Stockholm's Plans for LRT in the Suburbs

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A new light rail system, referred to as the Snabbspårväg or literally, "fast tramway," is being planned for the city of Stockholm. During preliminary planning the designation for the project was "Hästskon" or horseshoe line because of its appearance when drawn on a map. This name was dropped in favor of Snabbspårväg because officials feared that the name might conjure up images of a return to the old streetcar systems, perhaps even drawn by horses. The project is the responsibility of the transit operating agency for the greater Stockholm region, Storstockholms Lokaltrafik (SL), and is now in the final phases of detail planning. Construction of the first section will begin in 1992 with a planned opening in 1995. Taugbol & Överland a.s., a Norwegian consulting firm, was involved in the detailed planning of a 10-km section of the line.

The first rail transit operator in Stockholm, Stockholms Sparvägsbolag, was established in 1876. The following year horse-drawn streetcars began to operate on the streets of Stockholm. Over the ensuing years, the lines were extended and electrified.

By 1930, Stockholm, like many cities throughout Europe and North America, boasted an extensive system of streetcar lines. In that year, the total route length of the streetcar system reach its maximum length of 88 km. As in other cities, the number of automobiles competing for the use of city streets increased dramatically in the 1930s. The decision was made in 1941 to replace most of the streetcar lines with an extensive heavy rail system operating mostly in tunnels, both in the central areas and in the outlying districts as well. The first T-bane (tunnelbane) opened in 1950.

As the tunnel system was extended, streetcar lines were abandoned and tracks were removed from city streets. Today only two lines remain, the Nockebybanan on the west side of the city and the Lidingöbanan on the east. These two lines survived mainly because both operate in areas not served by the heavy rail system and operate entirely along separate rights-of-way. Also, because they operate on separate rights-of-way that are not parallel to existing roads, it was difficult to substitute bus service.

Despite these logistical and practical obstacles, Storstockholms Lokaltrafik (SL) made several efforts to eliminate these two remaining lines in the 1970s and 1980s. Only vigorous public opposition saved the lines. It is also interesting to note that both lines serve neighborhoods considered "exclusive"—areas where bus service would not be expected to enjoy high ridership levels.

By 1967 all light rail operations with street running were gone. But the streetcars returned to Stockholm in 1991, to coincide with the International Union of Public Transportation conference. The new line is relatively short (3 km) and runs from the center of the central business district (CBD) along a seafront promenade to a park and recreation area. It does provide a transit service but is also used to evaluate various types of vehicles for the Snabbspårväg. It will serve the same purpose as the mock-ups used in many cities, but will obviously give the public a better chance to evaluate the various proposed vehicle types.

POSTWAR DEVELOPMENT PATTERNS

During the past 50 years Stockholm has experienced a substantial increase in automobile traffic and congestion. In this regard the region is similar to many other large cities in Europe and North America. Unlike other cities, this congestion can partly be attributed to the officially planned pattern of development proposed and implemented in the 1960s.

The city of Stockholm is an archipelago, with many sections of the city isolated from neighboring areas by the various rivers, channels, and other bodies of water that give Stockholm a special character. The city's central business district is a major source of employment, culture, entertainment, and commerce.

Swedish urban planners in the 1960s, possibly in response to the topographic isolation caused by the water system, proposed satellite CBDs with offices, shopping centers, and housing. Each of these secondary CBDs was to be located on one of the recently completed rapid transit lines. The satellite CBDs would be separated from the central area and other satellite cities by extensive green areas, so called "urban lungs."

The Swedish satellite cities differ in some ways from the so-called "edge cities" of the United States in that a substantial number of people also live in these developments and public and social activities are located there as well. Extensive networks of pedestrian and bicycle paths were built within the developments and between them and the CBD through the reserved green areas.

The plan of course was based on the idea that the new developments would be the center of activity (work, shopping, entertainment, etc.) for their residents. In such a way, a better environment could be provided as it was planned from the ground up with green common areas, the internal pedestrian/bicycle paths, special areas for delivery vehicles, and so forth. Unfortunately although housing and employment were potentially available at the same location, it was difficult to
always find a job in the particular place that one lived. So, transport became a problem. And transport between multiple satellite cities is difficult when the public transportation system, a heavy rail system based on a radial pattern, is oriented for travel toward the CBD.

**ROAD BUILDING**

Concurrent with the building of the satellite cities, Stockholm also engaged in a massive program of highway construction. Despite gasoline prices, which still stagger most visitors from North America (now approximately $1.20 per liter or $4.50 per U.S. gallon), the use of the private automobile increased dramatically.

Roads and bridges were built connecting not only the suburban areas with the CBD but also connecting the suburban areas with each other.

