TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

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The interior space of railway carriages - balancing act between sense and operating efficiency

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Inition

- Vienna University of Technology (Research Centre for Railway Engineering), in cooperation with netwiss, has a **15 years' experience** on 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 an holistic system!

→ Optimizing single parts is inefficient!

- As University and as researcher we are independent
- Our aim is to be discerning in order to develop efficient rail systems

Efficient rail system - interiors

- Many things are important!
- Very important – **knowledge about passengers':**
  - **needs** and **expectations**
  - **experiences**
  - **actual behaviour** in their environment

Only if the rail vehicle interiors meets the passengers' needs in all phases it can be efficient!

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 need** 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 interiors 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**
- (hopefully) **satisfied** passengers

Expectation of industry and operators

- **Expectation:** Industry develops systems and

→ passengers behave as the industry and operators expect.

- **Reality:** Passengers have a lot of (conscious an unconscious) needs.

→ Passengers will **use the environment** they find in the vehicles **as it fits best** to their needs!

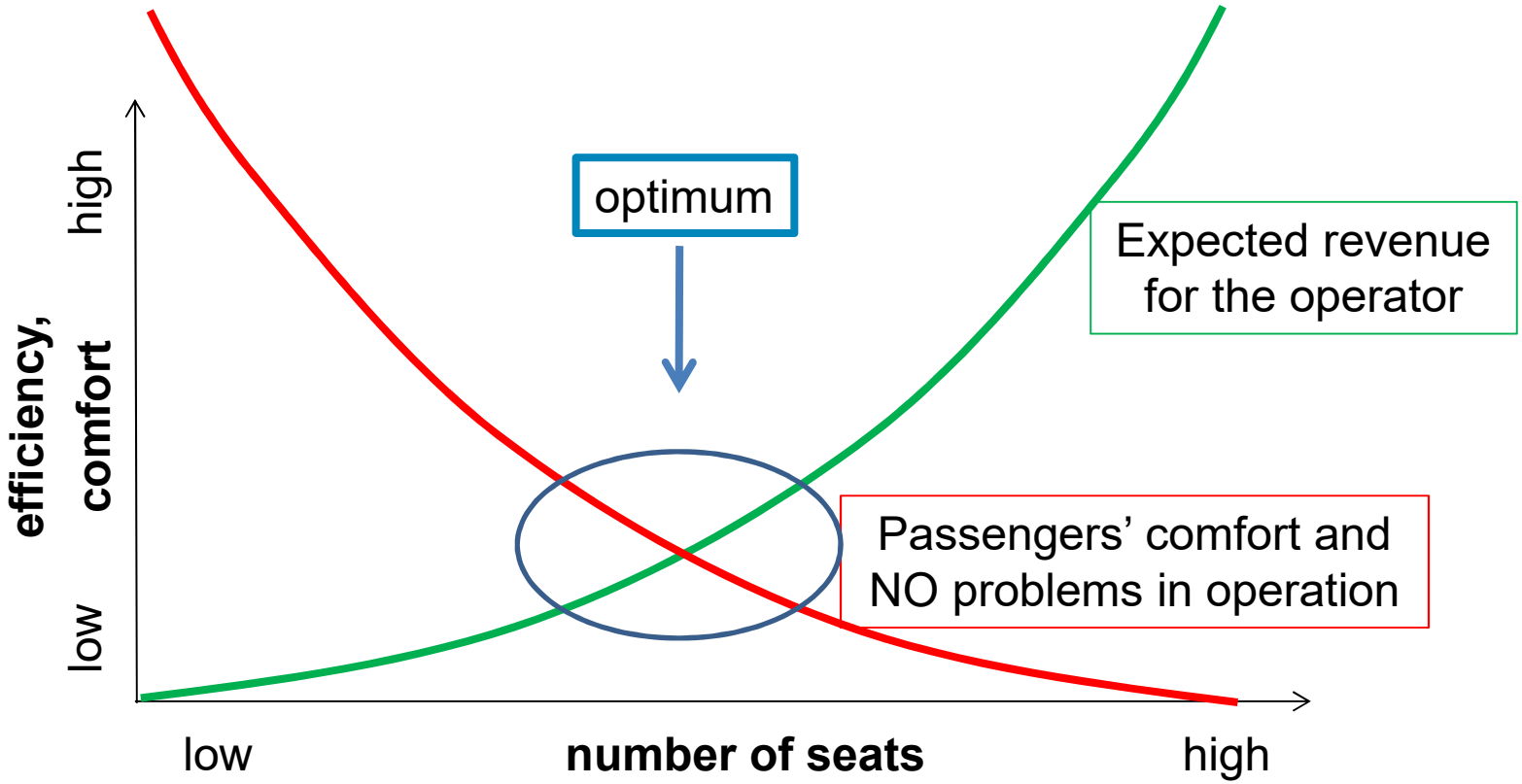
Requirements – passengers

- 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 corridor, 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 condition, 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 on the comfort needs is required!

Overal interiors concepts - effects



symbolic drawing

Baggage – two dogmas

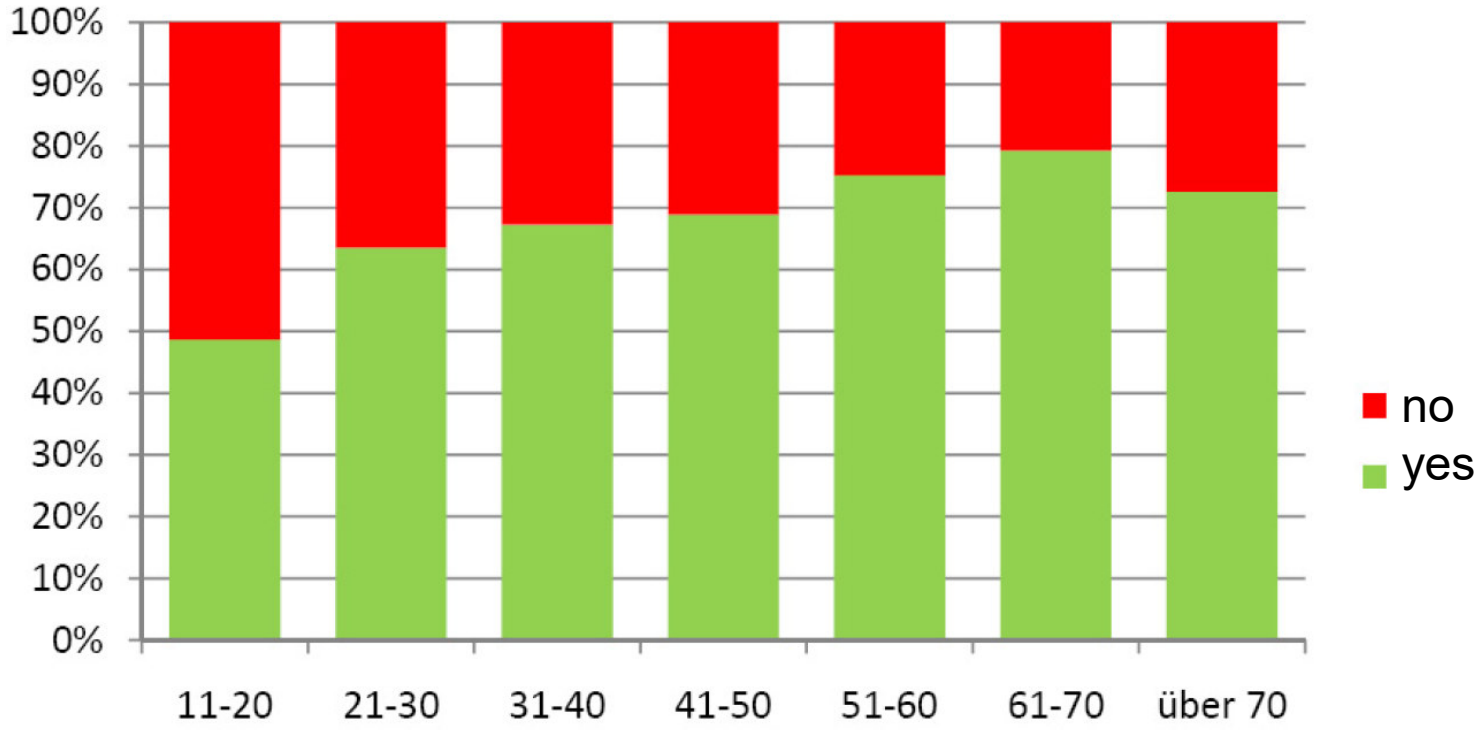
- Passenger try to **avoid lifting** baggage
- Passengers want to have **visual contact** to their baggage!

Willingness to lift baggage

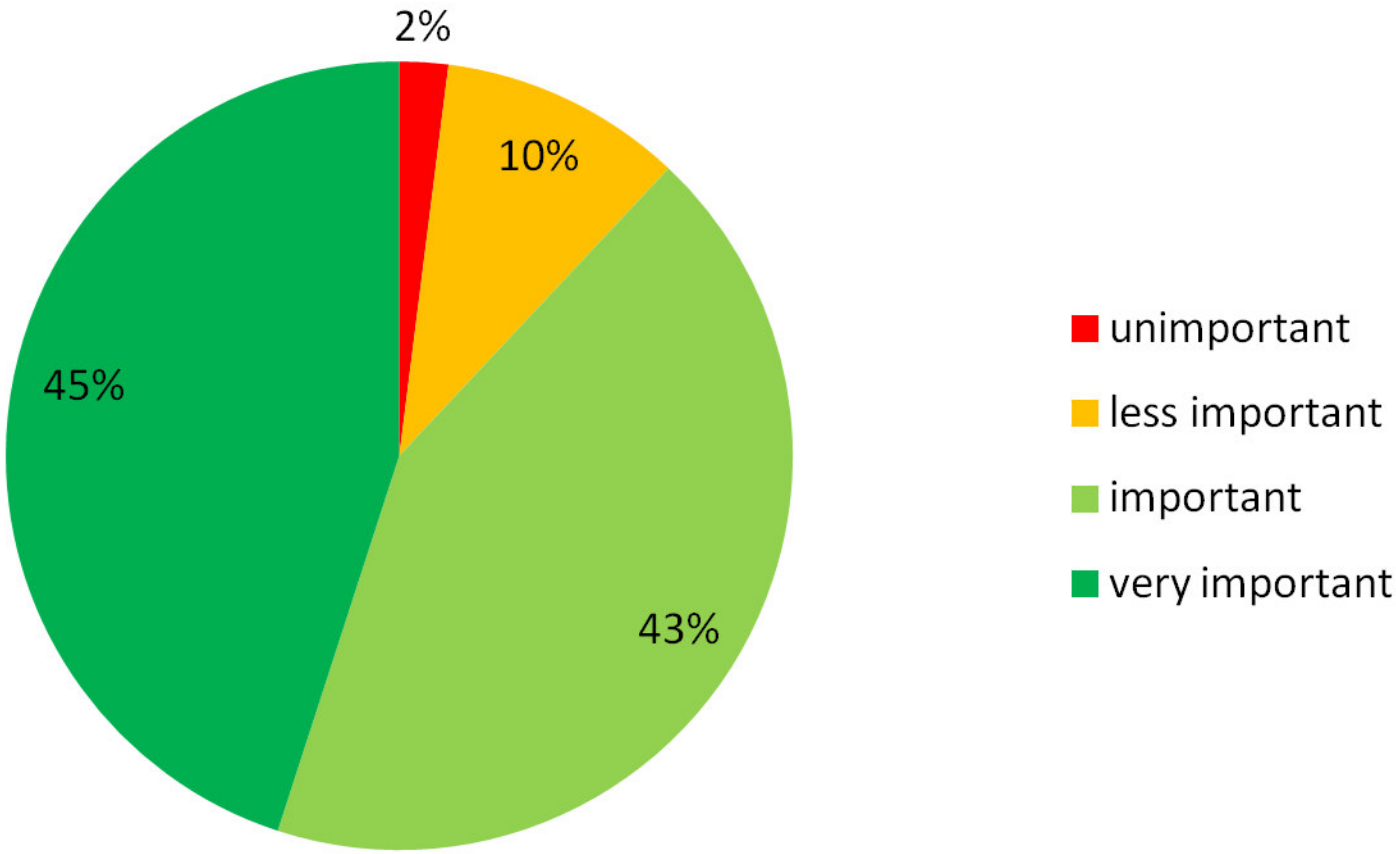
20% (heavy) **to 40%** (medium baggage) are **willing to lift** baggage to the overhead bin

