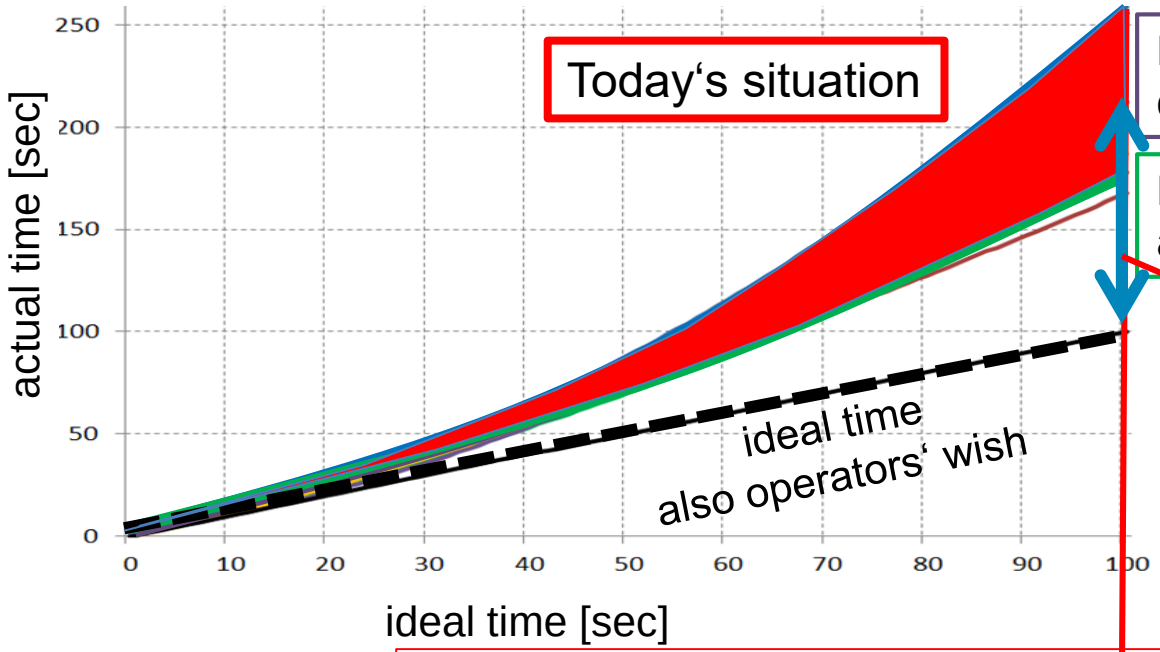
row seating– time requirement



Seat arrangements



Dwell time – different concepts



Row seating (no racks)

