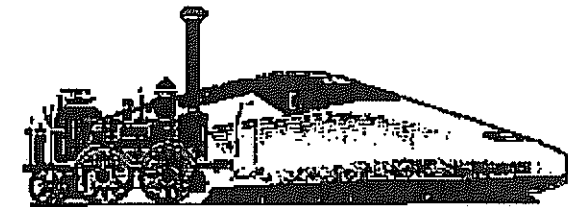




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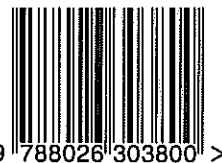
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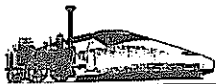


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## THE FUTURE OF PASSENGER TRANSPORT - AN OVERVIEW TO THE MOST INNOVATIVE SERVICE AND COMFORT CONCEPTS OF TRAIN OPERATORS

Peter Tauschitz<sup>1</sup>, Peter Judmaier<sup>2</sup>, Frank Michelberger<sup>3</sup>, Ingrid Stürmer<sup>4</sup>, Andrea Viertelmayr<sup>5</sup>

**Summary:** In this paper an overview of best-practice concepts in the area of interiors of railway wagons for passenger transport will be given. This research is part of the project FLEXICOACH that aims to design user specific vehicle interior concepts, for local as well as for long distance traffic, which gives the traveller the chance of using his time in the most optimal way. Within this project intensive research has been done on actual and future concepts to have an overview of the state-of-the-art as a basis for the further developments. For this, concepts with new and innovative solutions were looked after. This paper will present the most innovative concepts within the areas of media technology equipment (e.g. information, entertainment), acoustics and lighting from railway and some examples from the automotive industry and the aviation industry. Furthermore an overview of existing services that are actually offered on board by operators will be given. The findings will be discussed and recommendations for the optimization of the vehicle interior will be given.

### 1. Introduction

The project FLEXICOACH aims to develop an interior system for rail vehicles, which although meeting the needs and wants of all passengers best and is due to standardised solutions most economic when it comes to construction. Both efficiency and attractiveness are combined and thereby the acceptance of the system railway should be raised. Within this project the purpose and technical feasibility of different systems will be evaluated and thereby basic knowledge for further technical realisations will be gained.

Public transport vehicles especially railway wagons, are constructed to transport as many passengers as possible in order to increase profitability of train and public transport. However surveys show that a maximization of seats causes a drop in degree of capacity utilization and customer satisfaction. Reasons are the lacking loading space and missing need satisfaction of travellers in general. A big advantage of public transport, especially rail-bounded transport, is the time usable for working, studying or relaxing while travelling, which means a lowering of "lost" time in comparison to other forms of transport. Therefore an adequate vehicle interior concept, which combines efficiency and all different passenger necessities, is

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required. The project draws near the question of how to equip rail vehicles in order to permit efficient time management, in a scientific way. Based on accurate passenger behaviour studies and the needs and wants of travellers, a vehicle concept, which consists of different parts, will be developed. The approach will be interdisciplinary. Experts in the line of rail vehicles, car and aircraft industry are going to work together with experts in the branch of light and acoustic engineering as well as with sociologists.

The purpose of this targeting project is to create all basics needed for an efficient further project, in which a prototype will be constructed and tested in practice. This prefiguration is essential in order to meet all passenger needs as well as to create efficient interior concepts. In this paper the findings of the research about State-of-the-art of the interior in existing trains and train concepts as well as in automotive and aviation industry will be presented and discussed

### 2. Overview on the State-of-the-Art of interior system in rail vehicles

The research has been carried out mainly by as internet search. The results were documented and clustered in the categories media technology, lighting equipment, acoustics and services.

- The media equipment includes devices in trains that on the one hand are used to display current information about travel and other services. Another major part is the infrastructure that can be used by the traveller and that can promote the use of modern media in the train. Additionally the media equipment also includes the entertainment on the train or directly at the seat. In the following this area has been divided in sub categories.
  - Information in the train, whereas the display of the following information represents the actual state-of-the-art:
    - Time
    - Location with Map
    - Next stops
    - Delay
    - Connecting trains with display for accessibility
    - Current speed of the train
  - In addition to the usual information in modern trains partly some additional services are offered. These services include information that go beyond the current schedule and are not directly associated with the train. These are for example board phones or in some trains service points for general information. Furthermore, there are displays for seat reservations directly at the seats and an availability indicator for the toilets (free / busy).
  - For travelers and commuters a good information infrastructure in trains plays a very important role. With the increasing use of smart phones, tablet PCs and notebooks, it is essential that the provided infrastructure permits unrestricted use on the trip. The following services in infrastructure modern trains are usually standard
    - Power outlet at each seat (or for 2 seats)