Up to one meter: willingness to lift is higher

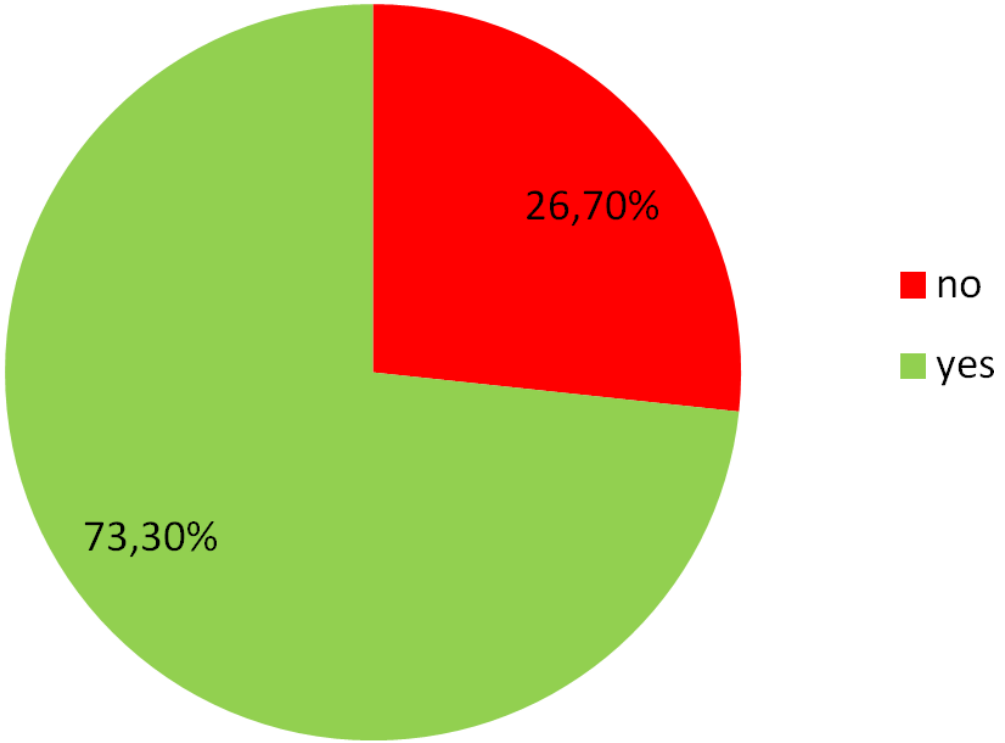
Willingness to **store baggage disturbing** (on floor, seats, in the corridor etc.) **to avoid lifting?**



Importance of visual contact

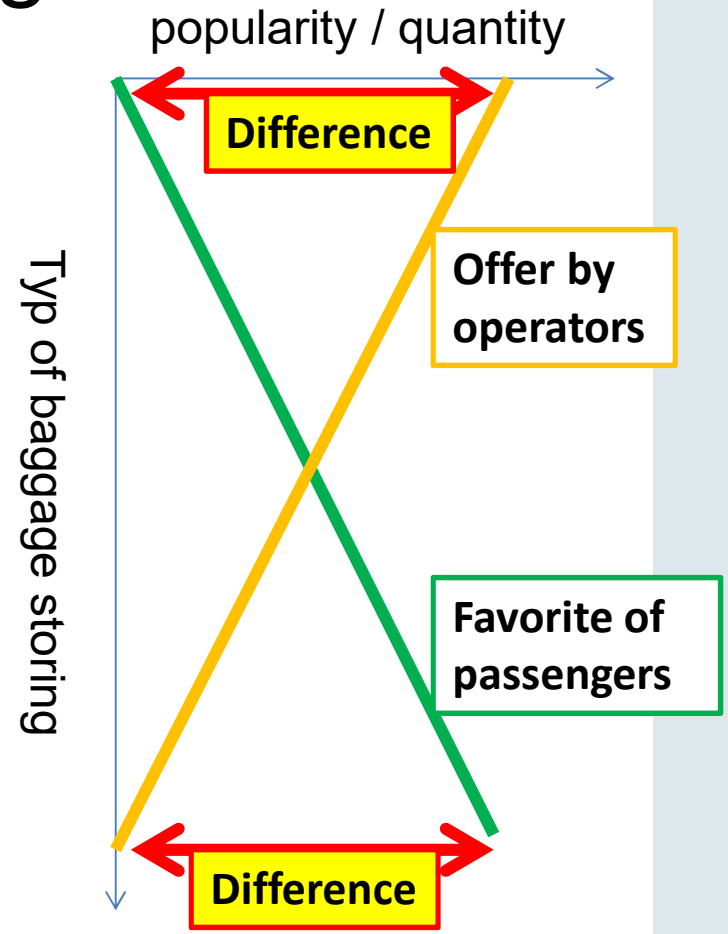


Willingness to **store baggage disturbing** (on floor, seats, in the corridor etc.) **to guarantee visual contact?**

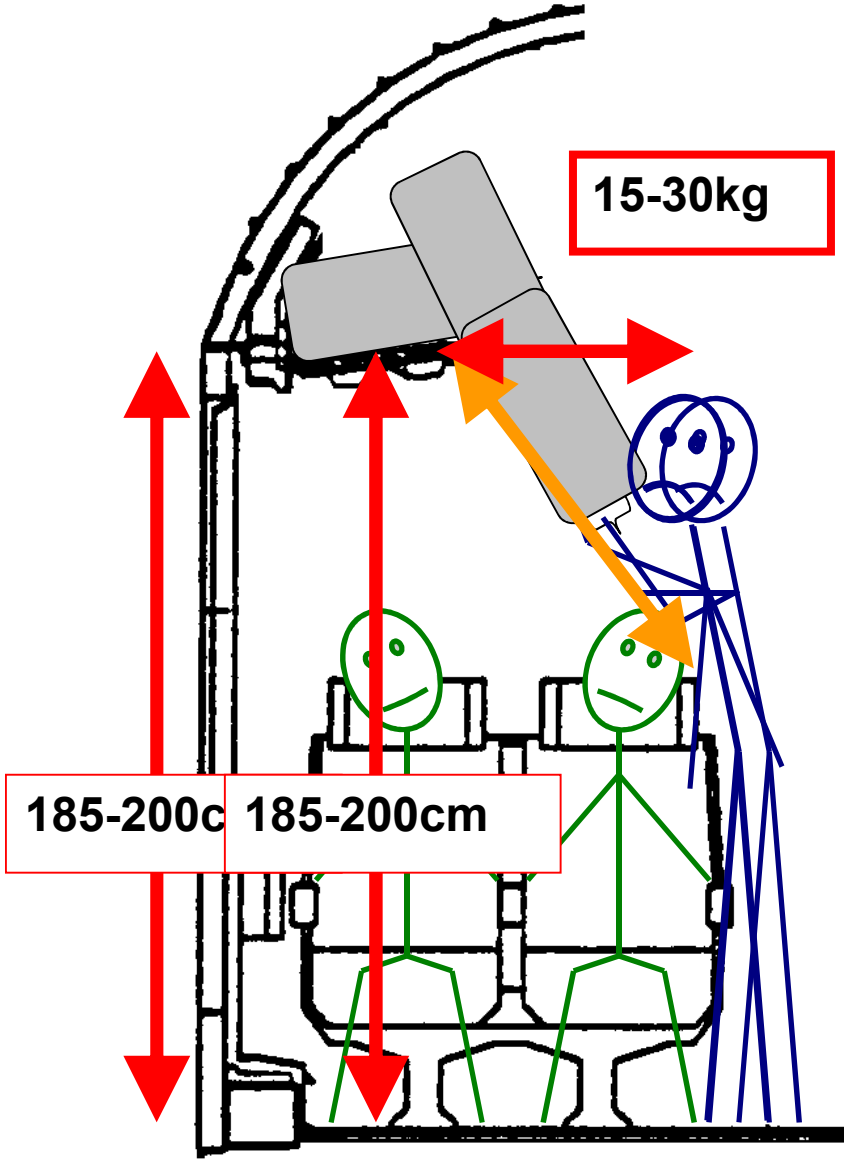


Offer of baggage storage

- **Overhead** bins
  - Frequently the only offer
  - **Not liked** by passengers
- Baggage **racks**
  - Sometimes offered, especially in new coaches
  - **Liked** by passengers
- **Between seat** back rests
  - Hardly offered
  - **Very liked** by passengers



Overhead bin



Height of overhead bin

Width of seats, large diagonal

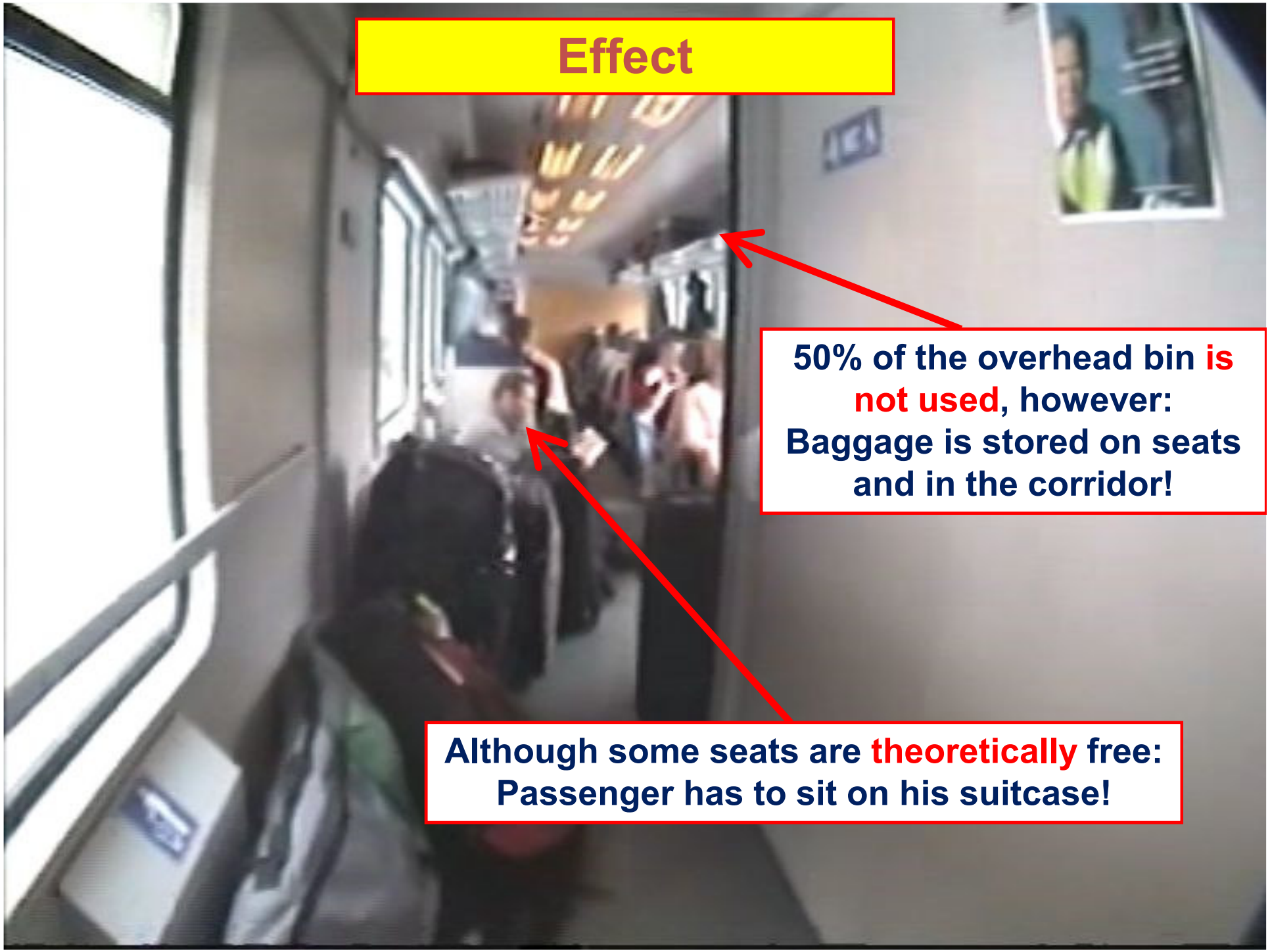
Baggage weight

Large torque, large force!