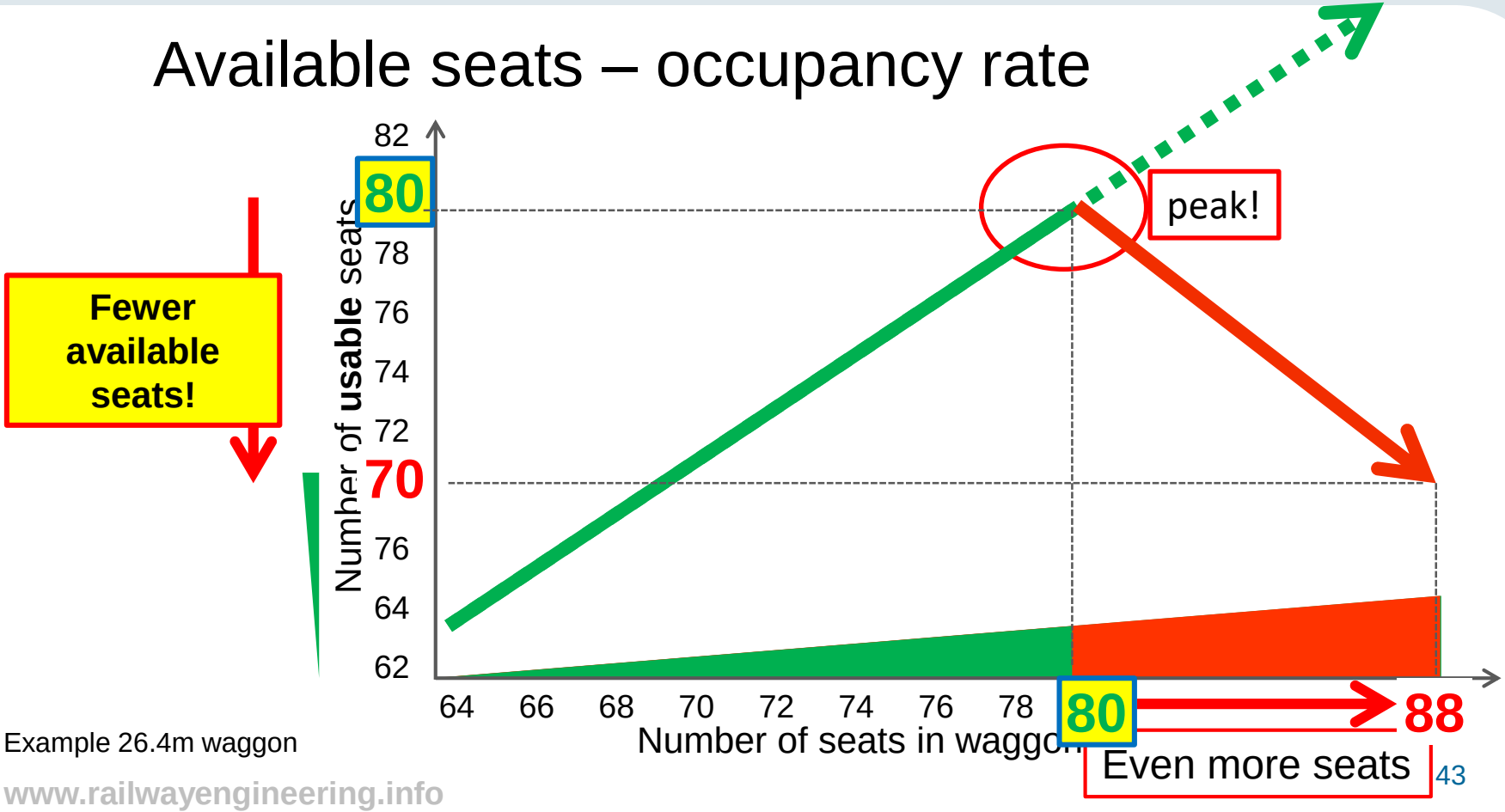
Mixed seat concept (rack close to entrance)

Mixed seat concept (rack away from entrance)

Dwell time needs double to three times longer!

Boarding time, approximately 30 passengers

Available seats – occupancy rate



Example 26.4m waggon

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

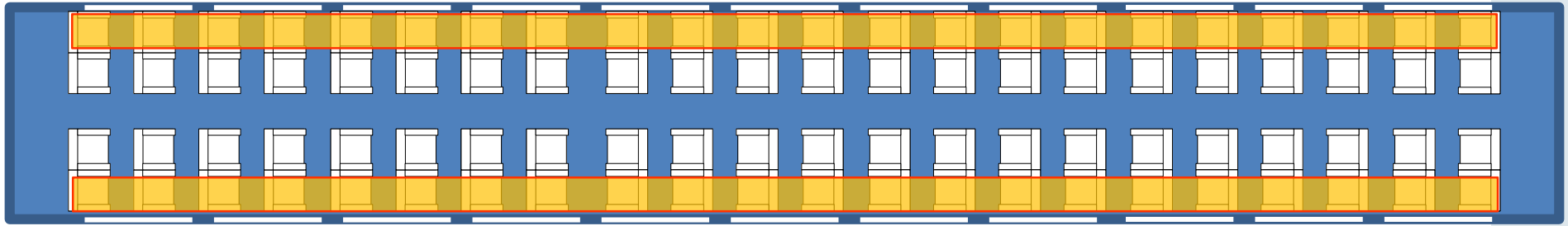
    → On most days 100% occupancy rate is possible
    → Dwell time can be reduced

