Control and Phased Development of LRT for Stuttgart

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Stadtbahn Stuttgart is a good example of how to introduce a light rail transit (LRT) system successfully. In Stuttgart political will was the key to launching the LRT system. The success of the Stuttgart LRT system partly depends on central coordination of all public transport modes, which enables every mode to fulfill a useful function. To reach general approval by the political institutions in charge, the Stuttgart experience reveals, an appropriate way to introduce the system by convincing steps is fundamental. To realize this a flexible and upgradable system is essential. In addition, development worked out quite well in Stuttgart because of the high quality of the vehicles and their performance. The influence of good equipment on the public's perception should not be underrated. Finally, a consistent financial program, supported by objective guidelines for grants and the requirements to obtain them, played an important role.

Taking into account that there are different conditions under which LRT systems were introduced, it is necessary to make the following distinctions in general. First, some light rail transit (LRT) systems represent an entirely fresh start for public transport service by rail. That means there has never been such a system before or, more often, a former tramway system has been abandoned previously. Second, some LRT systems originally opened years ago as conventional electric tramways. They represent upgraded versions of traditional systems. Stuttgart's LRT system is in the second grouping. Its origins are a horse tramway opened in 1868 and replaced by electric streetcars in 1895.

The scheme of mixed traffic in city streets worked until the first decade after World War II when a rapid increase of private car ownership began. This led to the problem with which everyone is now familiar: congestion in the city center.

It is interesting to look at the conclusions local politicians drew from this completely new experience. A very remarkable point was that even during the 1950s they did not simply discuss the road system. The Stuttgart City Council saw quite clearly that it was urgent to tackle the problems affecting the tramway system as well. The council reached a majority decision that showed the first signs that it was recognized that quality of public transit had an effect on traffic congestion in the city. This seems even more comprehensive given that it was during this period that residents' tendency to move to the outskirts of greater Stuttgart area while continuing to work in the city center became perceptible. The latter factor indicated that things might get even worse. At this early stage of post-war development, the city council was quite aware that improving public transit could be a promising way of regulating traffic. It seemed a logical thing to employ two local experts from Stuttgart University to prepare a study on an appropriate scheme for urban and suburban rail systems.

In this respect the first lesson from the Stuttgart experience is that, from the very beginning of drafting proposals for improved/public transit, a broad political consensus is needed. It is essential to convert expectations of the political sponsors concerning an increase in passenger demand and, in turn, lessened road congestion in the city into an effective array of measures.

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CENTRAL COORDINATION

The study submitted in 1959 emphasized that it was important to design rail service for the greater Stuttgart area in a way that would fulfill urban and suburban functions. The study recommended two compatible systems:

- An advanced commuter railway system (German term: S-Bahn) based on the existing suburban railway system operated by the German Federal Railway (DB), and
- An upgraded tramway system, improving the quality of service by introducing separated, surface sections wherever possible and subsurface sections where the achievements of urban development and private transport conflicted with those of public transit.

The part of the recommendation referring to the existing tramway was the root of the current Stuttgart LRT system. In the context of the study the later LRT system is characterized as an integral part of a multimodal public transit system. It is important to emphasize this fact because the successful introduction of LRT in Stuttgart was, in part, the result of this integrated approach, including a coordinated fare structure. That means LRT has to bridge the gap between commuter railway service and local bus services. Buses, from the point of view of transport efficiency, have to provide more and more of the feeder services for rail systems.

Against this background a second lesson from Stuttgart is that central coordination of all public transit modes within a city or within an area is essential to the success of LRT.

CONVINCING PLAN FOR INTRODUCING LRT

The main result of the 1959 study was the design of an improved tramway network. So the crucial question facing the

municipal authorities and the public transit executives 30 years ago was, What is the best way to proceed?

It was quite clear that the only realistic way to get the tunnel measures recommended for the city center was to do it step by step. The decisive reasons were financial and operational. It has to be considered that at that time financing of public transit infrastructure was different from today. It was totally a municipal obligation. In addition every effort had to be made to ensure the opening as soon as possible to improve service. This seemed to be essential because it was a promising way to show visible results to the political sponsors at very early stage. Therefore in the very beginning of LRT construction work in Stuttgart even comparably limited measures, such as the tunneling of crossroads, were separately opened.