Safety risk for sitting passengers

- Large exertion
- Safety risks

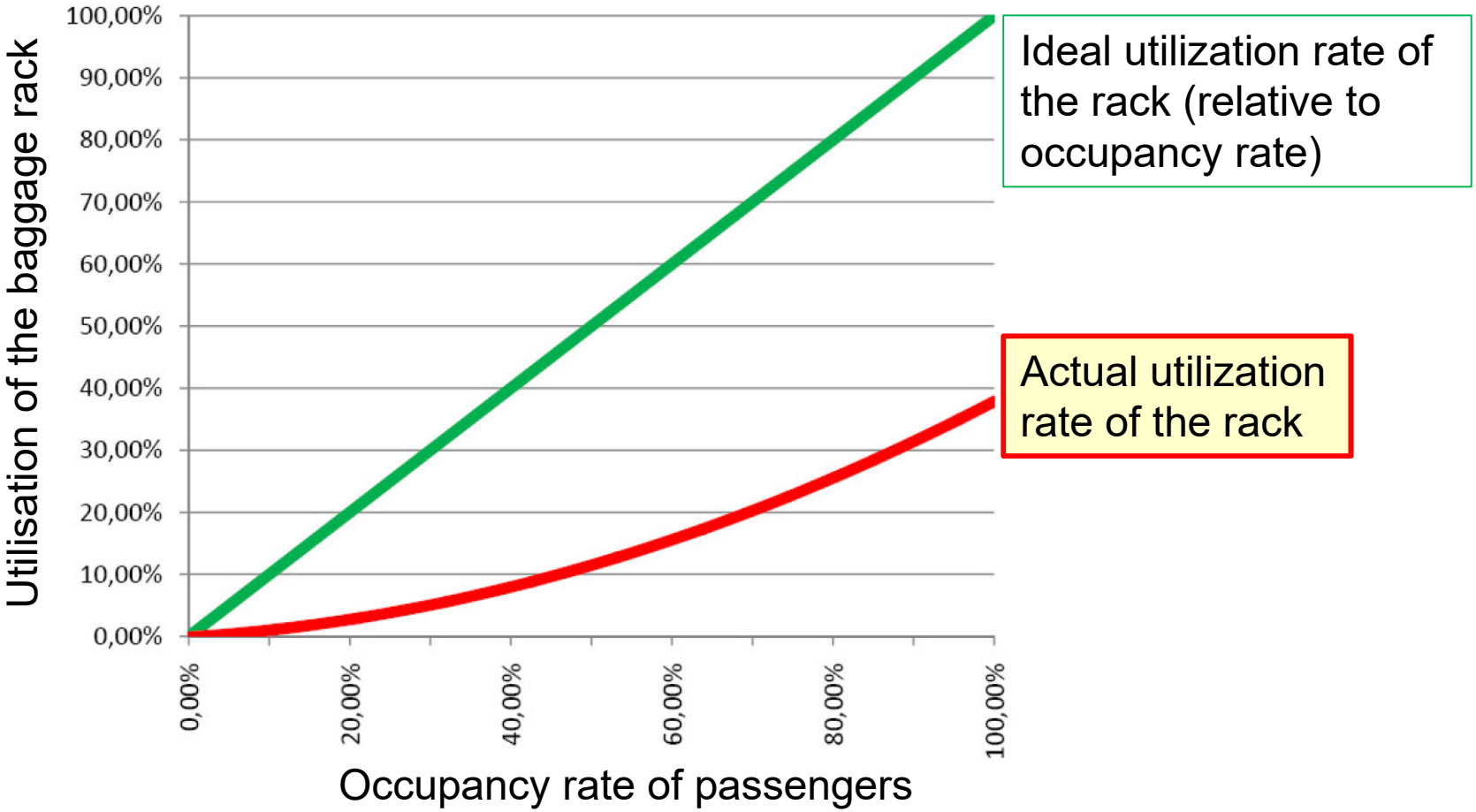
→ **negativ sensation**


Effect
50% of the overhead bin is not used, however:
Baggage is stored on seats and in the corridor!
Although some seats are theoretically free:
Passenger has to sit on his suitcase!