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

Requirement for designing

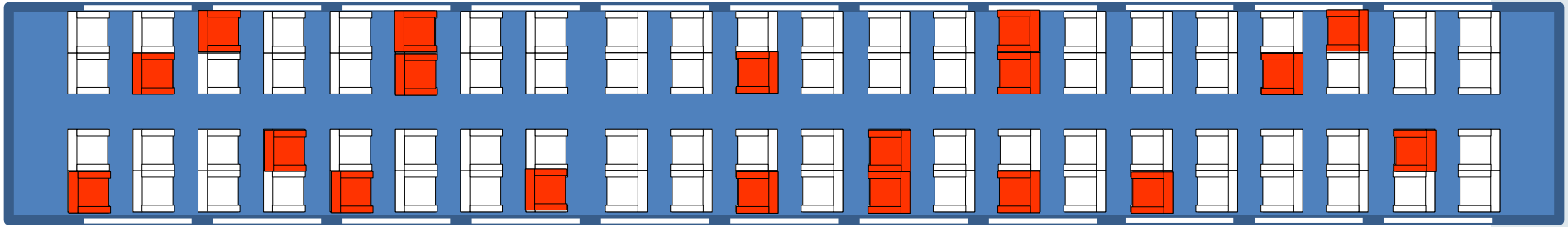
- For redesigning or designing new vehicles:
  - Passengers' **behaviour** must be taken into consideration from the beginning
  - Also passengers' **needs** and **expectations**
  - Exact **calculation** of the optimum number of the seats
    - Knowledge of passengers (main travel purpose etc.)
    - 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

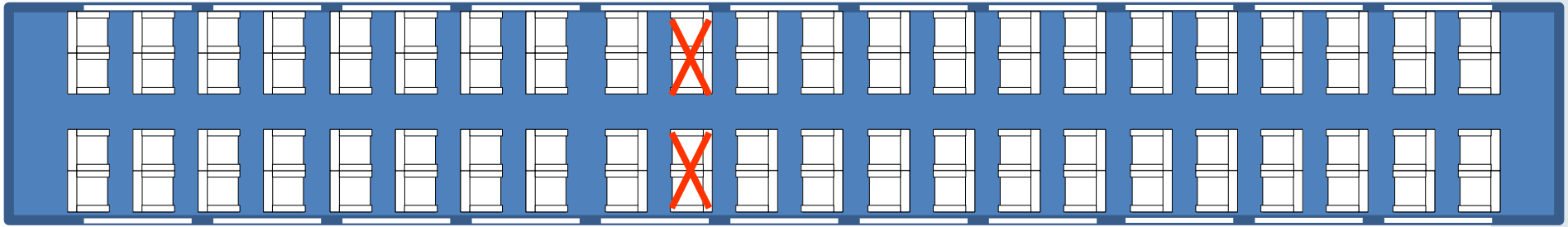


seats
existing : available
88 : 70

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)