In fact this step-by-step approach worked very well, and the financing of further measures always met with general approval from the city council because the visible, positive effects of the proceeding projects proved their benefits for public transit service. So a third lesson from Stuttgart is that an appropriate way to introduce the LRT system is through visible, convincing steps that upgrade public transit.

FIGURE 1 LRT underground station.

FLEXIBILITY AND UPGRADABILITY

Flexibility and upgradability of the new infrastructure was not only a question of step-by-step construction. In this context another question arose: What was the proper size of tunnel cross sections? This was a crucial point, too, because a small dimension set by the existing articulated tramcars would only allow use of the tunnels by vehicles 2.2 m wide. This decision had to be made just at the time when other big German cities came up with plans to introduce new metro systems. In view of this, Stuttgart left its options open to use the new infrastructure by vehicles wider than the traditional tramcars so that even the German metro cars of the standard width—2.9 m—should fit.

From the present point of view this was a very reasonable decision. Already by the end of the decade plans had been submitted to replace the improved tramway system by a real heavy rail metro system using 2.9-m-wide cars. These plans were furthered by forecasts that predicted about 800,000 inhabitants in the city—an increase by more than 30 percent. But these plans were not to last long. Once again a change in the forecasts submitted at the beginning of the 1970s revealed that a metro system would be out of proportion to the current number of inhabitants and their expected public transit patronage. But there was no going back to the initial tramway system. In 1976 the city council approved for a plan with

- Separated guideways were to be used. If required by topography or urban structures this means tunnels (Figure 1); otherwise separated, surface railroads (Figure 2) within or next to regular traffic areas were to be built.
- Priority to trains was to be ensured with fully train actuated signals (Figure 3).
- Vehicles that were 2.65 m wide and that used standard gauge tracks were specified (Figure 4). This feature required technical facilities for mixed operation of the new standard gauge light rail cars and the existing meter gauge tramcars. These facilities included three-rail tracks (Figure 5) and an overhead contact wire system to supply both types of vehicle.
- Implementation of high platforms (Figure 6) and combined high- and low-level platforms where mixed operation was provided.

As for flexibility and upgradability, the fourth lesson from the Stuttgart experience may be summed up by quoting the 1983 International Union of Public Transportation (UITP) definition of light rail system (*1*):

> Light rail systems are a rail-borne form of transport which can be developed in states from a modern tramway to a rapid transport system operating on its own right-of-way, underground, at ground level or elevated. Each stage of development can be the final stage, but it should also permit development to the next higher stage.

FIGURE 2 Separated surface alignment.

FIGURE 3 Level crossing with fully actuated signals.

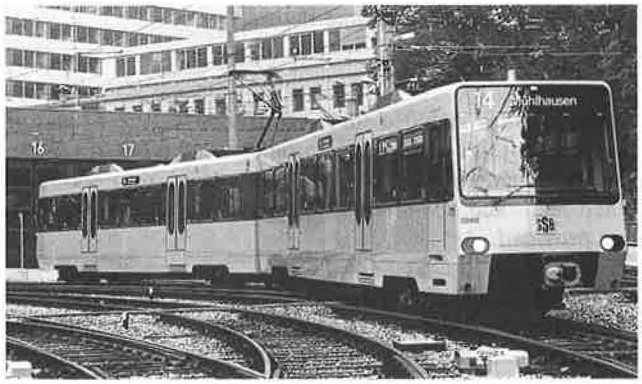

FIGURE 4 A two-unit Stuttgart LRV (Type DT8).

FIGURE 5 Three-rail track for mixed operation.

QUALITY VEHICLES AND PERFORMANCE

Stuttgart's successful introduction of LRT in Germany is ironic in that the city is southern Germany's center of the automobile industry. The metamorphosis of the tramway to LRT has caused a remarkable increase in public transit patronage, between 15 and 100 percent. The fact that passenger loads jumped

FIGURE 6 High platform at a surface LRT station.