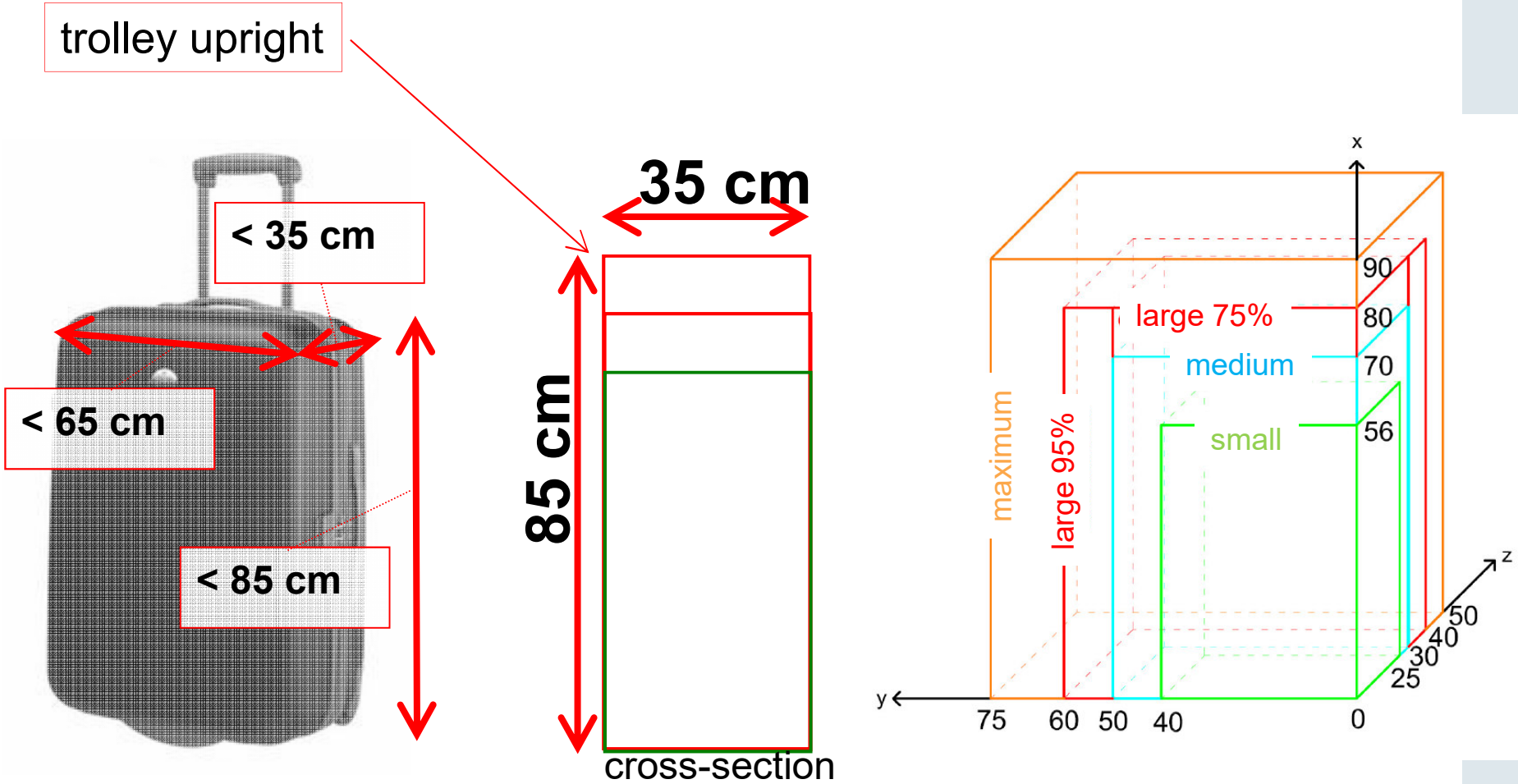
Baggage racks

- 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



knowledge about baggage - size

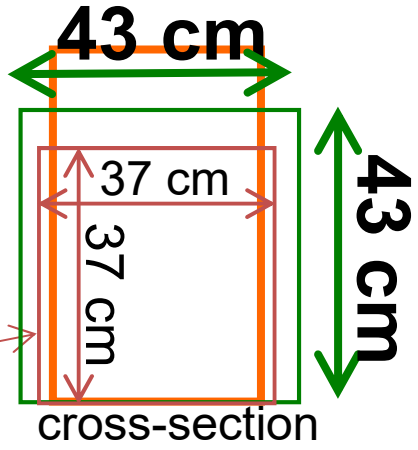
large carpetbag

< 43 cm

< 85 cm

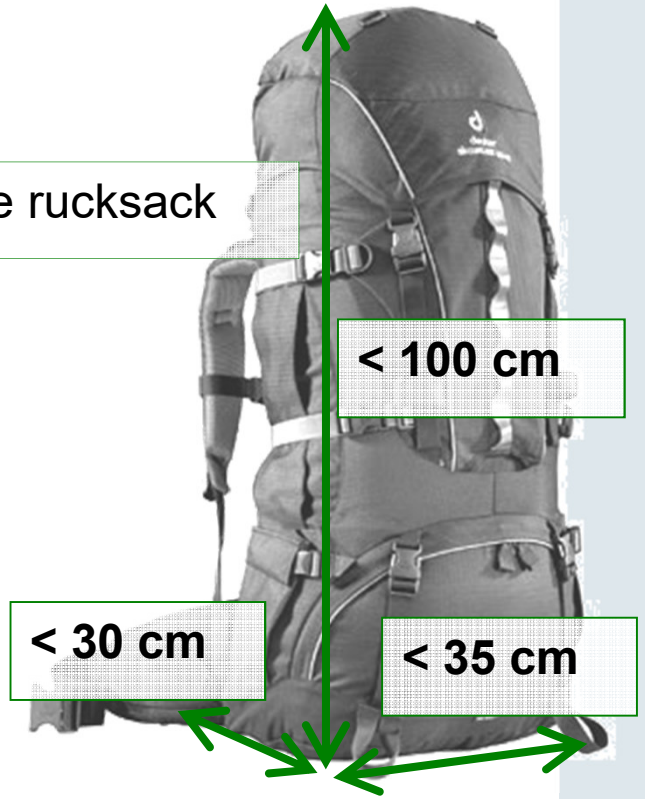
< 43 cm

medium carpetbag



cross-section

large rucksack

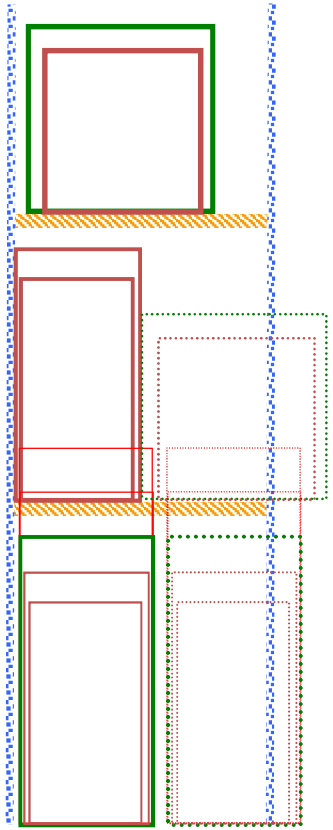


< 100 cm

< 30 cm

< 35 cm

baggage racks – dimesions - effects



not efficient

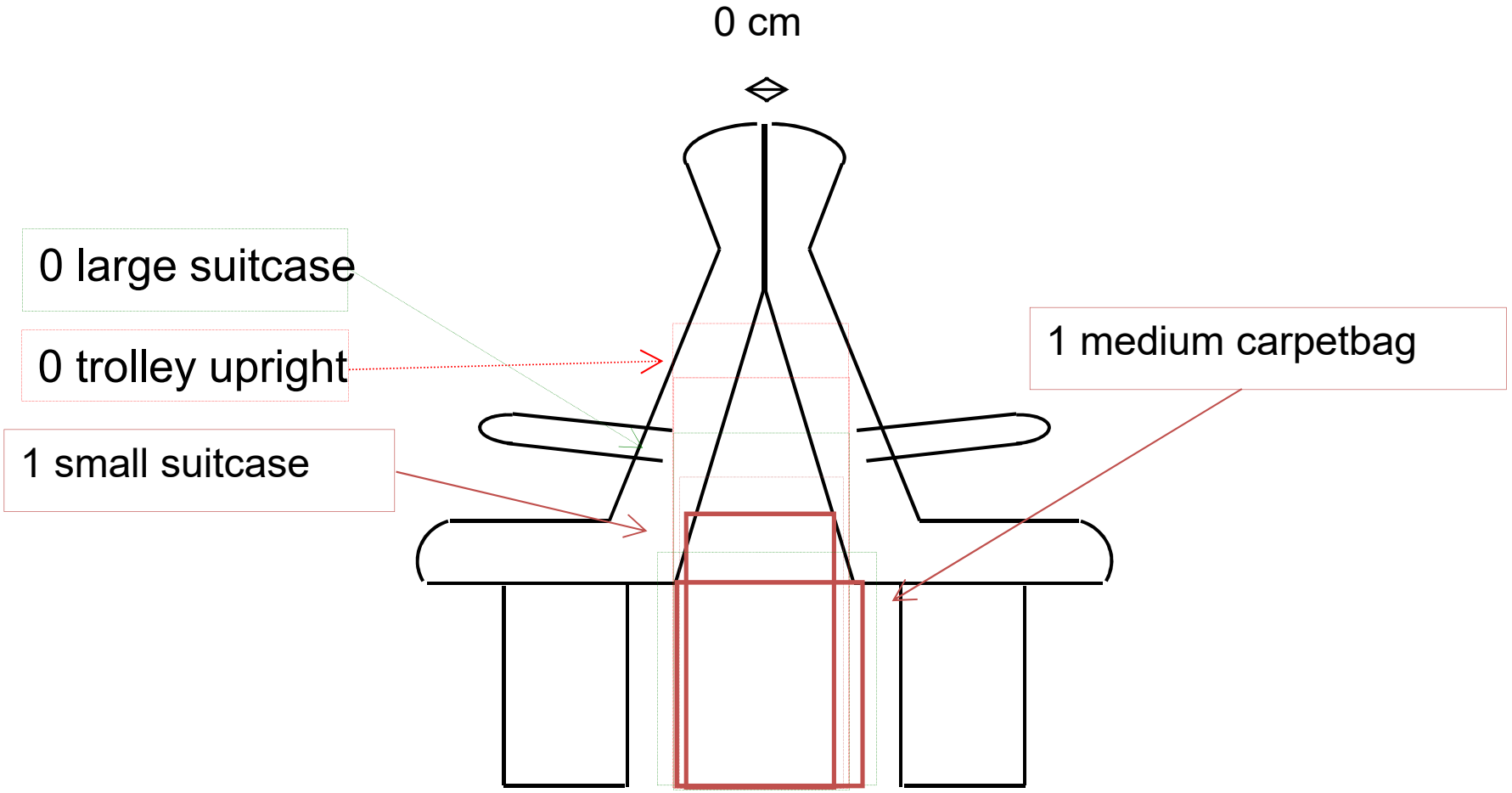
Between seat back rests

- Very liked by the passengers!
  - Easy storing, no lifting, close to passengers
- Main problems:
  - **Space** between the seat back rests does not match today‘s baggage (especially larger items‘)
    → inefficient

Space between seats – today‘s examles

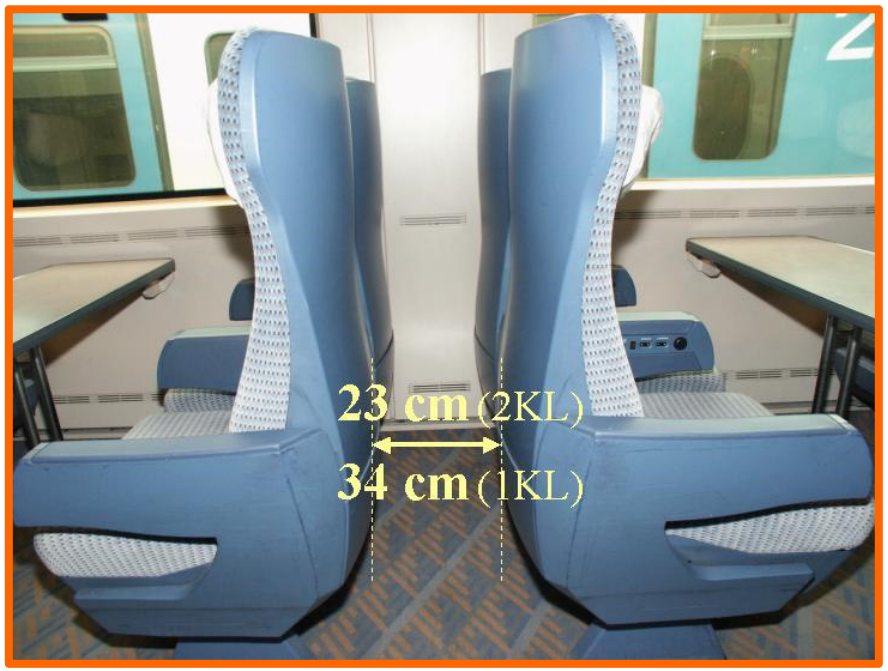
Bad solutions – no space for large items!