Possible improvement

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



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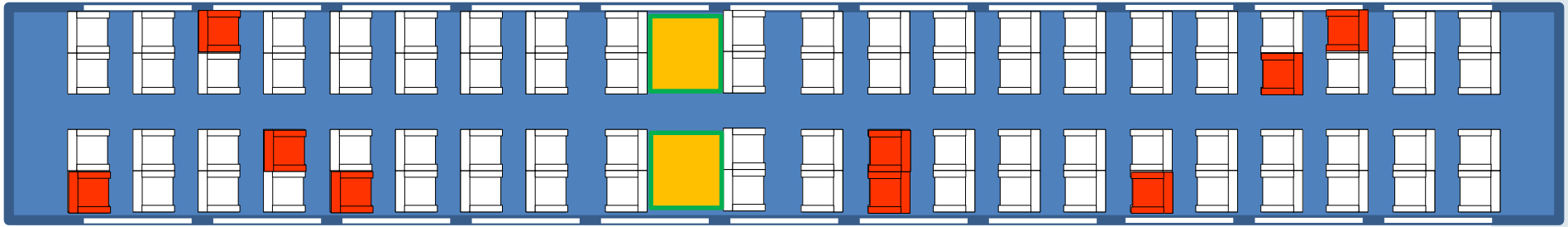

seats
existing : available
84 : 75

Possible improvement

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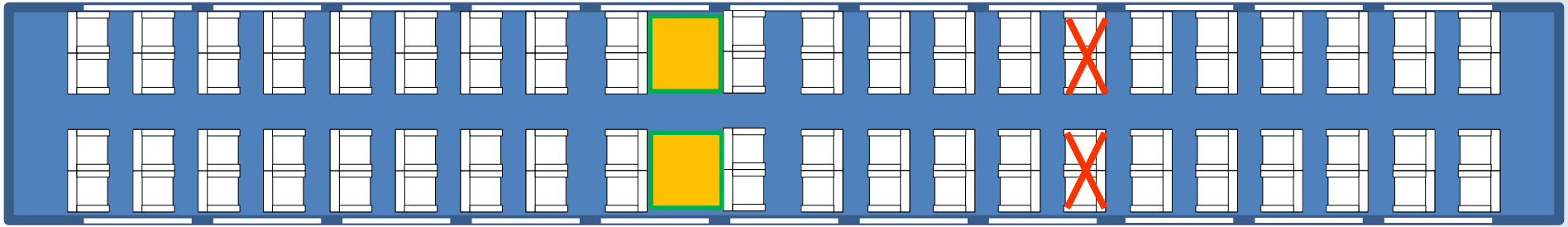