In recent years many proposals have been made to reduce dependence on the private automobile through incentive schemes (such as improved alternative transportation service) as well as disincentives (proposals for road pricing in the CBD). The Snabbspårväg was proposed to offer public transit service in corridors and areas not served well by existing surface transit services.

**LRT PROPOSAL**

In the early 1980s it was recognized that the transportation system in Stockholm had developed such that

- Public transport services were oriented primarily toward the CBD;
- Planned development, such as the satellite cities, led to increased demand for transport between suburban areas; and
- Road building provided a better alternative for many travelers not going either to or from the CBD.

This is not to say that public transit in Stockholm suffered the decline in ridership experienced in many American cities in the 1970s. Ridership was relatively stable. But its modal share did decline.

The T-bane system in Stockholm is based on three main lines, each with outlying branches, coming together at one major downtown station, T-centralen. This station serves more than 150,000 to 200,000 passengers per day with center platforms only 4 m wide. It is extremely crowded despite headways of less than 90 sec during the peak periods. Thus any improvements in public transport would have to address this capacity restraint at the center of the rail network.

The Snabbspårväg was a direct response to two needs: better communication between outlying areas and reduced passenger traffic through the bottleneck of the T-centralen station in the CBD. The obvious solution, and the one proposed and accepted, was a circumferential line not directly serving the CBD.

A plan for a rail transit line, originally proposed in the 1960s using available industrial rail trackage south of the CBD, was resurrected. The original proposal called for the use of a few kilometers of available rail rights-of-way. The plan in 1985, however, was expanded to a complete light rail ring around Stockholm.

Light rail transit (LRT) was proposed for the new line for the following reasons:

- **International development**—The success of the new lines in the United States, Canada, and France, together with the continuing success of upgraded systems in Germany, Switzerland, and the Netherlands, showed the potential of the mode.
- **Environmental considerations**—The growing concern in the 1980s for the environment forced the issue of providing a transportation alternative to the automobile.
- **Cost considerations**—LRT has many of the same benefits of a heavy rail system but with 30 to 50 percent lower construction costs.
- **Effective land use**—Stockholm is proud of its extensive green areas in the outer parts of the city: It was thought that LRT would blend in well with these areas.
- **Structure for future development**—The presence of a light rail line and major terminal stations, with interchange with heavy rail lines and the bus system, would stimulate and focus future development.
- **Accessibility and reliability**—LRT offered the benefits of better accessibility and reliability mainly because of the level of priority normally given to a light rail line.
- **Visibility**—LRT operating at grade, or in streets, is an attractive advertisement for public transport.
- **Comfort**—LRT offers superior comfort for passengers compared to diesel buses.
- **Attraction**—Because of many of the characteristics just mentioned, LRT can attract automobile users to an extent that diesel buses cannot.

**DESCRIPTION OF NEW LINE**

The circle line would be 45 km long if ever completed as a ring approximately 5 to 10 km from the CBD. The first phase runs from Gullmarsplan southeast to Alvik, west of the city.

Phase two runs from Alvik over the old airport at Bromma to the end of one of the heavy rail lines at Ropsten. The final phase would be the completion of the ring between Ropsten and Gullmarsplan. This is proposed for reasons of symmetry more than traffic at this point. Details of the LRT project are as follows:

<table>
<thead>
<tr>
<th>Item</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Length (m)</strong></td>
<td></td>
</tr>
<tr>
<td>Alvik-Liljeholmen</td>
<td>5,180</td>
</tr>
<tr>
<td>Liljeholmen-Årstafältet</td>
<td>2,800</td>
</tr>
<tr>
<td>Årstafältet-Alvsjö</td>
<td>3,150</td>
</tr>
<tr>
<td>Årstafältet-Gullmarsplan</td>
<td>2,930</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>14,060</td>
</tr>
<tr>
<td><strong>Length of different right-of-way (ROW)</strong></td>
<td></td>
</tr>
<tr>
<td>Grade-separated (viaduct or tunnel) (m)</td>
<td>2,470–3,220</td>
</tr>
<tr>
<td>At-grade, separated (m)</td>
<td>8,640–10,430</td>
</tr>
<tr>
<td>Street-running in traffic (m)</td>
<td>1,100–2,200</td>
</tr>
<tr>
<td>At-grade crossings (no.)</td>
<td>Approx. 25</td>
</tr>
<tr>
<td><strong>Stations</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total number</strong></td>
<td>15</td>
</tr>
<tr>
<td><strong>Distance (m)</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Maximum</strong></td>
<td>1,700</td>
</tr>
<tr>
<td><strong>Minimum</strong></td>
<td>600</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td>1,000</td>
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</table>
The line combines a variety of ROW types including street running, separated ROW at grade, and in tunnel, over bridges, and elevated. It crosses existing heavy rail lines at five major transfer stations and will operate jointly with the Nockebybanan on 1.5 km of that line near its terminal station at Alvik. The Nockebybanan will be extensively renovated concurrent with the construction of the Snabbspårväg to accommodate the new 60-m train-sets and higher operating speeds.

