

## EMPHASES IN PUBLIC TRANSPORT RESEARCH AND DEVELOPMENT IN THE INDUSTRIAL NATIONS UP TO THE YEAR 2000

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### 1. Basic position

Since the beginning of the 70's, the western industrial countries have been sponsoring technological and methodical development in the public transportation sector. Now, all essential systems and components which have enjoyed sponsorship have proved themselves in practice and are either ready for deployment or nearly so. Examples which should be mentioned include: the AGT systems in the USA, France and the FRG, various forms of paratransit, developments in track guided bus transit, automatization of command and control technology, improvements to passenger processing, introduction of preferential measures for the public transit sector, whereby there has been a clear move away from the development of new transit systems towards the improvement of individual components in existing systems in the light of changing fringe conditions.

Several of these developments have advanced beyond the stage of testing and have entered into practical operation. Others have not yet found their place on the market. The reasons for this are to be found largely in the changes to the fringe conditions which have occurred during the past 15 years:

- public financing and money within the transit companies has been drastically reduced;
- environmental problems have become more critical;
- the public are becoming more sensitive with regard to the effect of transit systems on the environment;
- the drop in the birth rate has a negative effect on the passenger potential of the public transportation sector;
- difficulties on the labor market alter perspectives when considering efforts to reduce personnel costs;
- technological changes can replace certain transit elements, they will however, also help to improve transit management.

Future research and development (R+D) policies in the industrial countries, as a prerequisite for efficient development of the transportation sector, will have to take these changes into account. In order to ensure the acceptance of R+D results, we have worked out a basis for research and development policies in the public transportation sector in the Federal Republic of Germany up until the year 2000. Due to the similarity of the problems, the FRG can be taken as representative of western European industrial countries.

The purpose of research and development is to balance out deficiency and shortage, devise new solutions to existing problems and search for answers to future requirements. Research and development in the public transit sector usually only leads to practicable results after many years of investigation; results which then, for reasons of economy, have to remain valid for decades to come. Predictions regarding future social and economic reality are, therefore, of particular significance for this area of R+D. For this reason the project started, with the help of scenarios, to determine the fringe conditions and peripheral considerations which will affect traffic and transportation in the year 2000.

On this basis, the weaknesses in the public transportation sector were then analysed in detail, in order to determine future demand for technology and methods for improving public transportation. Over and above this, the available technological potential of other sectors (e.g. aviation, communications technology) was analysed in depth with regard to the possibility of technology transfer. Special public transportation related technological and organizational developments will then be defined and examined with a view to their feasibility so that finally, the emphasis for the next 15 to 20 years for research and development in the public transportation sector can be determined by means of the interplay between the demand for technology and methods and their availability.

2. Development of the fringe conditions affecting public transportation up until the year 2000

The present, with its fringe conditions substantially changed compared to the expectations placed in it in the past, shows that reliable prognosis of medium and long term changes in the pattern of fringe conditions affecting public transportation is not possible. Under these conditions, the discussion regarding alternative developments of the essential factors determining R+D has proved itself useful. It remains for the connections, dependencies, different development probabilities and tendencies and the basis for control possibilities to be investigated. On the basis of three alternative developments in the economy - stagnating, moderate growth (trend), rapidly expanding economy - the quantitative demand for public transport services and the qualitative demands made on public transportation (thus, also the R+D requirements in public transit) were drawn up, taking possible changes in the sectors of settlement structure, appreciation in value, traffic and transit policy, energy and environment up to the year 2000 into account. With regard to these areas, we expect the following developments:

- The total population figure will slightly decrease by the year 2000. Then there will be a marked drop in the population.
- The numbers of school children and trainees will drop considerably, severely affecting the public transport sector.
- Economic growth will amount to a real 3%, which will lead to a slight improvement in the available real income of the private household.
- Largely independent of the economic development, the motor car will continue to play a major role in the esteem of the population as a whole. This will make itself apparent in a continued increase in the level of motorization.
- The relatively slow restructuring of the economy, affected among other things by the introduction of new technologies, will not have a major effect on the spatial and temporal development of the demand structure of commuter transport.
- In the medium term, the weekly working time and pension ages will be reduced, increasing the scope for other transport-related activities (e.g. leisure time transport). Transport demand will thus alter in form tending towards more flexible, purpose-oriented trip structure.
- Further increasing investment in the social, safety and technical infrastructure will reduce the scope for governmental investment in public transportation.
- There is a continued concentration of the population in conurbations although this tendency is not quite as strong as in the past. Changes in this development will not have a significant effect on transport demand structure.
- Neither energy prices, nor energy availability will have a long-term influence on the development of public transport demand; in the short-

- term, however, bottlenecks cannot be totally excluded,
- The problems concerning exhaust emission in the private car sector will be solved, from area to area, to the extent that it will have no positive effect on the development passenger numbers.
  - No financial legislation to the detriment of the private transport sector and in favour of the public transport services can be expected.

