

GLATTALBAHN: AN INNOVATIVE TRANSPORT SOLUTION FOR SUBURBAN AREAS

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ABSTRACT

The Glattalbahn is an innovative new public transport system serving Zurich's rapidly urbanizing suburbs. The new service combines features of traditional urban and suburban transport. In the city it operates like a streetcar using Zurich's tram network while in suburban communities it operates at higher speeds and with longer stop spacing more like regional rail service. The Glattalbahn incorporates the latest light rail transport best practices including a broad community planning process, coordinated transport/land use planning, continuous façade-to-façade planning and the use of high quality components to both reduce life cycle costs and to increase system attractiveness. Three different routes operate on the newly built infrastructure linking Zurich to the international airport. The project costs 652-million Swiss Francs (\$602-million). The line has been very successful, exceeding its patronage estimates, encouraging significant development and generating highly positive ratings from customers and the community. This paper describes the Glattalbahn project and its innovative features.

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1. INTRODUCTION

The Glattalbahn represents an innovative solution to the complex problem of providing effective public transport service in suburban areas. It is a hybrid rail transit system combining features of urban trams with regional rail (called "Stadtbahn" in German).

The Glattal is a rapidly growing set of suburban communities located between Zurich and its international airport. These communities were originally separate villages, but have grown together as Zurich's economy and airport expanded. The area's development pattern consists of fairly dense mixed-use buildings located on the periphery of the "old" lower density Glattal villages. This development has no organizing structure; development in one village is unrelated to that in the next. As the region and transport demand grew, the roadway network reached capacity, negatively impacting both automobile and public transport.

In 1990 four mayors of the larger Glattal communities recognized the need for action. They met with key stakeholders from the surrounding communities and proposed working together to solve the area's transport problems. Importantly, they believed that the transport solution should be closely linked with coordinated land use planning to help tie together the area's communities, improve quality of life and encourage sustainable economic development.

During the 1990s the Glattalbahn plan was developed in a broad community process. The process resulted in a plan for building a light rail transit line integrated with Zurich's city tram network. The Glattalbahn is being completed in stages; the first stage opened in December 2006, the second stage opened in December 2008, and the third is scheduled to open in December 2010. Patronage is higher than expected and the project has been successful both in terms of its transport and development objectives.

This paper describes the Glattalbahn's planning, guiding design principles, and four key innovations used in the project. The paper closes with conclusions and lessons learned.

2. GLATTALBAHN PROJECT

The Glattalbahn is a new rail service linking downtown Zurich with the airport via the Glattal communities. This section describes the Glattalbahn technology, its relationship with Zurich's transport system, planning and initial operations.

2.1 Glattalbahn Technology

Classification of rail transport systems that combine features of urban trams and regional rail systems is difficult. The German term "Stadtbahn" is used to describe several different operating approaches ranging from 'open' systems where light rail transit (LRT) vehicles operate on the same track as standard railway vehicles (e.g. Karlsruhe, Germany), [1] to 'closed' systems where LRT vehicles operate on tracks used only by other LRT vehicles/trams. [2] [3] One characteristic that distinguishes different Stadtbahn systems is the degree of signaling (i.e. whether the vehicles operate under visual control or signaling systems).

In some cases the German term "S-Bahn" (Schnell-Bahn = fast train) is used for 'closed' Stadtbahn systems (e.g. Zurich's Forchbahn S-18) rather than its more common definition as a regional rail line (US commuter rail) that operates on tracks shared with standard railways. In the former case S-Bahn is being used to differentiate between LRTs that operate on shorter local routes and LRTs that operate on longer regional routes.

The original idea for the Glattalbahn was to build a new line exclusively serving the Glattal area. This would improve accessibility and operations by allowing the stations and rolling stock to be designed together. However, during the planning process Zurich began operating low floor trams and Glattalbahn planners recognized that operating low floor vehicles on an integrated network would provide the same boarding benefits but also eliminate transfers for passengers traveling into the city.

This means that the Glattalbahn shares tracks with the city's trams in Zurich; here it benefits from Zurich's comprehensive public transport priority program. [4] Outside the city, the Glattalbahn has its own dedicated right of way (ROW) designed for higher speed operations both in terms of stop spacing and track geometry. This combination provides a good mix of speed and convenience. Thus the Glattalbahn can be classified as an open Stadtbahn system.