Integration with Existing Transit Network

The Snabbspårväg, being a circumferential line, intersects many of the radial rapid transit lines. At these intersection points, interchange stations are proposed with easy transfer between the two rail systems, as well as feeder bus lines and park-and-ride facilities.

Rolling Stock

The Snabbspårväg will be operated using one- or two-car train sets. Each car will be approximately 30 m long, have a low floor over most or all of its length, and operate at a maximum speed of 80 km/hr. Low-floor vehicles are being specified because the line will operate both on separate right-of-way and on the street.

Right-hand Versus Left-Hand

Another interesting aspect of the project was the question of left or right side operation. Sweden was historically a left-hand drive country. In 1962 the country changed over to right-hand driving on roads, whereas rail operations, including rail transit, to this day continue operating on the left. It was felt that rail facilities were a closed system, and the conversion costs to right-hand operation were unacceptably high.

As the Snabbspårväg interfaces other rail lines at so many stations, the question of left versus right emerged early in the discussions. There was no disagreement that, when operating in streets, even pedestrian areas, right-hand operation was necessary for safety reasons. The difficulty and cost of changing to left-hand operation for several stations led to the decision that operation would be on the right side for the entire line.

Automatic Operation

At one time the planning process considered whether the line could be operated automatically sometime in the future. This would necessitate a completely separate right-of-way. When the change was made to automatic operation, new vehicles would be substituted for the existing vehicles. This appeared very difficult, and the idea was eventually dropped.

Priority for transit does not necessarily mean a separate right-of-way in all circumstances. Rerouting road traffic, pedestrianization of streets, signal priority, and placement of right-of-way away from existing traffic corridors were also incorporated into the system. Of course, it is a truism that most potential passengers live, work, or want to travel to those areas with a lot of traffic. So the possibilities in this regard are limited.

However, because the line is circumferential, it tends to run at a right angle to the established radial travel corridors. As mentioned earlier, the topography of the Stockholm archipelago, with many separate land masses, also has helped to establish rather rigid transport corridors. The Snabbspårväg cuts across the established travel grain. The disadvantage of this strategy is the necessity of building two major river crossings, both of which are important arteries with ocean-going vessels and the accompanying requirements for clearance.

Alignment Decision Based on Time-Motion Analysis

One of the interesting elements of the project was the establishment of the exact route based on a model of running times given different horizontal and vertical alignments. The shortest running time weighed heavily in the decision of where to place the alignment of the route. An overall goal for the Snabbspårväg is an operating speed of 35 km/hr.

Construction Costs

The cost of the first phase from Gullmarsplan to Alvik (length 14 km) is estimated at 1 billion Swedish kroner (approximately $180 million U.S.). This price does not include the cost of rolling stock or additional maintenance facilities.

Cost-Benefit Analysis

A detailed analysis of the benefits of the new line was done. This analysis included the following benefits:

- Savings in operating costs,
- Reduction in waiting time because of improved regularity,
- Time savings for current and new public transit users,
- Improved traffic safety, and
- Environmental benefits (air and noise pollution, health).

The major economic justification for the construction of the line is the reduction in travel times for both current and new passengers. This explains the importance attached to routing decisions based on travel times. The goal of the line is to provide a high standard of public transit services in a corridor and to areas not previously served to such a standard by existing transit services. Travel times compare as follows:

<table>
<thead>
<tr>
<th></th>
<th>Snabbspårväg (min)</th>
<th>Existing Transit Services (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alvik-Liljeholmen</td>
<td>8</td>
<td>26 (T-bana)</td>
</tr>
<tr>
<td>Liljeholmen-Alvsjö</td>
<td>10</td>
<td>18 (Bus 133)</td>
</tr>
<tr>
<td>Liljeholmen-Gullmarsplan</td>
<td>10</td>
<td>18 (Bus 130)</td>
</tr>
<tr>
<td>Gullmarsplan-Alvsjö</td>
<td>12</td>
<td>19 (Bus 144)</td>
</tr>
</tbody>
</table>
CONCLUSION

The Snabbspårväg represents an attempt to use a rail-based system to serve passengers with travel patterns not conducive to the provision of public transit services. The authorities in Stockholm believe that this is the challenge for public transit in the future; that is, to serve the ever-increasing percentage of trips not oriented toward the CBD.

ACKNOWLEDGMENTS