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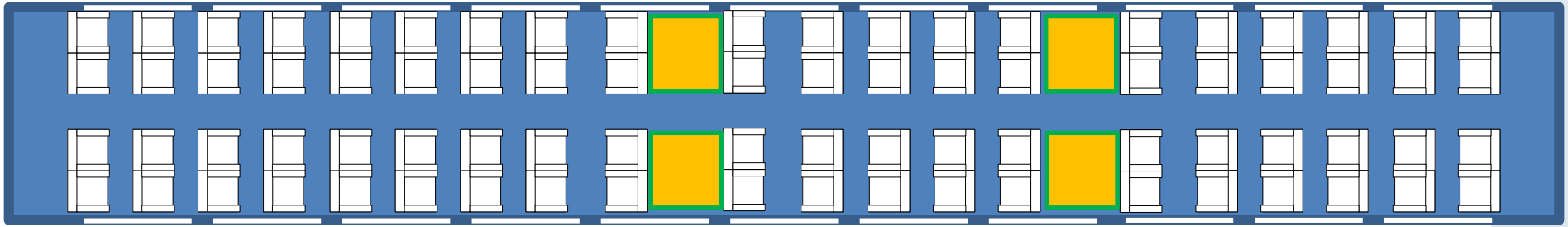
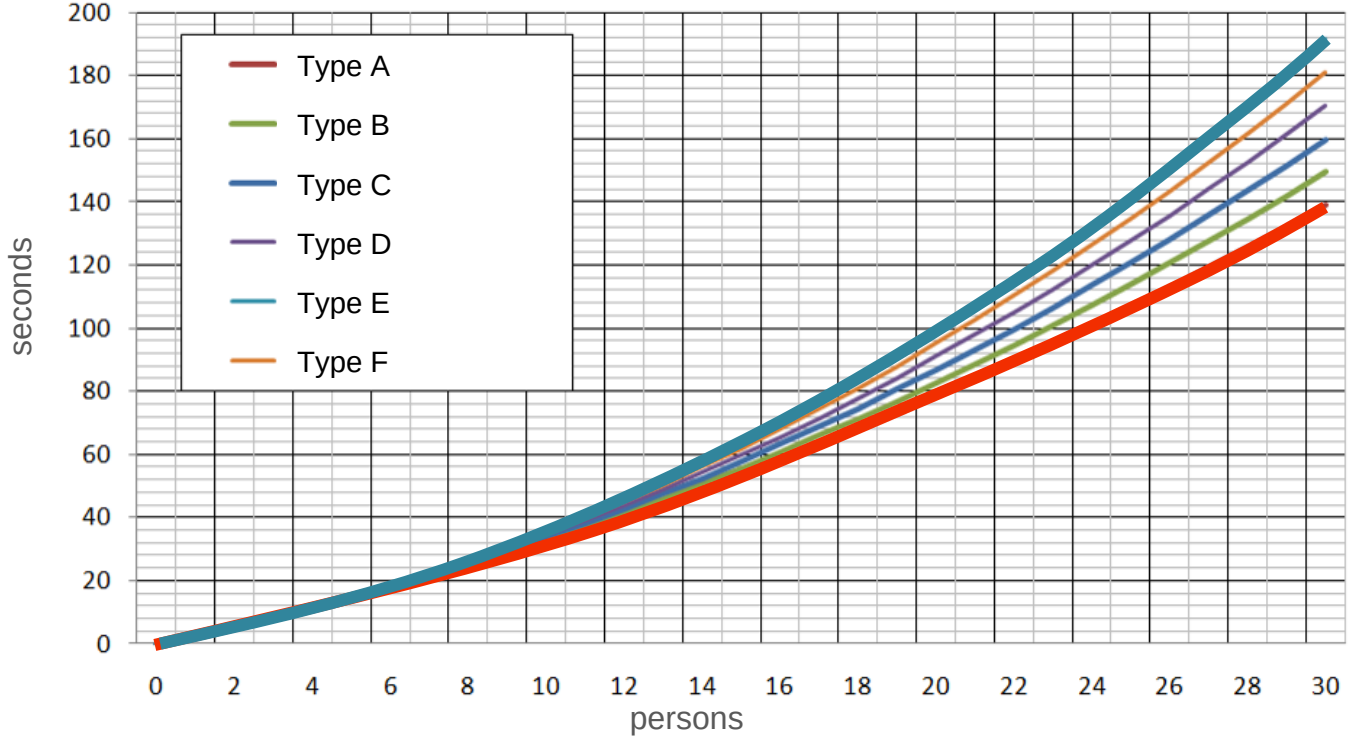