The need for fast and convenient service was clear from the beginning. Only with these qualities would it be possible for public transport to provide competitive service in suburban communities. Technically the Glattalbahn is a tram, but a tram that has been fundamentally redesigned to better serve the needs of suburban communities.

2.2 Glattalbahn integration in the Zurich public transportation system

Zurich's public transport system is widely recognized as one of the best in the world. The system consists of 42 different public transport companies providing long-distance rail, regional rail, urban tram, bus, ship and cable railway services to the approximately 1.3 million people living in the greater Zurich region. The key factor in making this diverse system work is a highly integrated schedule and ticketing system coordinated by the regional public transport agency, the Zuercher Verkehrsverbund (ZVV). [5] (<http://www.zvv.ch/en>)

The Glattalbahn was designed to be fully integrated with the rest of Zurich's public transport network. Physically, it has direct links to seven regional railway (S-Bahn) stations (three also offer long distance service), the airport's regional bus terminal as well as numerous bus and tram connections at specific stops. Organizationally the Glattalbahn uses the same zone-based ticketing system used throughout the ZVV's service area.

2.3 Planning Objectives, History and Milestones

The Glattalbahn is the product of a careful planning process. As outlined above, initiative for the project came from four local mayors who decided to solve the area's transport problems, but wanted a solution that helped support higher quality urban design and sustainable land development. They began by speaking informally with fellow community leaders who agreed to join them in planning and implementing the project.

These community leaders worked together with other stakeholders (citizens, property owners, businesses) and professional planners to develop and refine plans for the new transportation system. Since the Glattalbahn project was quite complex from the procedural and political perspectives, the willingness of these stakeholders to work cooperatively together through the whole process was a key success factor.

One strategy that helped facilitate project planning was adoption of four key guiding principles. These principles were used to help make decisions and to keep the broad set of stakeholders focused throughout the process. These principles were:

1. **Integrated Multimodal Transport Planning** – The Glattalbahn is more than just a tram. It is a multimodal transport corridor closely integrated with the regional transport network. It includes the rail line, new roadways, multimodal transport nodes and improvements to local pedestrian networks, bicycle facilities and access routes for disabled persons.
2. **Transport – Land Use Coordination** – The Glattalbahn project was conceived as a key element for unleashing the Glattal area's economic potential. By combining a multimodal transport project with a coordinated urban design program and land use planning, the project helps improve life quality and encourage sustainable development.
3. **Façade to Façade Planning** – The Glattalbahn is an integral part of its environment. Therefore, the project's planning area extends from building façade to building façade. This helps integrate the rail infrastructure with the street, sidewalks and buildings along its route.
4. **Continuous High Quality Design** – The Glattalbahn uses a consistent design vocabulary featuring distinctive, high quality modern architectural elements. This

makes the rail line more attractive and helps integrate it with adjoining spaces. Particular attention was paid to station design and access including connections to important nearby destinations.

Section 3 describes these principles and how they were applied in the Glattalbahn project.

The Glattalbahn plan was added to the Canton of Zurich's official transport plan in 1995. In 1998 the Canton of Zurich gave responsibility for planning and constructing the Glattalbahn to the VBG Verkehrsbetriebe Glattal AG (VBG) (<http://www.vbg.ch>), the Glattal area's existing public transport operator.

In early 2003, Zurich citizens voted 66% to provide a 652 million Swiss Francs (\$602 million) grant for the project. This funding comes via the so called "transportation funds" from general tax revenues. The vote illustrates strong support for well-planned public transport projects. Especially interesting is the fact that the Glattalbahn only serves a portion of the Canton, but the entire Canton voted to pay for it.

2.4 Glattalbahn Construction and Operations

The Glattalbahn project consists of 12.7 km of new double track light rail track and 20 stations. The route does not pass through the traditional village centers, but rather follows a relatively direct route through the border areas of the communities – areas currently defined by the railway, freeway routes, and utilities systems. This route was chosen with the goal of transforming these formerly peripheral areas into high quality "urban" development. The Glattalbahn, as a continuous "common thread" was designed to bring a new urban quality to the area, thus encouraging high quality development.