### 3. Current and foreseen deficiencies in the public transport sector

Taking the direction of development analysed within the scope of the scenario investigation into account, current and future deficiencies in the public transport sector have to be defined. The possible spectrum of deficiencies was analysed on the basis of current objectives in R+D:

- Better fulfilment of transportation tasks
- Improvements in economic efficiency
- Improvements in attractiveness
- Reductions in environmental pollution
- Decrease in the dependency on mineral oil
- Improvements in safety and reliability
- Improvements in usability of transit services by the handicapped

Taking expected development of the fringe conditions affecting the public transportation sector into account, varying degrees of significance must be accorded to the weaknesses compared to the current emphases being placed on them.

Independent of the economic development over the next 15 years, the first priority is going to be given to eradicating, or reducing, all deficiencies affecting economic efficiency. The pressure of costs on the transport companies, the pressure of competition from the private transport sector and the lack of available financing from the government are the most significant dimensions which will affect the actions of the transport companies in the future.

The greatest importance must be accorded to the following deficiencies:

- insufficient utilization of modern management and operational control methods and technologies,
- a lack of cooperation between the transit companies with regard to operational and management oriented functions, e.g. joint use of maintenance and storage facilities, creating of transit and fare-price associations,
- insufficient plan-oriented and technological adaptation of the traditional transport service offer to meet changing demand factors such as temporal and spatial flexibility of trip purpose,
- poor utilization of cost reduction potential both for investment capital and operators, a lack of further rationalization, standardization, use of new technologies and materials together with less expensive construction methods,
- insufficient marketing activity due to a lack of media and sales-oriented marketing strategies.

The attractiveness of the public transportation service offer is becoming increasingly important in the face of rising cost pressure and increased competition on the private transport side.

There are a number of new techniques and inexpensive ways open to the transport sector to eradicate the deficiencies in the area of attractiveness.

- There is a lack of uniform, passenger-oriented information systems covering both static and dynamic information,
- Information regarding fare prices and the purchase of tickets is in definite need of improvement. There is an insufficiency and lack of

uniformity regarding the issuing of tickets, payment of fares and tariff rates,

- The ever increasing trend towards temporal and spatial flexibility must be taken into account to a greater degree,
- The general image of the public transport sector must be improved.

Depending on the economic development and politically oriented changes regarding the environment, it will be necessary to intensify the labour split in the transit sector. The higher the level of economic growth, the greater the need facing the transit companies to actively improve their situation, especially in the face of increasing competition.

Questions relating to energy and environment will only have an effect on the public transit sector if the connected problems get so bad as to require urgent political action or cause a fundamental change in public habits regarding choice of transit vehicles. For this reason the noise and exhaust emission caused by public transit vehicles can only be considered as a deficiency to a limited extent.

Deficiencies in the system relating to service offer for the handicapped will only be of subordinate significance in Western Europe due to the general pressure of cost development.

#### 4. Technology on offer and emphases in research

The demand for methods and technologies was compared with the current and expected availability levels. Hereby, the existing technological potential of other sectors such as aviation and space technology, communications technology etc., were analysed regarding possible technology transfer. Over and above this, special transit-oriented technological and organizational developments were defined and checked out with a view to their realization potential. Finally, based on the interplay between the demands for technologies and methods and the possible supply, the emphases for research and development during the next 15 to 20 years could be defined and laid down.

Interdependent on the deficiencies, several emphases were defined within the scope of the further research:

- communications technologies including the implicit organizational questions
- utilization of new production methods and materials
- energy and environmental technologies.

##### 4.1 Possible utilization of new information and communications technologies in the public transit sector

On the basis of the recorded deficiencies, a number of ideas can be found in the field of "communications technologies".

- Utilization of modern management and operational control methods and technologies, especially taking rationalization into consideration

The function-oriented deployment of EDP in transit companies has, up to now, been concentrated on the classical business management tasks.

Starting with this sector, however, the entire field of "management" is being increasingly affected by EDP, from the fare cost accounting through statistics right up to the sphere of economic planning.

Sectors such as the workshops, operational command and control, personnel disposition and scheduling are all making use of the advantages offered by communications and information technology. The most important aspect here, however, is the acquisition of a uniform data structure and database for all operational sectors in order to ensure a smooth and rational operational procedure. In order to achieve this, a standard, modular-form "operational control and information system for the public transit sector - BISON" has been developed in the FRG for

deployment in a wide variety of transit companies - also medium sized companies.