Space between seats – today‘s examles

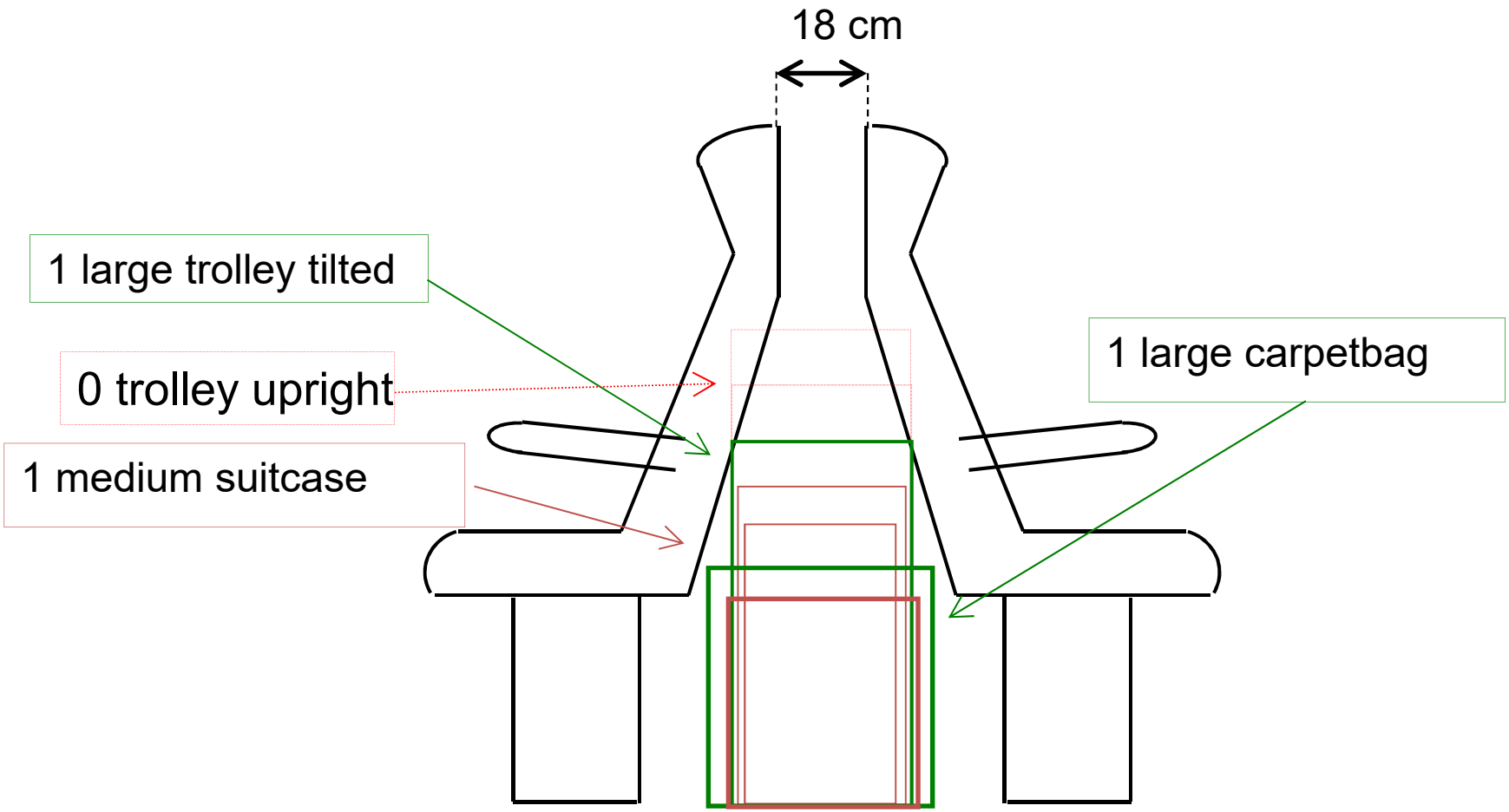


Space between seats – hardly to find anymore

moderate solutions – few space for large items



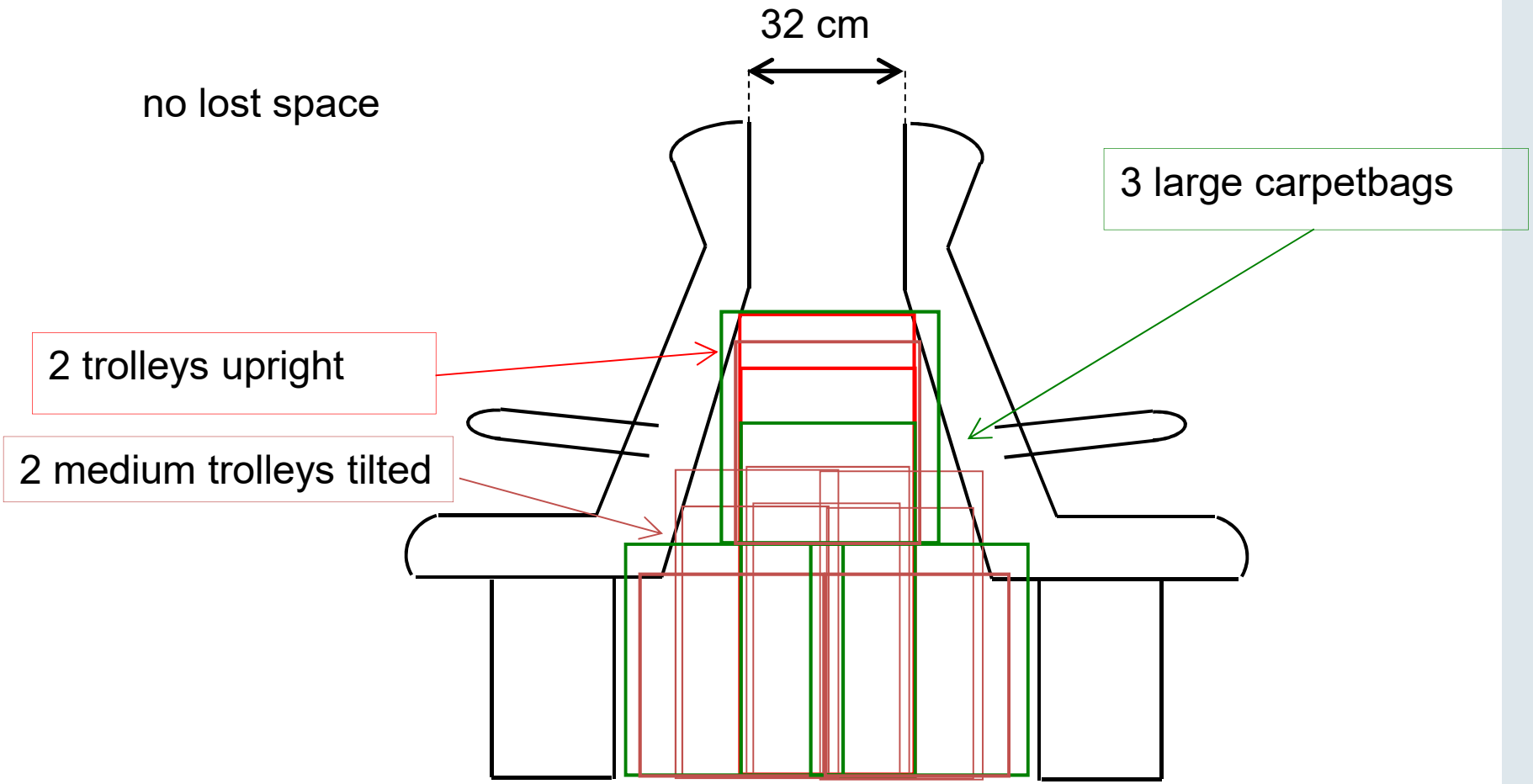
Space between seats – hardly to find anymore



Space between seats – **past!**

Good solutions – enough space for large items

Space between seats – **past!**



Effect of the overall vehicle interiors

Arrangement of

- Seats
- Baggage storages

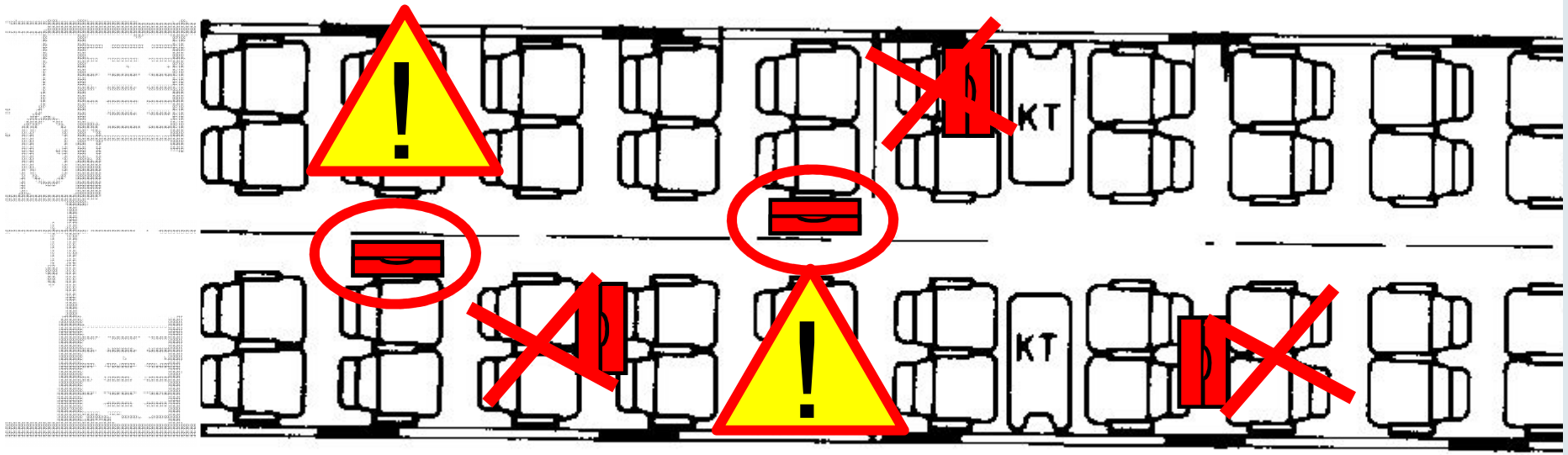
→ has got a big influence on:

- Occupancy rate
- Dwell time

Following some examples:

Row seating – only overhead bin

Many large items are stored on floor level →
ON or IN FRONT OF SEATS / IN THE CORRIDOR

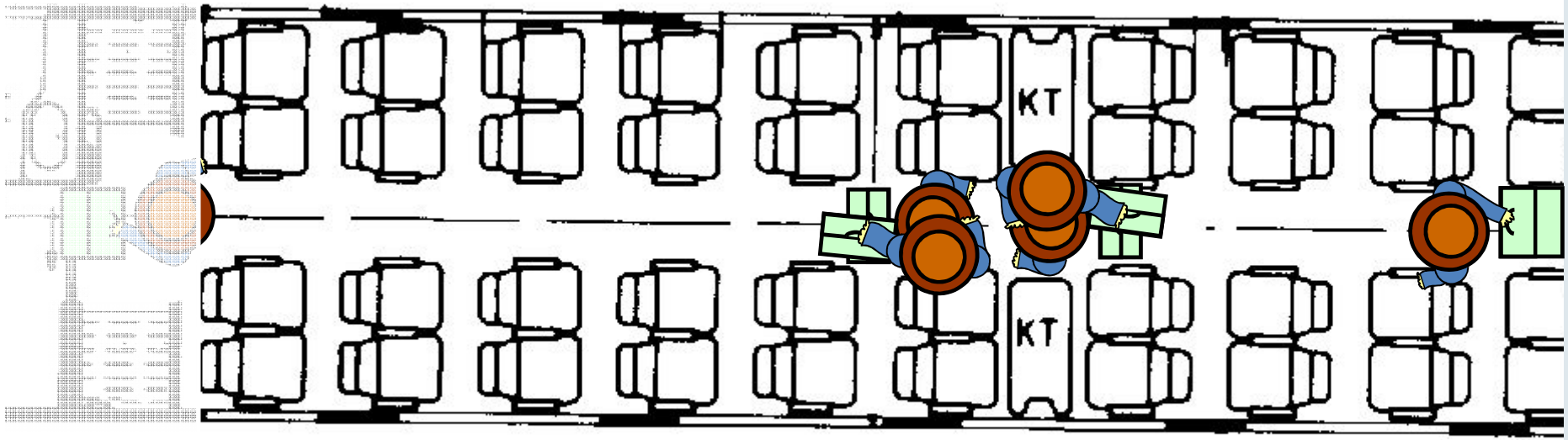


Hindrance in the corridor
→ **Time need**

Seats are blocked!

Row seating

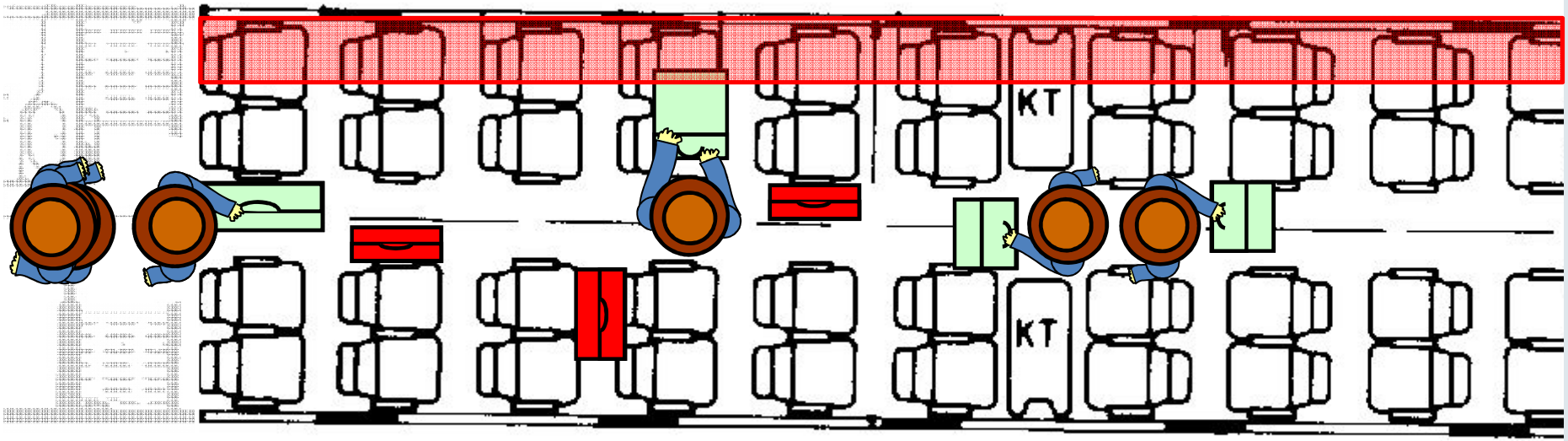
3rd problem: oncoming passengers



No passing room

Row seating

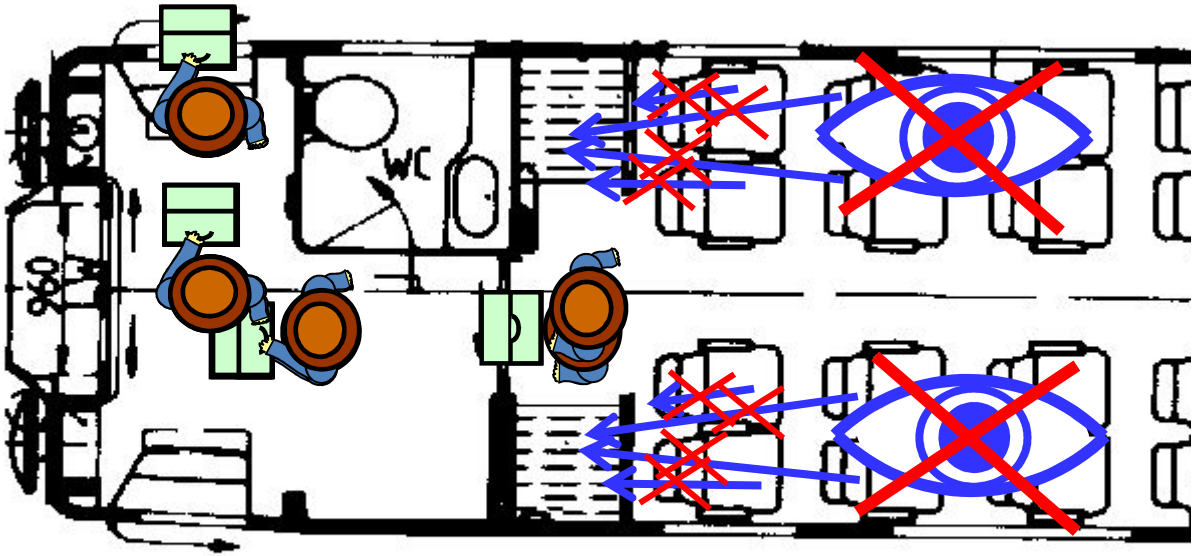
Baggage in corridor, on seats
Oncoming passengers
Overhed bins