The initial Glattalbahn project consists of three stages. The first two stages are in operation and the third is under construction; several extension projects are being considered. The initial project's three stages (solid lines) and the future extensions (dashed lines) are shown on Figure 1.

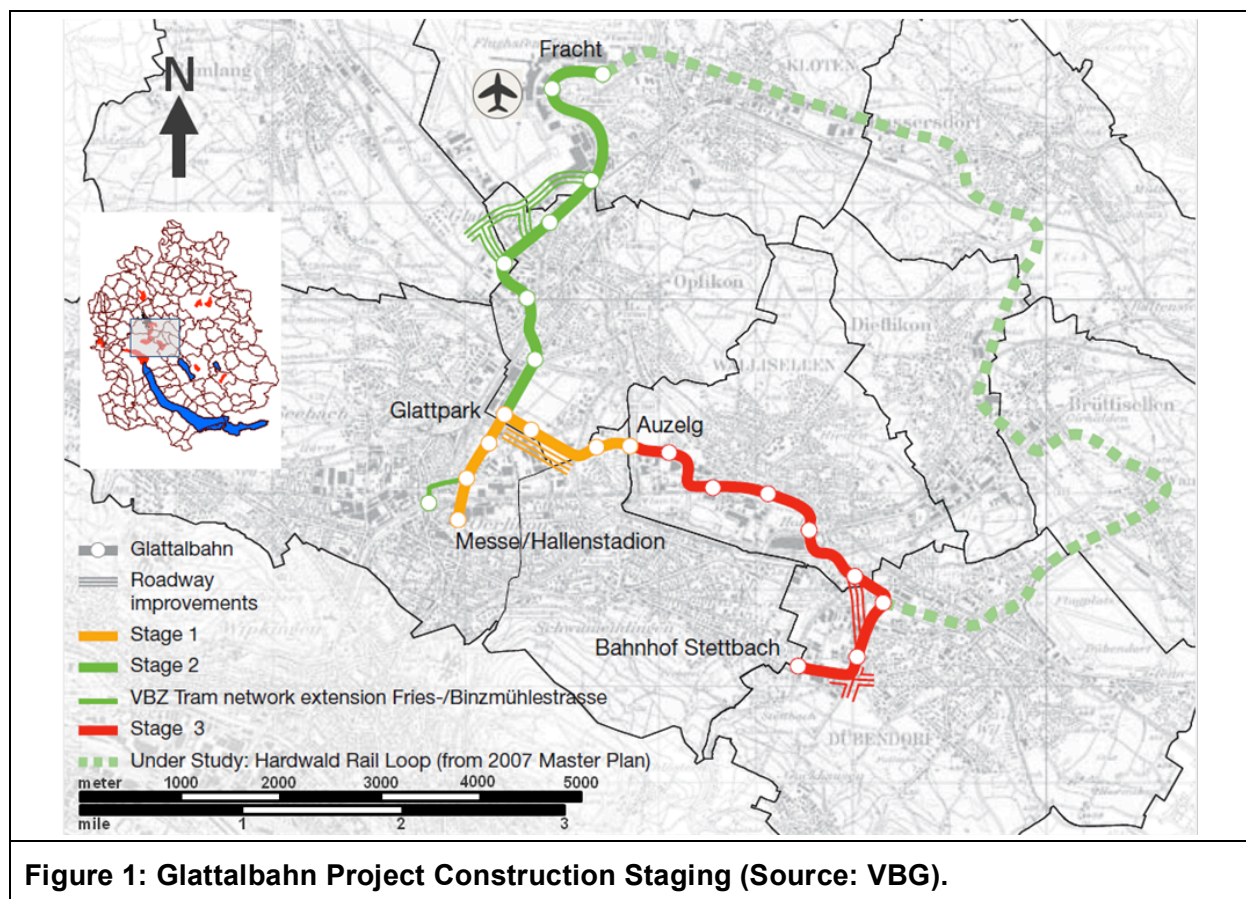
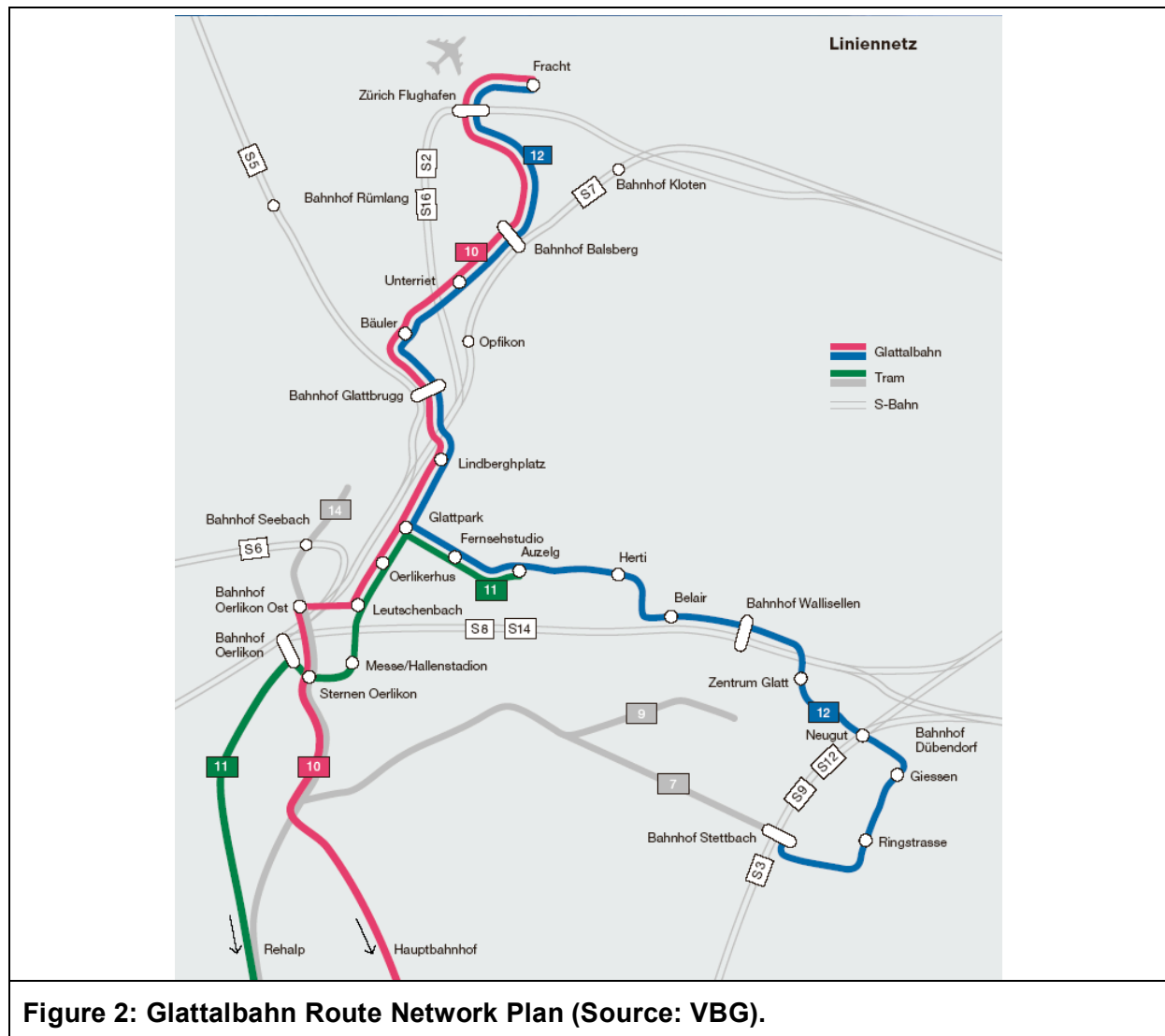


Figure 1: Glattalbahn Project Construction Staging (Source: VBG).



Stage 1 of the Glattalbahn project consists of a line extending from Zurich's convention center (Messe) tram station to the Glattpark station and then turning east to Auzelg station. This is all on the surface and is mostly dedicated right of way. Service on this section began operating in 2006 and was provided by an extension of Zurich tram #11. End to end travel time on the route is 48 minutes.