- Internet (Wi-Fi)
- 3G Network
- Board Telephone
- Service Point for general information
- Entertainment plays an increasingly important role in modern trains, especially with long travelling distances. Modern long-distance trains often offer different options for entertainment for example screens that are available at the seat. The screens are integrated into the head portion of the front seat or can fold out from the seat.  
The services offered in the field of entertainment include:
  - Movies and series on multiple channels
  - Radio
- Passenger compartment lightning
  - Sunshade or curtain
  - Reading light at each seat
  - Lightning trough LED spots, special glass so that the lightning varies. During the stretch dimmed light and before arriving at the train station more intensive light.
- Acoustic
  - Acoustic room features: flooring with impact sound insulation
  - Separated compartments
    - Compartment for families
    - Compartment for privacy and resting
    - Compartment for mothers (breast feeding)
    - Compartment for kids (children cinema)
    - Compartment for women

In some of the trains there exist special compartments for more privacy and resting. In these zones people can work, read or relax. In most cases this zones are in the 1. Class. In that area speaking or a conversation is prohibited, even if it is on a low and quiet intensity. Furthermore listening to music or radio, even with headset as well as playing audio- or video programs on the notebook and speaking on the phone are not allowed. Within two story express train wagons, compartments for families are integrated into the upper deck and have a playing area.

### 3. Examples of automotive and aviation industry

Innovative concepts in the automotive industry:

New car seat system consists of 7 seats and the configuration of every seat can be adjusted to the individual situation. The seating arrangement can be extended to 7 seats within a few seconds. The rear seats in the third row can be completely stowed in the ground to create bigger storage space.

In the second row are 3 seats. This seat can also be folded to create any farther storage space. If only the rest of the middle seat folded, it forms an armrest for the two outer seats and creates a lounge-like atmosphere.

Multimedia systems with monitor located in each headrest. The system makes it possible to work comfortably, because the seat position must not be changed or the upper body must not be twisted and the system can be completely stored after use.

In the centre console there are also controls for the climate control and massage functions of the seats. The seats are also individually adapted to the ergonomics of the passenger. Under the armrests are storage compartments and a cooling compartment.

The Stow in Floor Technology are seats that can be completely stored into a floor. By covering the stored seat is no longer visible and the free space can be used as storage space without any further manipulation. There are no rails or unsealed openings on the floor, as they are used in other systems.

The operation is very easy and is done by pressing a lever. The seat can be folded up and then it slides into the stored position in the floor. When pulling a spring support the manipulation so only a little force is required. The remaining elements correspond to those of conventional car seats.

Reversible seat are used in vehicles with three rows of seats. Sometimes it is required that the position of the seats turn to each other. The reversible seat has a backrest which can be pivoted over the seat. The seat is lowered automatically to back down, so for both positions the backrest of the seat always has the same position. The rest is the same on both sides, but the shape of the backrest is changed.

Innovative concepts in the aviation industry:

The iPad-friendly seat has a holder for iPads and other tablets. This service is introduced together with the already proven "QStreaming" that provides the passengers with the access to on-board entertainment via WLAN.

The Italian manufacturer Aviointeriors SpA has developed the SkyRider, a standing seat which can be used for short distances up to one hour of travel time. The stand-up seat offers a similar comfort as the passenger seat of a motorcycle and is also equipped with storage space for hand luggage and pockets for magazines, safety instructions, etc..

The Skycouch™ consists of three economy seats next to each other. The armrests can be completely folded back. The leg support can be pulled out so far that they form a common, continuous, planar surface to the seat surface. If all three seats folded up the armrests and leg supports are fully extended, it creates a 155 x 74 cm large area that can be used for example as small couch.

### 4. Services provided by train operators

Services include all information and benefits, which are not primary part of the train ride. They are offered as an additional benefit for the traveller. The following list shows standard services offered in the railway area:

- Self-service in terms of eating and drinking (Selbstbedienungsservice)

- Table Service
- Newspaper Service
- Internet (Wi-Fi)
- Lounges
- 1. Class/Frequent traveler counter
- Fast track check-in (Eurostar)
- Boarding guarantee (Eurostar)
- Taxi reservation via train staff
- Chauffeur Service
- Selling of tickets for regional public transport/in train shopping
- Online-Shopping during the train ride
- Frequent traveller programs

## 5. Proposals for the optimization of the vehicle interior

### Travel Information:

This information should be displayed at info screens which are seen from every angle and each seat.

A proper and convenient additionally idea would be a fold -out screen (touch screen) which shows the information. The traveler can than switch between different views and notifications:

- Current location and map
- Current delay and estimated arrival time
- Information about connection trains
- Information about cities the train stops
- Hotel information
- Weather
- Wagon/compartment overview (free/occupied/reserved seats)
- Television
- Radio
- Watch Videos/series
- Board service selection
- In trains with connections to an airport: Check in information

### Services:

It would be convenient if these services were displayed at each seat. Additionally or instead of that option "Info Points" are recommended. These should be installed, of a certain amount, in each wagon.