seats
existing : available
80 : 80

Possible improvement – boarding time

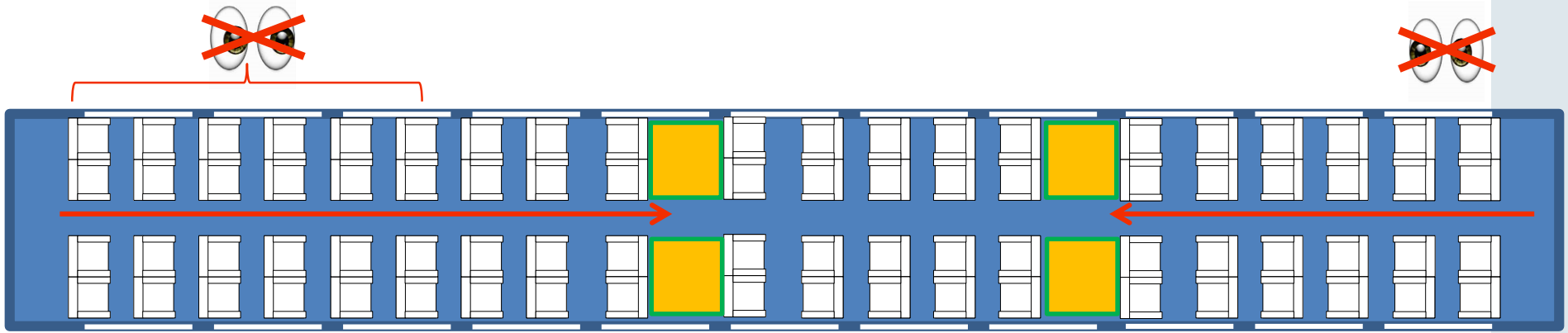


e.g. 88 seats

e.g. 80 seats

fictive example

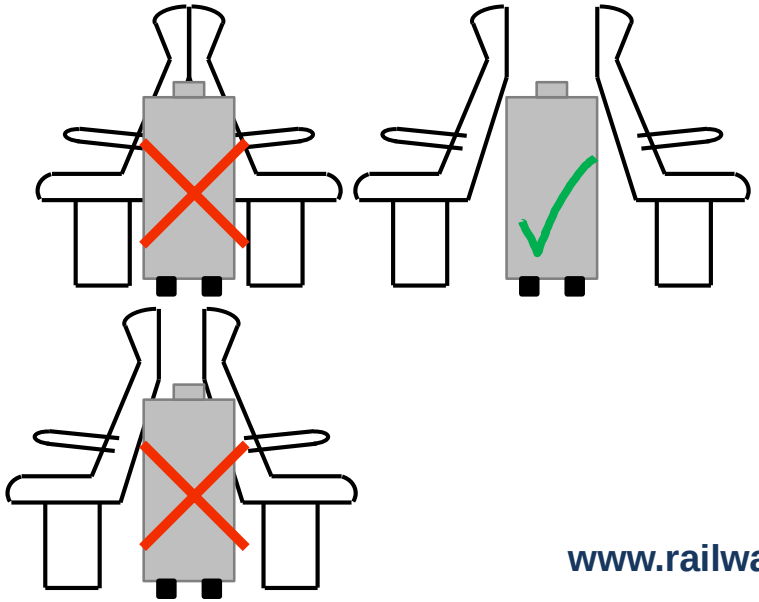
Still suboptimal

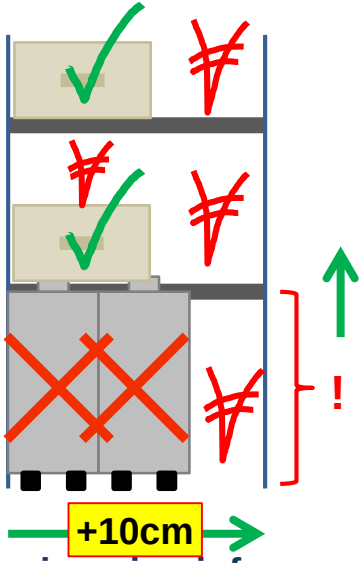


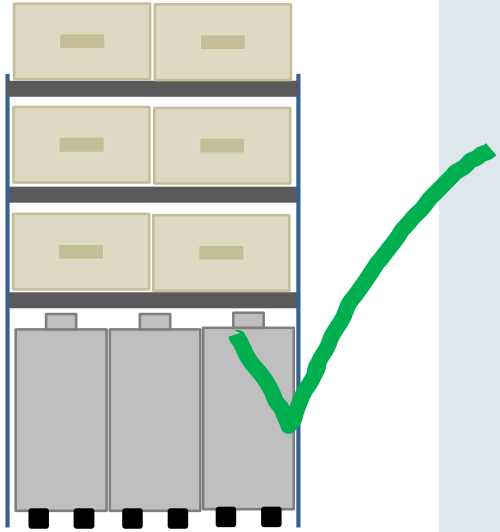
Long way from entrance to rack
Visual contact from a few but not from all seats
Rack width is based on seat divider