15 percent without any reduction in trip time reveals that much of this success can be credited to the new twin car units especially developed for Stuttgart. They had to compare with the quality of the locally made Mercedes automobiles, so it was essential they provide a very high standard of ride, comfort, and seating (Figure 7). On the other hand, high-quality furnishing of light rail vehicles (LRVs) and stations led to decreased vandalism.

As for quality, on-schedule performance and reliability are no less important. The infrastructure measures mentioned, such as tunnels and segregated tracks, are not the only contributions to ensure performance. A computer-aided command and control system (Figure 8) and train-actuated signaling of level crossings are essential as well.

So the fifth lesson from Stuttgart is that it is very important to have quality LRVs that perform to a high standard to improve the public perception of public transit service.

FINANCIAL PROGRAM

Part of the decision made in 1976 is the plan of a fundamental network for the light rail with a local length of 88 line km (53 mi). Based on the 1976 plan, 72 line km (44 mi) of Stadtbahn Stuttgart have been opened so far. Eighty-one new LRVs are

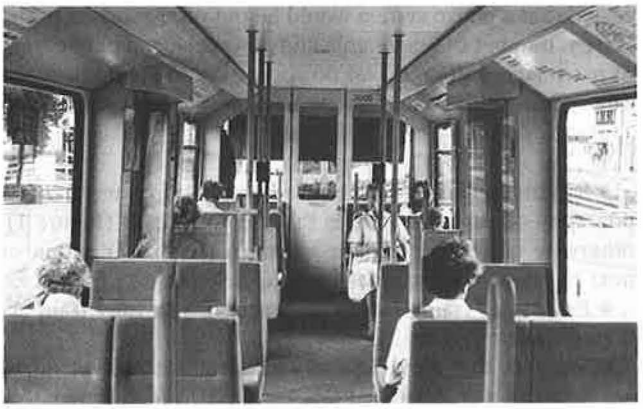

FIGURE 7 Stuttgart LRV interior layout.

FIGURE 8 Stuttgart central control.

serving six routes. Another 19 line km (11.5 mi) are under construction or are prepared to start construction work soon. A further extension of the network up to a total of 130 line km (79 mi) is being discussed.

The essential reason that these plans have every prospect of succeeding is the way public transport infrastructure is financed in Germany. As mentioned before, at the beginning of LRT construction in Stuttgart, finances were totally the municipality's obligation. Were that still true, no infrastructure investment on this scale would be realistic. But the approach of the national and state governments taking a financial stake in public transport infrastructure made it possible to invest more than 2 billion DM (more than $1.2 billion U.S.).

Since the end of the 1960s, the Stadtbahn Stuttgart project was funded by a 60 percent infrastructure grant from the national government. Another 25 percent was funded by the State of Baden-Wurttenberg of which Stuttgart is the capital. This extent of grants to create rail systems is laid down by federal law, so the financial arrangement is the same throughout Germany. The balance has to come from local sources. In contrast to other German cities where this amount is paid by the municipality, in Stuttgart the public transit company, Stuttgarter Strassenbahnen AG (SSB), has to provide this money. Not getting the money from the city has an advantage. It is easier for a stock company to raise money than for the municipal administration to do so, hence this is a more flexible way of providing the balance required.

In addition the financial source for funds from the national and state governments is a dedicated share of the fuel tax. Raising the fuel tax was connected with an extension of the grants to rail vehicles. Therefore, in the state of Baden-Wurttenberg about 40 percent of the investment in LRVs is now covered by government grants.

Good results from a standardized economic evaluation following the approach of cost-benefit analysis is the most important condition for getting infrastructure funds.

So the sixth lesson from the Stuttgart LRT emphasizes the important role of reliable financing. An LRT plan and a consistent financial program have to go together and be supported by objective guidelines for grants and the requirements to get them.

REFERENCE

1. M. Bonz. *Insertion of Alignment and Infrastructure of Light Rail in Cities.* Report by the International Light Rail Commission at the 45th International Congress of UITP, Rio de Janeiro, 1983.