Stage 2 consists of an extension from the Glattpark station north to the airport. The majority of this section is on the surface with dedicated right of way, although there is a short section of tunnel under the long-distance railway tracks and a 0.8 km section of aerial alignment near the airport. The city of Zurich's public transport company (VBZ) operates this service under contract to the VBG. It operates as an extension of Zurich's tram #10 under the new name "Glattalbahn tram #10" for the whole line. End to end travel time on the route is 38 minutes. Service began in December 2008.

Stage 3 is currently under construction and extends the line from Auzelg in a southeast direction to the Stettbach regional rail station. This line will enable the Glattalbahn to provide the region's first tangential service from Stettbach to the airport via Glattpark – just skirting Zurich's city border. End to end travel time on the routes is projected to be 27 minutes. Service is scheduled to begin in December 2010.

Figure 2 presents the Glattalbahn route network superimposed over the area's regional rail lines. Regional rail lines are shown as a double line marked with "S" and a number, while Zurich VBZ tram lines are shown as a solid gray line with a number. As shown in Figure 2, three different routes will use the Glattalbahn infrastructure.

Finally, it is important to note that the VBG operates buses in the Glattal area, but did not have experience in operating rail vehicles. Therefore the VBG decided to contract with the city of Zurich's VBZ to operate the Glattalbahn until at least 2017. The contract covers operation and provision of rolling stock (low floor vehicles are required under the contract).

The initial Glattalbahn project (three stages) will cost 652 million Swiss francs (\$602 million). Of the total, 555 million is for the Glattalbahn and 97 million is for associated roadway construction. The Glattalbahn costs are distributed into the following main categories:

- 40% heavy construction and structures
- 25% Rail equipment including track, signaling, catenary, stations, power systems
- 15% land acquisition
- 20% planning, administration and other costs

As mentioned above, the project's capital costs were funded by the Canton of Zurich. Operating costs are funded in the same manner as other Zurich region public transport, namely a combination of passenger fares (approximately 60% in the year 2008) and local community assessments. [5] The service provider (VBZ) is required to provide the 18 vehicles used on the Glattalbahn as part of their operating contract with the VBG; thus the vehicles are paid for from contract revenues.

The latest passenger figures show that the Glattalbahn is well used. Over 2.9 million passengers are expected to use the new part of the line in 2009, the first full year of service. This compares to approximately 1.5 million passengers who used the bus service previously operated on this route. There are four key reasons for this increase in passengers:

- The Glattalbahn provides more frequent service than the previous bus route (service operates every 7.5 minutes during the peak and 15 minutes off peak);
- The Glattalbahn operates over a longer daily time period;
- The trams are larger and more comfortable than the buses; and
- The Glattalbahn provides direct service to Zurich destinations (no transfers).

Ridership counts made during the first five months of 2009 show that 57,600 boardings and alightings are made on the Glattalbahn stations per week: 10,200 on weekdays, and 3,300 on weekends. The VBG has not yet collected more detailed origin-destination data to determine the number of trips between the Glattal stations and city of Zurich stations.

3. INNOVATIVE PLANNING FOR THE GLATTALBAHN

The Glattalbahn project is a successful example of LRT operating in a suburban environment – a generally difficult market for public transport. One reason for the Glattalbahn's success is that it uses four innovative public transport planning principles. The following sections describe how these principles were implemented in the Glattalbahn project.

3.1 – Integrated Multimodal Transport Planning

The Glattalbahn was conceived and planned as an integrated transport system designed to meet the needs of both the urban and suburban communities it serves. Technically the Glattalbahn is a tram. It operates using visual control, the track gauge is 1.00m and the power system is 600 volts direct current (VDC). This means the Glattalbahn is fully compatible with Zurich's city tram system and through-running is possible.

The Glattalbahn tram #10 uses this through running ability to connect downtown Zurich to the airport. The line uses both the new suburban Glattalbahn track and the existing city tram network. Table 1 summarizes the different design characteristics of the two different track sections.