Tailback after view passengers, long time need

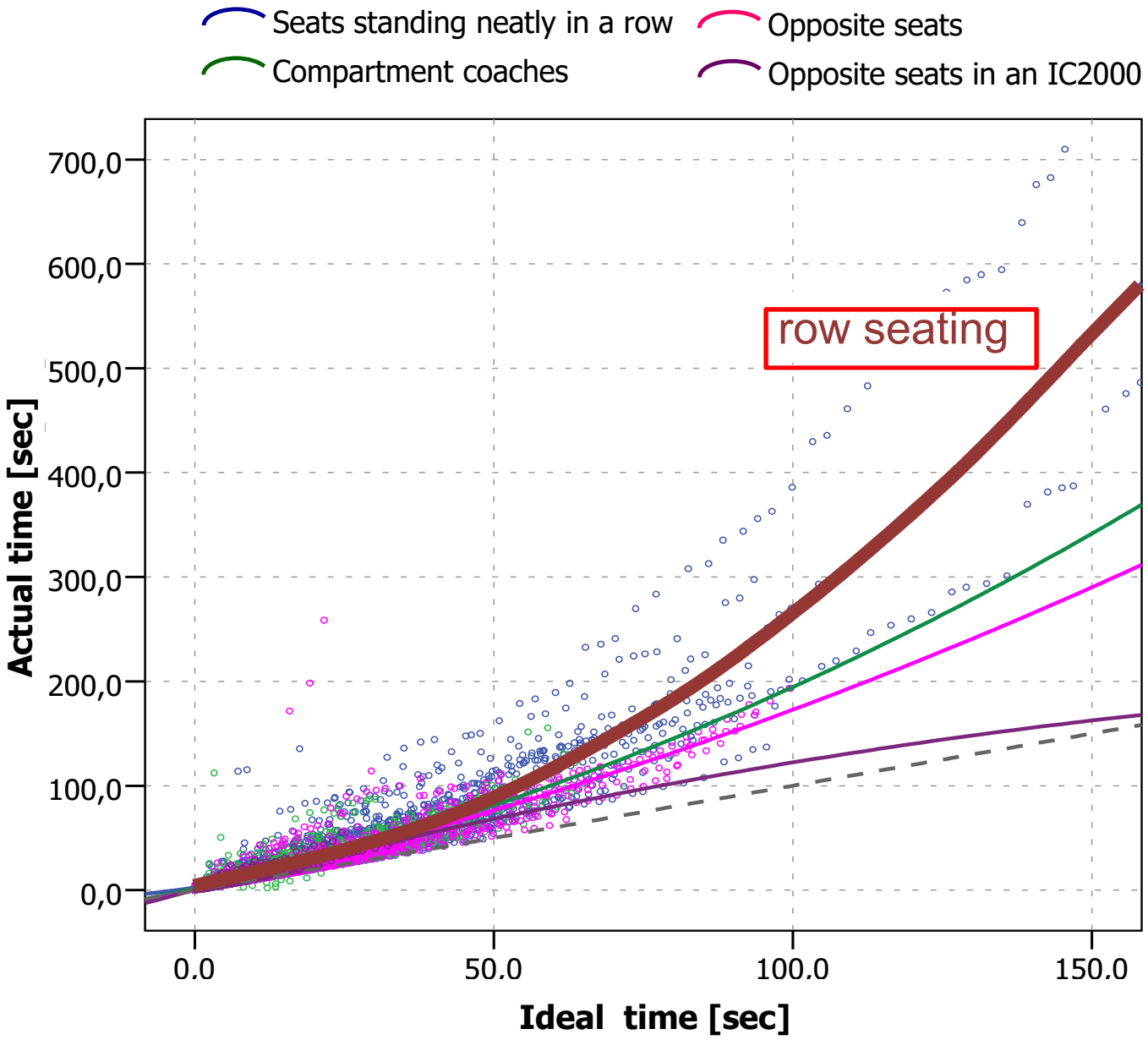
Row seating + baggage rack close entrance

No visual contact



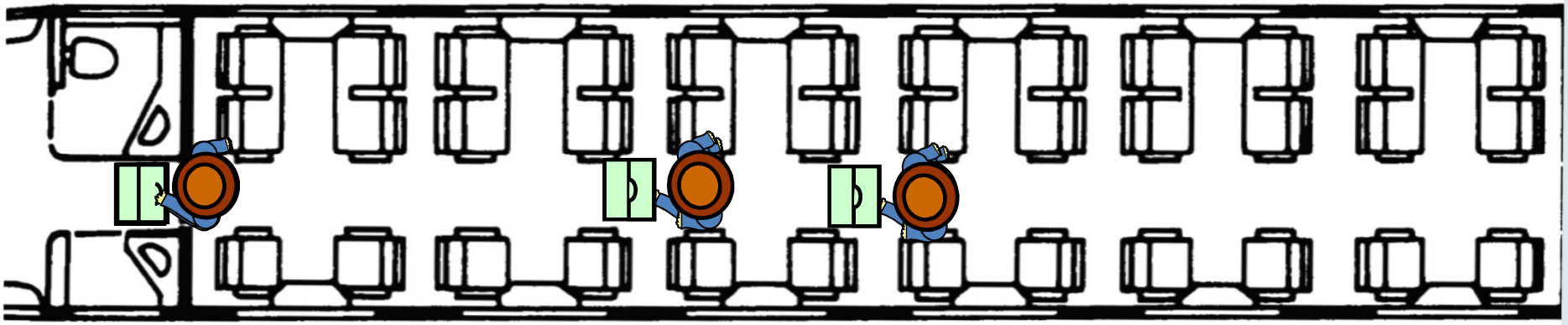
Tailback after view passengers, long time need