In order to ensure that all factors are included in the decision making processes in long-term operational planning, the opportunities offered by the so-called expert systems must also be considered. This is particularly valid, for example, when considering efforts to create integrated optimal traffic flow controls of public transit and private transport or for testing the alternatives thrown up by increased consideration of changing demand parameters.

- Improvements to punctuality and speed

Efforts to improve the punctuality and increase the speed of public transit vehicles require means of influencing traffic control and recognition of disruptions together with means of locating vehicles. The following technological innovations can offer a variety of ideas here:

- o improved vehicle location (especially in the rural regions) e.g. by means of satellite detection,
- o small-scale procedural control and recognition of disruption by using picture-sensitive computer systems,
- o traffic control by means of intelligent program systems (expert systems).

- Passenger service and information

Improvements to passenger information through the use of new information and communications technology are particularly necessary and feasible, above all in the field of up-dated passenger information and assistance to passengers in working out routes. The following technologies can offer ideas here:

- o use of videotext (Btx) to provide information concerning routes and schedules
- o use of automatic voice recognition and voice production in supplying information and tickets
- o use of possibilities available for vehicle locating for up-dating passenger information regarding times of departure, operational breakdown etc.
- o use of picture recognition and picture-sensitive technology for the supervision of train dispatch and station equipment (detering of criminal acts and vandalism)
- o use of possibilities for deploying chip cards in cash-free financial transactions
- o use of media innovations for target-group specific and localized marketing of the public transit services.

- Vehicle construction and maintenance

The deployment of information and communications technology in the vehicles affects, on the one hand, passenger information in/at the vehicle and, on the other hand vehicle installed equipment within the scope of the command and control system. Both aspects depend in their technical design on the general development status, as mentioned above. This is also true of information and communications technology in public transit equipment and plant e.g. passenger information facilities at stops or the communications equipment at control centers, etc.

One special field of deployment of new information and communications technology in the vehicle can be seen in error diagnosis, especially remote diagnosis of errors or breakdowns in vehicles and equipment. In this area, the enormous advances made in recent years in the field

of measurement and sensor technology, is of special significance for the transit sector. A further step in this direction would be taken by the development of methods for the remote elimination of errors.

#### 4.2 Areas of deployment for new production methods and materials in the transit sector

In the area of production technology and materials, there are a number of ideas for the elimination of existing deficiencies which are of special interest from a cost point of view.

##### - Reducing of production costs

Here it is important to transfer the existing production procedures used for large-scale series production, such as, CAD (computer aided design) and CAM (computer aided manufacturing) to small-scale series production, taking the increasing standardization into account. This can be carried out as an aspect of cost reduction measures.

##### - Use of new materials

New compound materials make it possible to design and construct long-life basic structures with replaceable - short-life - components to adapt to changing requirements or new technological breakthroughs. Furthermore, the use of new, lighter materials means weight savings on the vehicles which, in turn, can result in lower energy consumption. Problems concerned with fire hazard must, however, be seriously taken into account here.

#### 4.3 Areas of deployment for new energy and environmental technologies in the transit sector

Basically it must be said that the significance of the public transit sector with regard to energy savings and environmental pollution is two-fold. The share taken by public transit in the problems concerning energy and environment or, indeed, in the larger scope of the whole economic situation, is presently very small. The high level of environmental quality enjoyed by the public transit sector is due largely to the higher degree of productivity in comparison to private transport, especially in its much lower specific use of energy ( a factor of 4 ).

At the same time the energy consumption and environmental pollution engendered by the various individual means of transport can be further improved, especially as the noise and exhaust emission occur in a concentrated form in the inner city regions.

Moreover, the arguments which favour an increased deployment of public transit in the future due to its low energy consumption and relative environmental cleanliness, only appear to be practicable on a large scale if its advantages can also be technologically supported and do not depend solely on productivity effects. Furthermore the public transit sector should not give up its position as forerunner in the field of new development.

For these reasons, efforts to find alternative energy sources and economize in the energy sector should be concentrated on electrification, use of alcohol based fuels and hydrogen based energy together with new forms of drive system. The intensely diversified efforts relating to the deployment of alternative energy sources in the public transit sector should be stopped due to the changed fringe conditions and experience to date. Aside from electricity and methanol, only R+D efforts concerned with the use of hydrogen as a source of energy appear to have prospects of success in the long-term. This is being given priority in terms of federal energy policy.

This research will also go a long way towards reducing the problems caused by exhaust emission, although the current research into the use of soot filters etc. should continue to be sponsored.

Environmental problems which remain open are thus primarily to be seen in connection with noise reduction in the field of engine and gear noise, and noise emission from the running gear of buses and trains.

#### 5. Closing remarks

In this paper it has only been possible to sketch over a few selected examples of the emphases to be laid on research work. These, however, together with further planning and organization-oriented research projects will form the backbone of Western European research and development work in the public transportation sector during the next two decades.