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



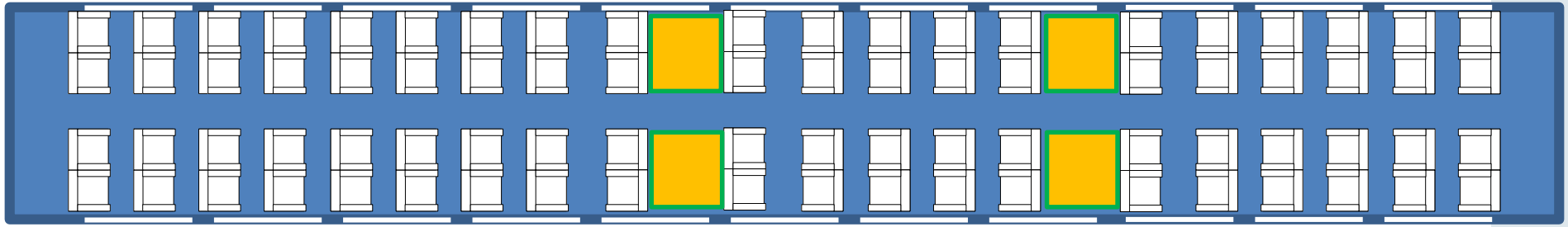




What to consider exactly - examples

- Visual contact → **close** to passengers
- Passenger flow

→ Good baggage storage distribution in the waggon



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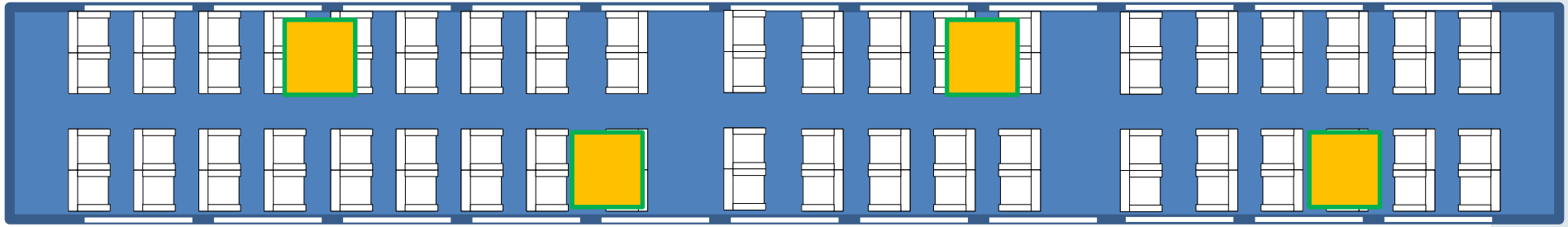
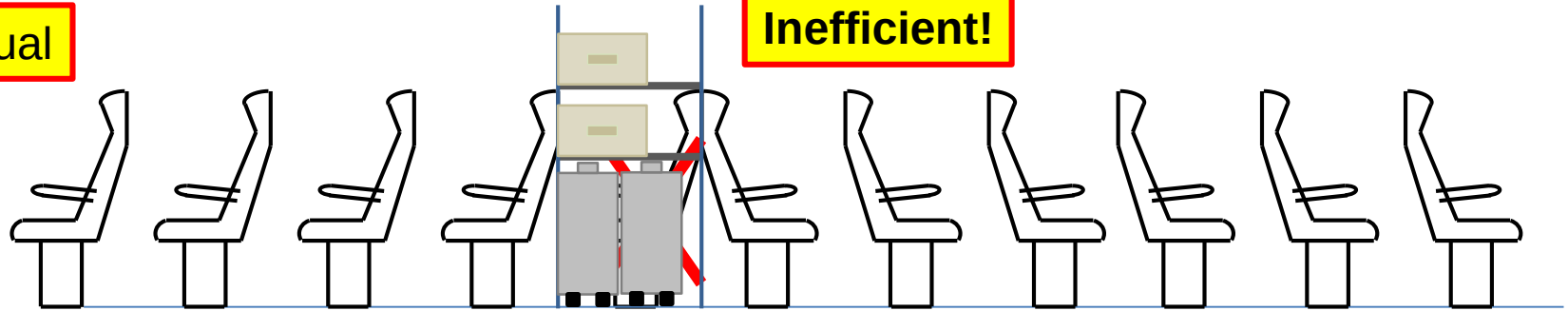


