RailCab System: Engineering Aspects

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Abstract The test vehicles of the Paderborn RailCab system, especially developed and scaled down for testing purposes, are conceived as complex mechatronic structures. In designing their components for driving, energy management, suspension system, control and communication system we broke fairly new ground. As university research teams have only extremely limited personal and financial resources at their disposal, realisation of such a system was only possible using new design methods particularly customised to mechatronics. These comprise a model-based approach with appropriate modular-hierarchical structuring for a holistic observation that includes primarily the elements for control and information processing from the outset. In view of the drive and suspension components dealt with in detail in this paper, this purely computer-aided approach was complemented by extensive lab tests in hardware-in-the-loop technology before the test vehicles were actually constructed and tested.

1 Introduction to the RailCab System

Almost ten years ago a group of professors in engineering at the University of Paderborn jointly started up a concept, along with its technical basics, of a novel traffic system that was to translate the individual possibilities of the motorcar to the well-worn railway tracks. Such autonomous traffic systems have been in the discussion for many years, especially in the English-speaking world, and labelled “personal rapid transport” (PRT) or “personal automated transport” (PAT); some of them have even been realised as prototypes. The particularity of the Paderborn approach is the combination and fine-tuning of novel and well-proven technical components for the drive, chassis, and steering/control technology along with new modular-hierarchical elements of a distributed global/local information processing. The focus was and still is on easing resp. diminishing traffic in densely populated urban regions (e.g. the Ruhr area) and/or connecting and integrating sparsely populated areas (e.g. the region of East-Westphalia and Lippe). This requires solving the conflict between individual and mass transport.
The essential features of such systems are the following:

- many small vehicles,
- driverless, fully automated operation,
- uninterrupted journey on demand.

As has been said, such PRT/PAT systems have been in the discussion for more than thirty years. However, a successful realisation depends essentially on the availability of viable technical solutions for all components - a condition that has only been fulfilled for a few years, especially regarding the necessary information technology.

The elements of the Paderborn design are the following:

- a modular-hierarchical construction-kit structure ensuring an exceptionally high flexibility, scalability, and adaptability as regards technical and application-specific features, at a speed spectrum of 80 to 160 km/h, to be applied both in passenger and freight transport on short and long distances,
- using existing rails and tracks with high reliability, disposability, and safety,
- using the most recent technologies of drive technology and energy management, mechatronic chassis technology, distributed global/local information processing for control and monitoring technology and a novel globally/locally distributed logistics.

The developments in the RailCab system pertain to the vehicles, the vehicle system, the convoys, and the superordinated traffic system.

As to the origin of the RailCab system:

The conventional railway is marked by
- a proven technology,
- an extensive route network,
- centralistic, monolithic features.

Figure 1: Conventional railway.

The relatively new Transrapid system is marked by
- an innovative drive- and supporting/guiding technology,
- a high top speed,
- but also centralistic, monolithic features,
- requiring an entirely new route network.

Figure 2: The Transrapid.