In the suburban sections, where the Glattalbahn built new track, 96% of the route is dedicated right of way (ROW), while 4% uses time-based transit priority techniques to improve speed and reliability (i.e. traffic signals enable trams to go ahead of other traffic on shared sections of roadway). In the urban sections the Glattalbahn uses the city of Zurich tram network; this network includes sections of dedicated ROW and extensive use of time-based public transport priority techniques. [4] The type of ROW is one factor in setting the

maximum speed; in mixed traffic maximum speed is 48 kph (30 mph) while on dedicated ROW maximum speed is 60 kph (37 mph).

Another important difference between the urban and suburban sections is the station spacing. On suburban sections the Glattalbahn station spacing averages 600 meters (about 2,000 feet / 0.4 miles) compared to 350m (1,150 feet / 0.23 miles) for sections on Zurich's city network. In planning the Glattalbahn careful consideration was given to the exact location of stops allowing vehicles to reach higher speeds and thereby reduce travel time. The Glattalbahn has an average speed (including stops) of 25.4 kph (15.8 mph) in the suburban sections and 16.8 kph (10.4 mph) on the Zurich city network.

City	Glattalbahn			New French LRT Systems		
	Suburb Section	Urban Section	Total	Strasbourg Line A	Montpellier Line 1	Grenoble Line B
Length	6.0 km 3.75 mi	5.9 km 3.65 mi	11.9 km 7.4 mi	12.6 km 7.8 mi	15.2 km 9.4 mi	6.9 km 4.3 mi
Number stations	11	18	29	22	28	17
Average stop spacing	600 m 0.4 mi	350 m 0.23 mi	NA	600m 0.4 mi	560m	430m
Average speed	25.4 kph 15.8 mph	16.8 kph 10.4 mph	21.1 kph 13.1 mph	23 kmh 14.3 mph	21 kph 13.1 mph	17 kph 10.6 mph
mi = Miles NA = not applicable m = meters kph = kilometers/hour						
Table 1: Glattalbahn Tram #10 and new French LRT System comparison (Sources: VBG, Groneck [6] pg. 94).						

Table 1 also presents stop spacing and speed data for three recently constructed French LRT systems. As shown, the Glattalbahn's average station spacing is similar to Strasbourg and Montpellier but the speed is higher. All these systems have similar stop spacing and share of dedicated ROW. The Glattalbahn's urban section is similar to the Grenoble line and has similar performance characteristics.

In addition to the new rail line, the Glattalbahn project included roadway, bicycle, pedestrian and accessibility improvements along the corridor. Seven Glattalbahn stations are adjacent to regional rail (S-Bahn) stations and all stations are well connected to local pedestrian and bicycle networks. Safety improvements were made to pedestrian street crossings and bicycle lanes adjacent to the project. Finally, all stations include clear maps of local transport networks and destinations, and many stations include bicycle parking. As outlined below, high quality designs were used in making improvements to adjoining sidewalks and facilities.

3.2 – Transport – Land-use Coordination

The Glattalbahn's second key innovation was to combine an integrated multimodal transport project with a coordinated land use planning. The transport infrastructure was designed to provide a structure for sustainable development that would be spurred by the new investment. While coordinating transport and land use planning is discussed frequently today, it was a new idea in 1990 – especially for suburban mayors in Switzerland. On the other hand, it was understandable since these mayors recognized that uncoordinated land use planning was helping cause the transport problems.

The Glattal area experienced very significant growth pressure beginning in the 1970s as Zurich grew and people moved out of the city into suburban housing. Growth in the Glattal area was especially strong since it is located directly between the city and the international

airport. The Glattal has been one of Switzerland's fastest growing areas for over 20-years. Today the area has over 100,000 inhabitants and 100,000 jobs. About 300 of the 2,000 largest Swiss companies have their headquarters in the area. And the development continues: 3 of the largest of 11 development areas in the Canton of Zurich are located adjacent to Glattalbahn stations.

Encouraging mixed-use development adjacent to the Glattalbahn was one of the project's key goals. The objective was to create sustainable development, paying particular attention to the landscape, the environment and quality of life. The Glattalbahn stations provide orientation for efficient internal site development while the railway line both connects these new centers and neighborhoods together – creating a "network city Glattal" – as well as Zurich and the regional transport network.