Design from inside

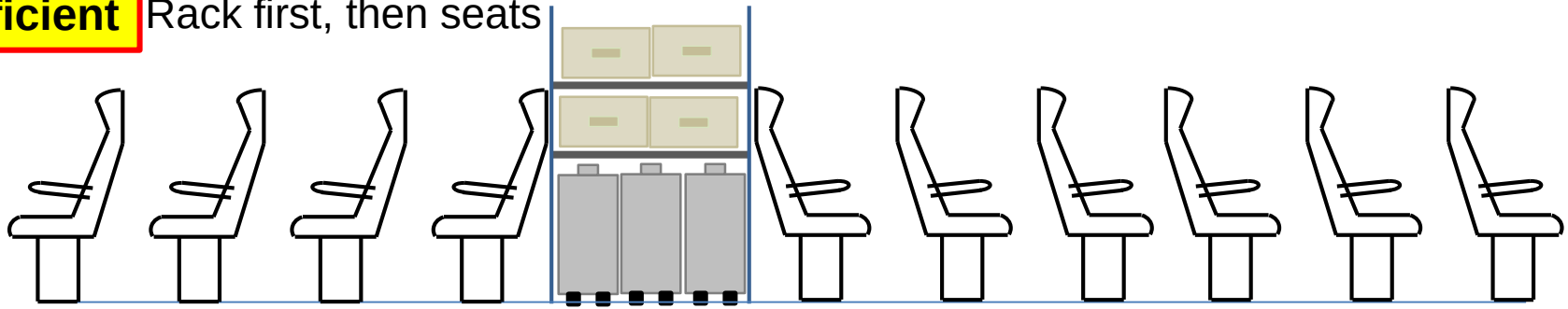
- Baggage racks must have an efficient width and must not be restricted by the seat divider

usual

Inefficient!

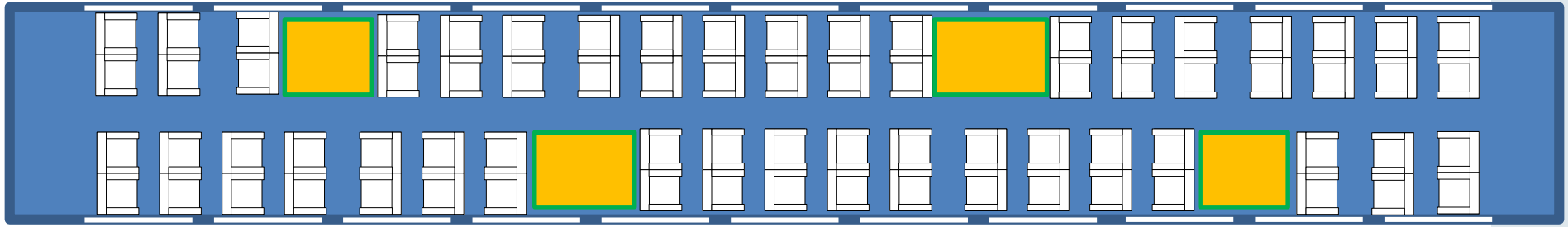


efficient Rack first, then seats



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!

Questions to: bernhard.rueger@tuwien.ac.at

www.railwayengineering.in