row seating– time need



Vis-a-vis seating

Baggage stroring between the seats

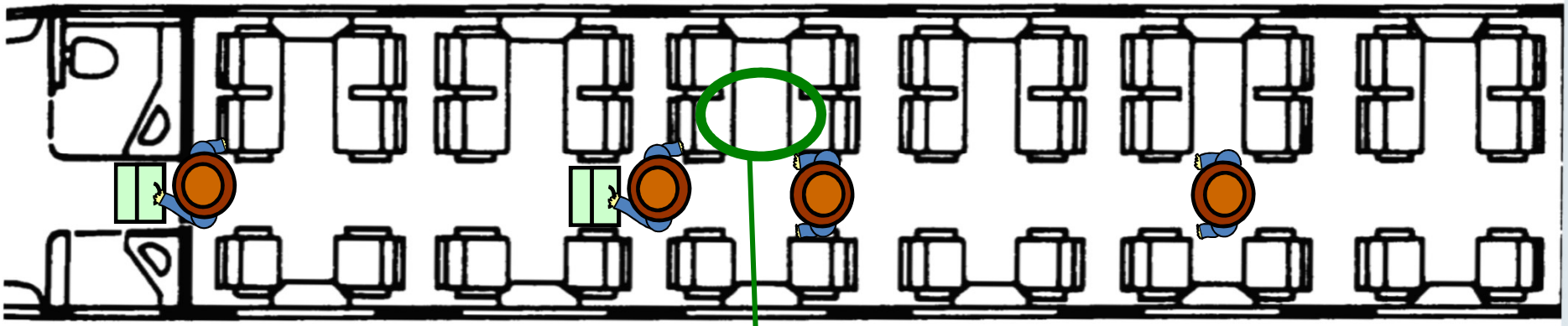


enough space required
→ Very fast and easy storing

Coach interiors

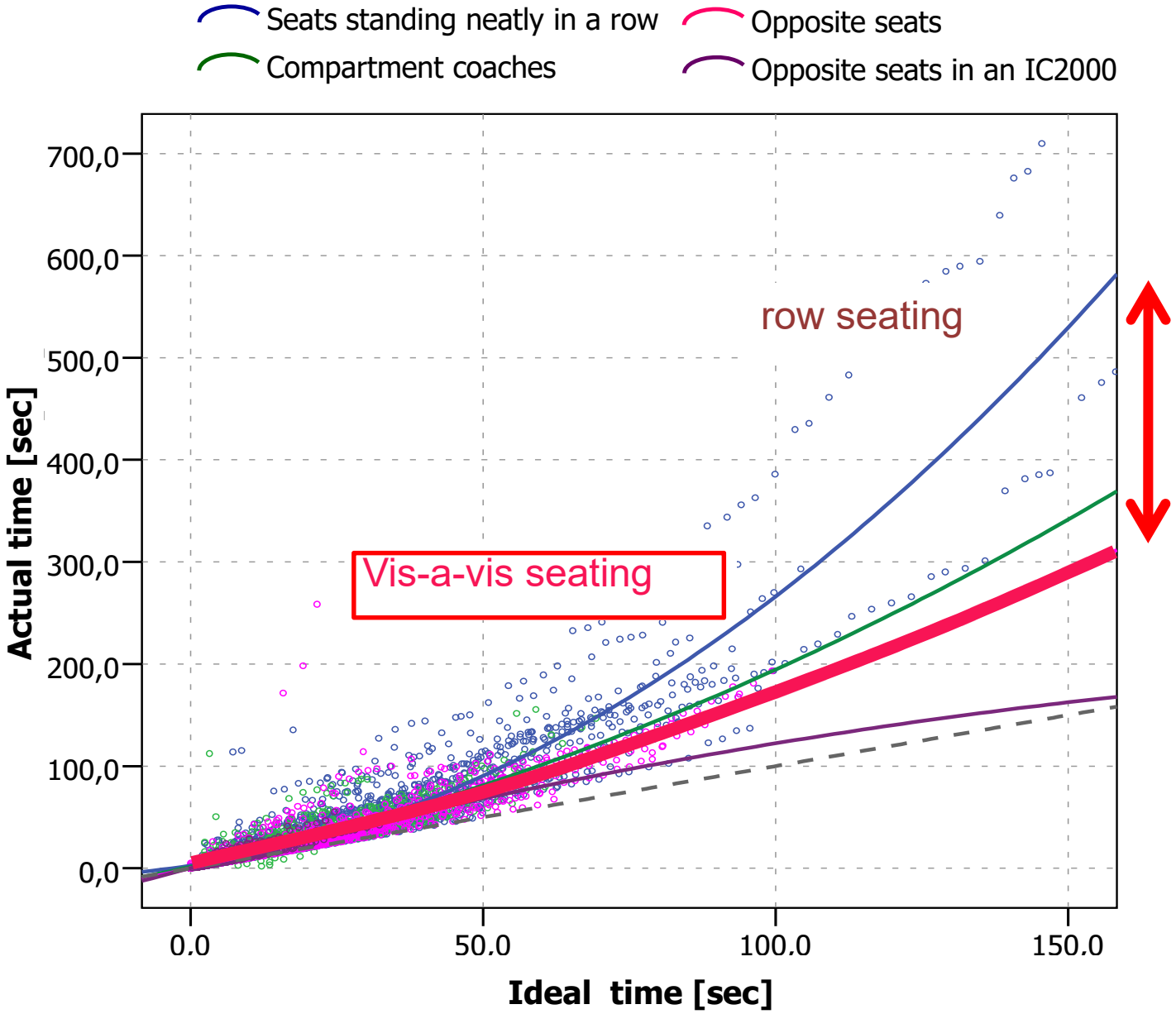
Vis-a-vis seating

Oncoming passengers

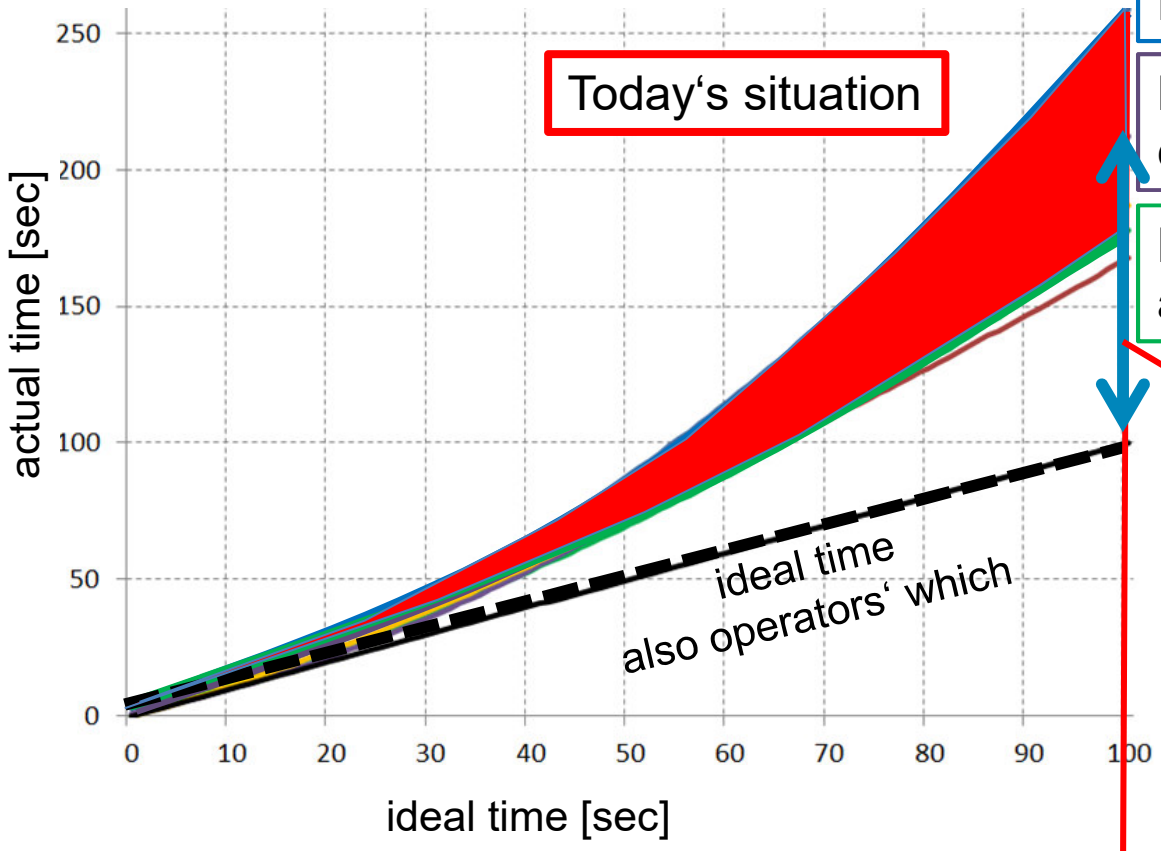


+ Passing points

Seat arrangements



Dwell time – different concepts



Row seating (no racks)

Mixed seat concept (rack close to entrance)

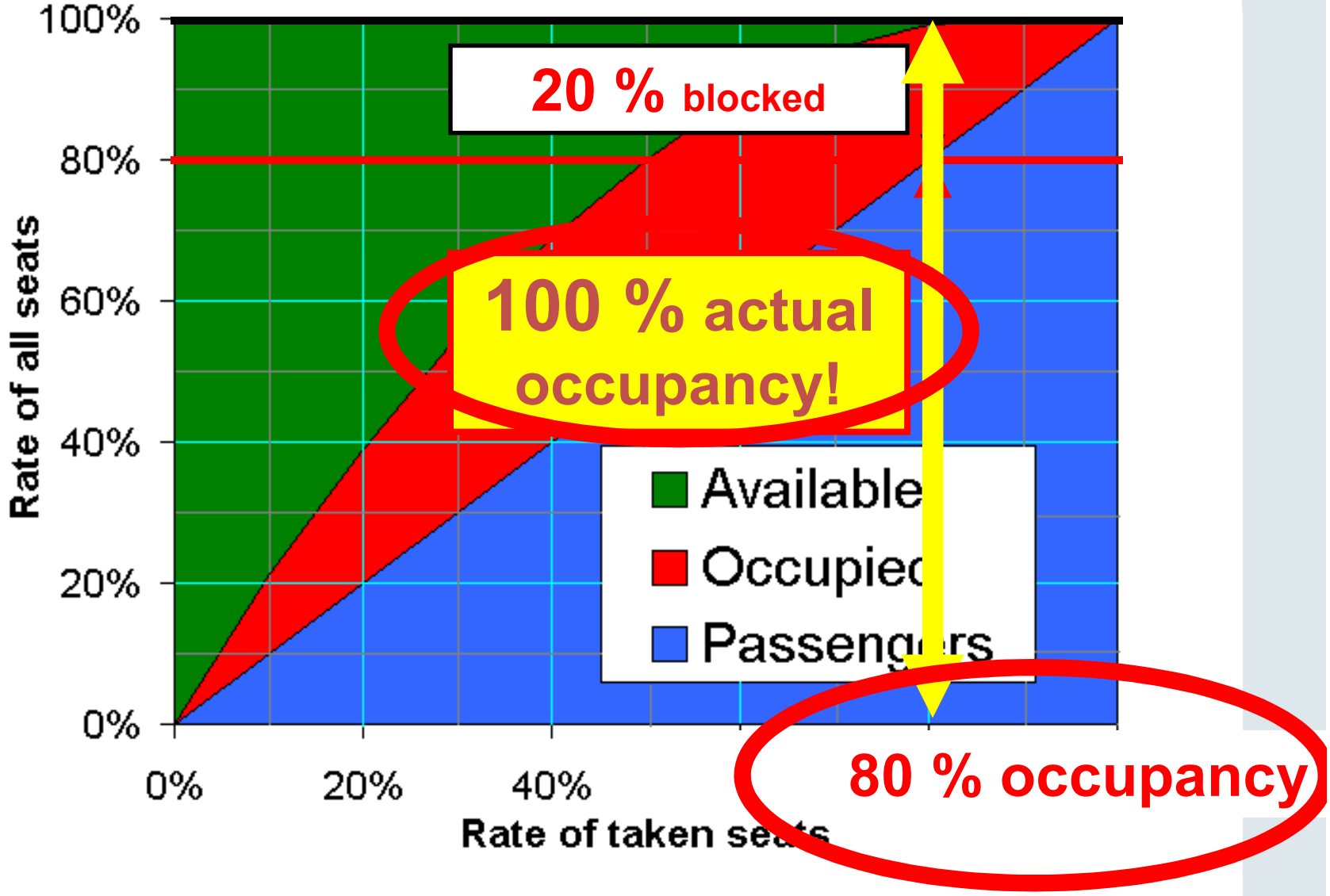
Mixed seat concept (rack away from entrance)

1st big difference between theory and practice

Dwell time needs double to three times longer!

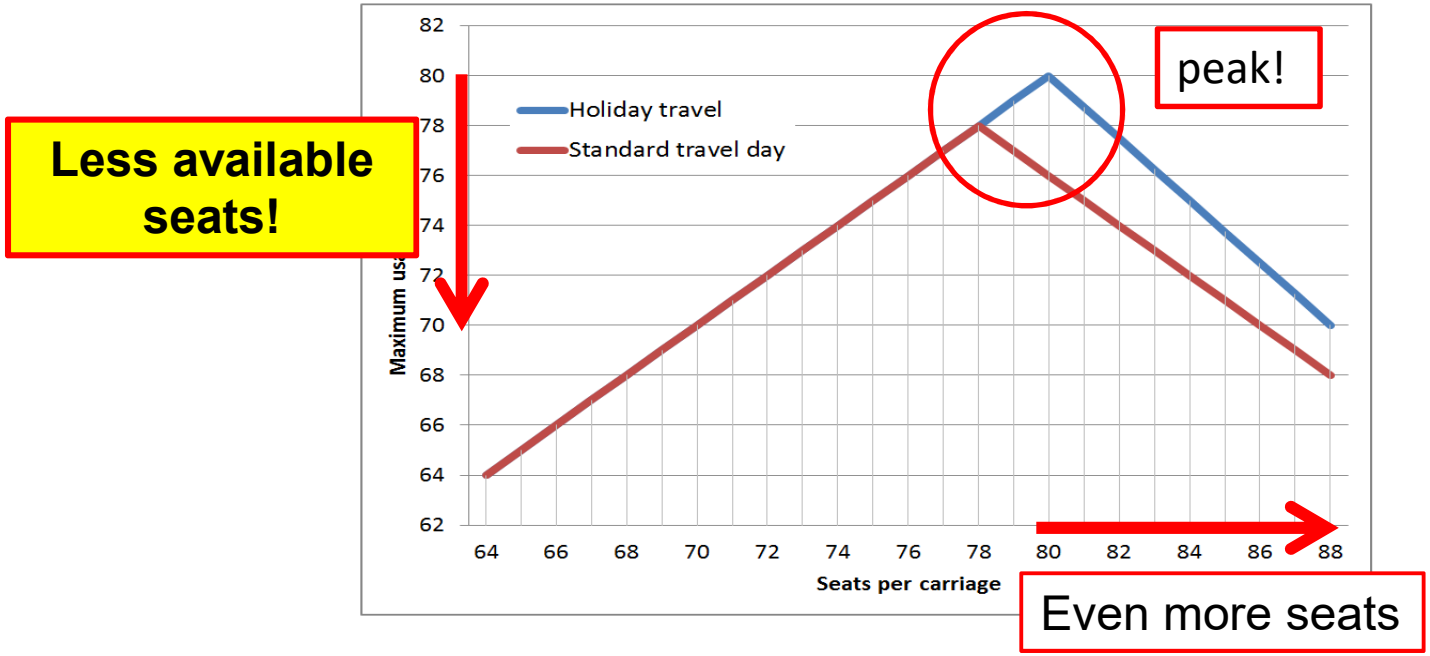
Boarding time, approximately 30 passengers

Occupancy rate - Seat maximum (operators' which)



2nd big difference between theory and practice

- Seat maximum (maximum expected revenue)
  - → **actually max. 80% of the seats can be taken!**
  - → Rest is blocked by baggage



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Theory versus practice

- Operators whish:
  - Best possible efficiency
    - Short dwell time
    - High occupancy rate
    - High revenue (as many passengers as possible)
  - Today's approach
    - **Maximizing number of seats** (like air 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