The following services are relevant:

- Call Board Service
- On-board ticket selling
- Online seat reservation with an overview map and seat selection
- Wake-up-call for a desired train station
- Order a taxi departing from the next train station

- Temperature regulation
- Online shopping for groceries and pick up at the final destination

"Smart Window" in combination with rotating seats (facing the window) Sun shades or curtains are not necessary, as the "Smart Window" can adjust the lightning. Notebooks can be connected to the "Smart Window" as well and the Train-information system runs directly via the "Smart Window". The general information systems, as part of the "Smart Window", can also be attached next to the glass doors.

### Infrastructure:

- Power outlet (one per seat) with continuous charging during the whole journey. Currently the charging process is partly interrupted and for sensitive equipment problematic.
- Open, free and functioning WI-FI or LAN
- Computer, which can be used publicly (Touchscreens, Info screens) at special seats (info-seats) with a stool so that the person does not sit there the whole journey.
- Continuous 3G or LTE network
- Online platform with information about cities, hotel and so on. This platform should be available via the train network, even with the traveler's own equipment.
- Info screens, which can be read from each seat
- Info screens at the entrance showing free and occupied seats in the entire wagon
- Multi touch tables in compartments for families for child and parents entertainment
- Info points (info screens with stools)
- Cup holder that can be pulled out of the table

### Entertainment:

- Parlour games/family games
- Multi touch tables with virtual games for the whole family as part of the Compartment for families
- Entertainment for kids
- Relaxing zones for adults
- Group seating
- Enough space for eating at the seat

### Acoustic improvement:

- Possibility to regulate the sound volume of announcements individually for each seat.

- Head phones with active Noise Cancelling (e.g. Bose Quiet Comfort) to listen to music and videos.

## 6. Conclusions

- Current trend in passenger transport shows in addition to the increase of efficiency and a focus on the needs of the passengers. For the latter comes in existing rail vehicles increasingly modern media technology are used. An Internet connection, indirectly or directly G3 telephone networks via wireless LAN allows the work on the train and the traveler has an opportunity to use outside entertainment and information services.
- In addition to internet use on private devices there are different systems for displaying travel information such as travel time and delays, current location, nearest stations with transfer facilities, etc. existing.
- Information and entertainment is offered in modern rail vehicles partially directly to the seats, like in air travel.
- Computer work or the consumption of digital media new requirements come on rail vehicles. Individual sun protection and lighting at the seats that adapt to the environment and thus provide a good screen perception. Also rest compartments that facilitate the work and provide an atmosphere for relaxation.
- For the future, there is foreseen a more increased and improved accessibility of rail vehicles to the Internet. This development allows to offer the existing needs of travellers like a smooth working at the computer and the offering of new services and information services. Current information about the train facilitate simplify the search of free seats, flexible and extensive entertainment options make the journey entertaining, services and information on the train also facilitate the arrival at the destination.

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## KRONECKER ALGEBRA AND ITS BROAD APPLICATIONS IN RAILWAY SYSTEMS

Mark Volcic<sup>1</sup>, Johann Blicberger<sup>1</sup>, Andreas Schöbel<sup>2</sup>

Summary: Kronecker algebra consists of Kronecker product and Kronecker sum. It can be used to model systems consisting of several actors and a number of limited resources. In particular, it can be used to model railway systems consisting of trains, their routes in the system, and track sections building up the railway infrastructure. In this paper we will show several applications of Kronecker algebra in the railway domain. In particular, we consider: deadlock analysis [1], travel time analysis [2], and energy analysis. Integrating all three types of analysis within one single type of Kronecker-based analysis is rather simple and can be done very efficiently. Our implementation is very efficient both in time and space. Kronecker algebra operations can easily be parallelized and thus our implementation can fully take advantage of today's multi-core computer architecture. In addition, our implementation shows that adding constraints (connections, overtaking ...) to the problem improves execution time. In fact, a harder problem is easier to solve.

Keywords: Kronecker algebra, deadlock analysis, travel time analysis, energy analysis

### 1. Introduction

Kronecker algebra and its applications in railway systems have been introduced in some previous scientific papers. In [1] it is shown how to avoid deadlocks within a railway network with several trains. In [2] it is explained how to calculate the travel time of trains within a railway system. Blocking among trains occurs due to sharing of track sections, connections and overtaking. Blocking time is incorporated into the calculated travel time.

In the following sections we show some examples and introduce a new application – energy analysis. This paper is focused on a number of practical relevant examples, in contrast to the preliminary papers which deal with the theoretical background.

### 2. A simple example

In this section we give a small example on how deadlocks can be avoided by the Kronecker algebra based approach.

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