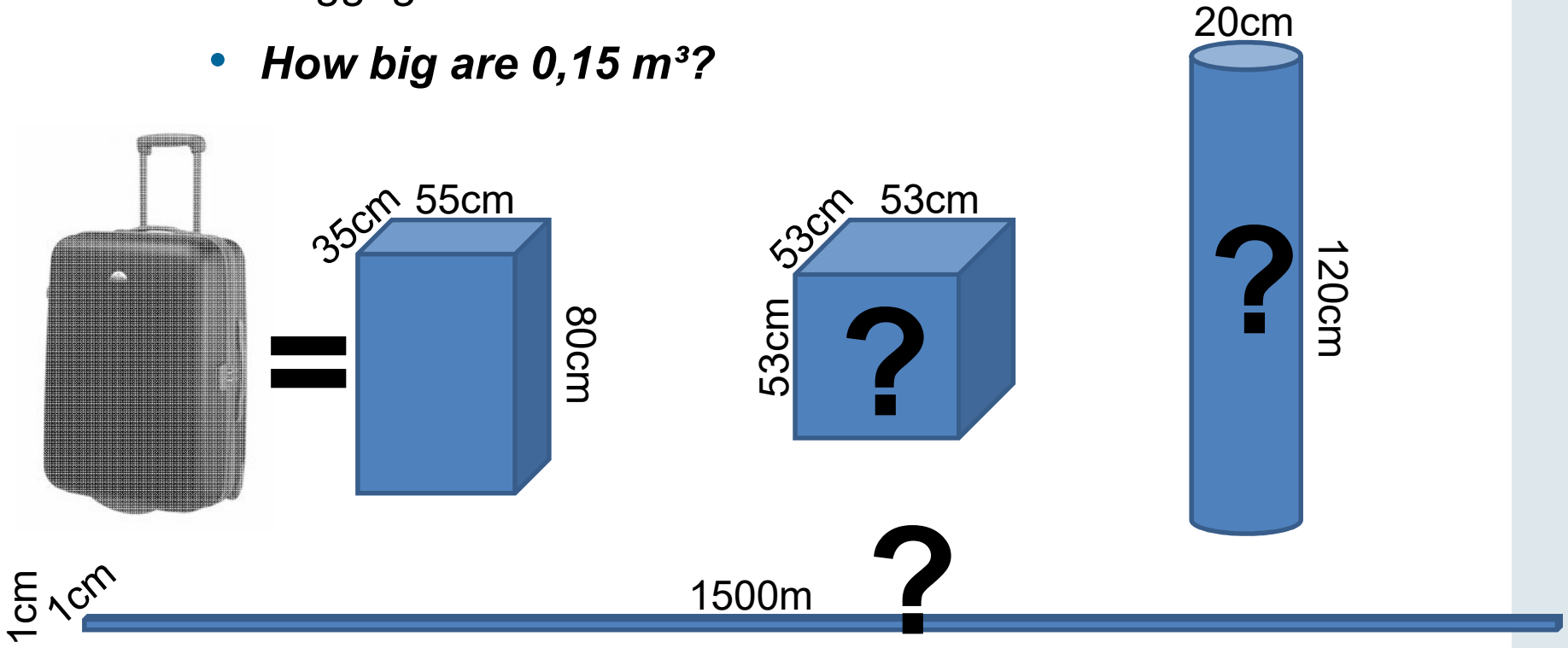
  - Further concepts like changing of the door locations or car body types leads to even more benefit

Requirement for designing

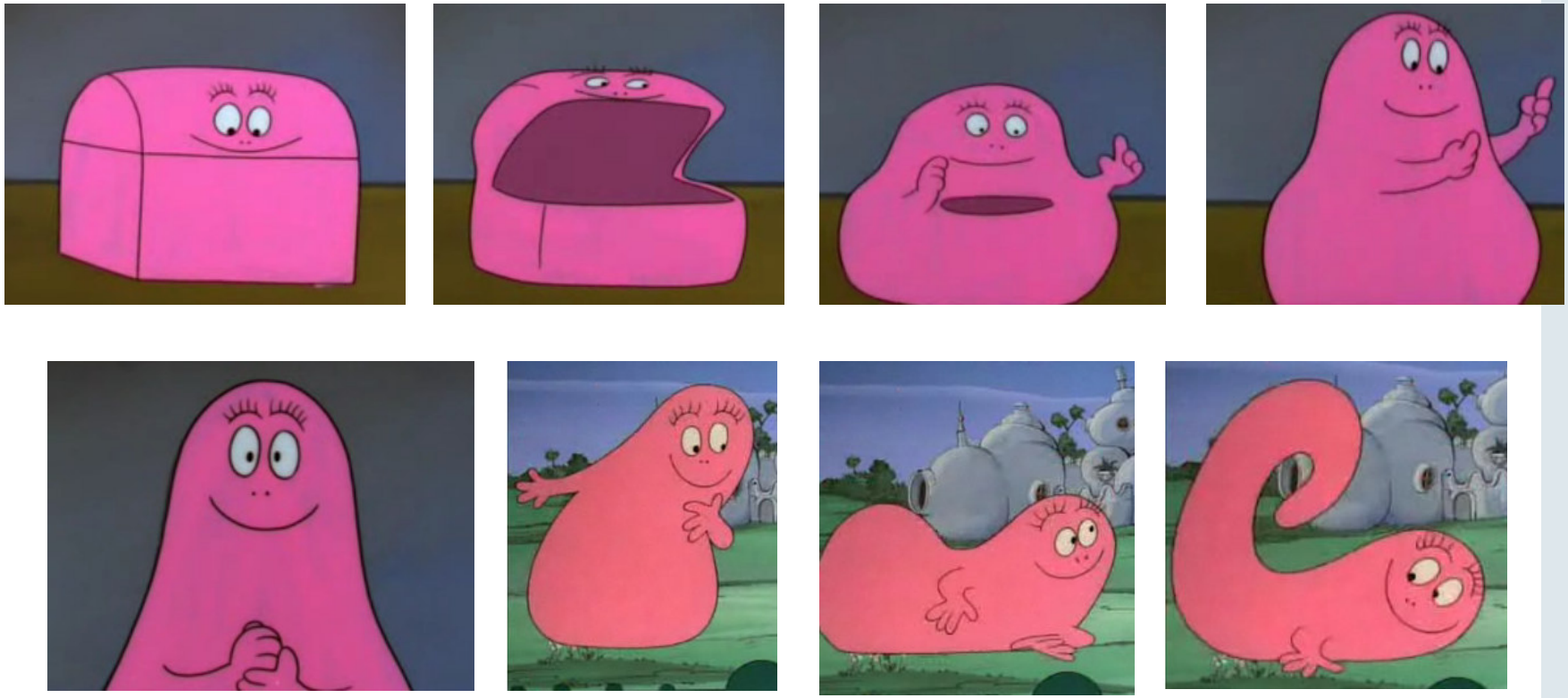
- For redesigning or designing new vehicles:
  - Passengers' **behaviour** must be taken in consideration from the beginning
  - Also passengers' **needs** and **expectations**
  - Exact **calculation** of the optimum number of the seats
    - Knowledge of passengers (main travel purpose etc.)
    - Knowledge of baggage distribution
  - **Start** the vehicle designing **from inside** (the interiors must be fixed first) – the **car body must match the interiors,** not the other way around!

Five typical designing errors

- **Error 1: Volume calculation**
  - Baggage has a volume AND three dimensions
  - ***How big are 0,15 m³?***

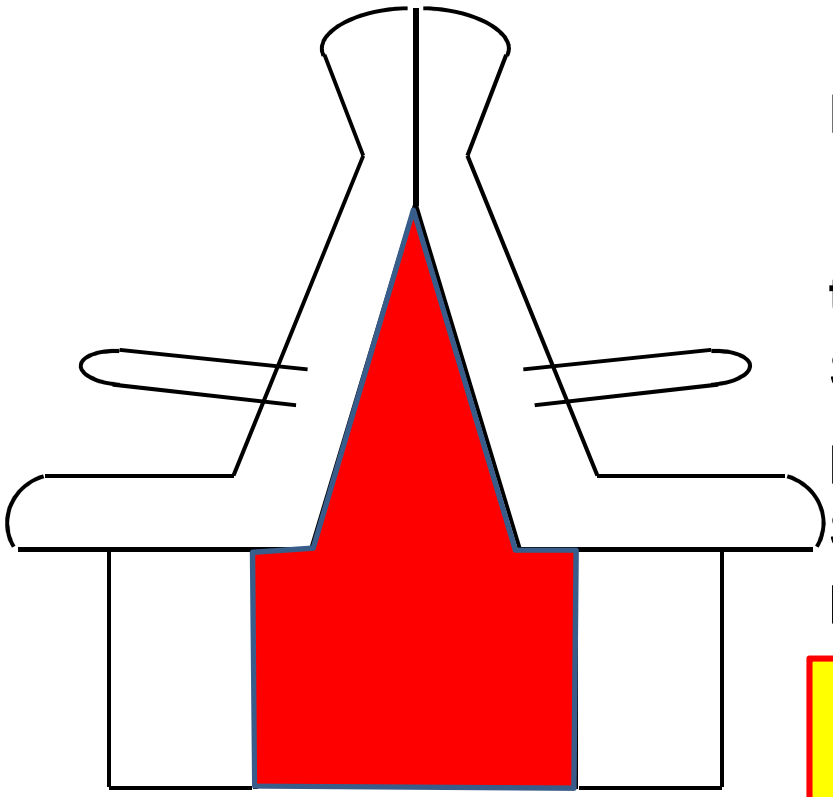


Our baggage is not able to do that:



Source:
https://www.youtube.com/watch?v=A8UqhGFar6w
and www.youtube.com

Just volume calculation:



0,50m² x 1,00m = **0,50m³**

Large trolley → 80x55x35cm = **0,15m³**

theory:

Space for 3 big or 4 medium trolleys

practice:

Space for one medium trolley (if passengers are able to tilt (corridor width))

Error: Industry adds all – even the little „umbrella“ storages - to a total sum!
Actually only 1/3 to1/4 of the calculated space is available!

Five typical designing errors

- **Error 2: Disregard of passenger behaviour**
  - Passengers do **not** want to **lift** baggage
  - Passengers want to have **visual contact**
  - **Practice:**
    - Most of the storages do not meet these requirements!
    - Storages are inefficient because they are used bellow average
    - Passenger store baggage everywhere it is “forbidden”

Five typical designing errors

- **Error 3: False awareness of luggage volume**
  - Every situation is unique, you cannot use general numbers of baggage
  - It is required to know exactly about the baggage quantity for the area of operation
  - **Practice:**
    - Usually the baggage distribution and the quantity is underestimated!
    - False number of baggage in combination of false dimensioning of storages is potentiating the problems

Five typical designing errors

- **Error 4: False dimensioning**
  - All baggage storages must be designed well-considered
  - 5 cm to narrow rack can reduce the efficiency for about 30% or more!
  - **Practice:**
    - Baggage racks and other storages (e.g. between seat back rests) are the remaining result of the vehicle designing
    - The car body is designed first, the window divider is fixed, all other is remaining → in most cases **only inefficient storages remain!**

Five typical designing errors

- **Error 5: False evaluation criteria for orders**
  - Criteria must be e.g.:
    - Maximum available seats
    - Shortest possible dwell time
    - Satisfied passengers

Five typical designing errors

- **Error 5: False evaluation criteria for orders**
  - **Practice:**
    - "Funny" and not logically comprehensible numbers which are only **"psychological numbers"** (like prizes in the supermarket) are often very important criteria:
    - *Example: "The train must have at least 500 seats!"*

      → Actually only 450 seats may be taken, if you reduce the number to 470 seats all these 470 seats can be taken!
    - **Big problem:** If those numbers are fixed in call for bits the industry has no chance to offer innovative and much more efficient concepts!

Conclusion

- Meaningful criteria in call for bids that allows the industry to think about innovative solutions!
- Less is more (less 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!

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

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