Figure 3: Glattalbahn Glattpark Station with development under construction (VBG).

In Switzerland, cantons are responsible for the high level spatial and transport planning. Linking development and transport planning is strongly supported in the canton of Zurich's policy objectives, which call for densely developed areas to have a balanced (i.e. public and private) transport infrastructure in order to preserve and improve the quality of life. Local communities are responsible for detailed land use planning. Unfortunately, this two-level planning system can make it difficult to coordinate transportation and land use planning. Often, aggressive land use planning at the local level means a lack of sufficient transport, while the best made regional transportation plans suffer when development lags behind the provision of new transport capacity.

The Glattalbahn planners decided to address this problem from the beginning. As soon as the Glattalbahn's conceptual alignment was identified, local plans had to be developed recognizing the new rail system. Furthermore, stakeholders worked together to prepare master plans including transport connections for planned development areas along the route.

A good example is the Glattpark development shown in Figure 3. This project is directly adjacent to the Glattalbahnhof ROW and is served by 3 stations. Development planning proceeded concurrently with the Glattalbahnhof project and the results show this coordination: buildings are oriented to the station, site design guidelines help ensure easy access to the station from the entire site and internal pedestrian/bike paths are coordinated with the Glattalbahnhof corridor facilities. During the 15-year building process this area will be transformed from vacant land into an urban center with 7,000 inhabitants and 7,000 jobs. Already many of Glattpark's residents and workers use the Glattalbahnhof regularly.

In addition to the Glattpark development, many other development projects planned together with the Glattalbahnhof project have been constructed and others are under construction. An internal study estimates that the Glattalbahnhof will stimulate private investment of 9 billion Swiss francs (\$8.3 billion) between 2001–2015. This means that the Glattalbahnhof has stimulated construction worth 16-times the value of the initial transport investment. Interestingly this development is continuing even under the current economic crisis.

3.3 – Façade to Façade Planning

The Glattalbahnhof's third key innovation was using façade to façade planning. This means that instead of simply being a 7m wide strip of land in the middle of the street, the Glattalbahnhof project covers the entire street width including the adjoining roadway lanes, landscape strips and sidewalks – in other words everything up to the façades of the buildings on both sides of the street. While this approach has been used in the newer French LRT systems it was entirely new to Switzerland and cannot (yet) be considered standard design practice.

Facade to facade planning has several advantages. First, it helps increase the region's urban character by creating a consistent identity. This was important because the Glattal had grown organically and therefore communities had no common visual identity and often lacked connecting infrastructure such as bike lanes or sidewalks. Building the Glattalbahnhof gave the area a unique opportunity to build a common infrastructure to connect the area.

Second, the façade to façade approach provided planners with more flexibility in designing the rail project and replacements for facilities removed to construct the project. The functionality of the street, sidewalks, bicycle paths, public lighting, plazas, parking lots, building entrances, etc. had to be replaced but not in exactly the same place.

Third, façade to façade planning enabled the project to create a high quality environment for the entire corridor. This has helped encourage economic development and improve the area's quality of life.

Façade to Façade Planning Principles

The following three principles were followed in implementing the façade to façade planning approach:

1. Existing transport capacity in the corridor should not be reduced;
2. A consistent design and uniform street furniture/public transport elements should be used for the entire corridor; and
3. All project elements (e.g. rail line, roadway, sidewalks and public spaces) should encourage and support adjoining transit oriented development.

The design process was carried out in close cooperation with Canton of Zurich planners and stakeholders adjacent to the Glattalbahnhof. It was very important to involve adjacent stakeholders because the Glattalbahnhof, in the perception of the affected residents, meant a big change in character. The project transformed the formerly 'rural suburban' area into an 'urban' area, this meant that residents needed to admit that they are only formally outside the city – functionally the area is urban, and therefore requires urban transport infrastructure.

The big advantage of façade to façade planning is that it creates an attractive environment thus making public transport more attractive and helping to reduce opposition to the project from neighbors impacted by construction and operation of the system.

Furthermore, in the case of the Glattalbahn, by including all impacted stakeholders in the planning process, it was possible to develop designs that eliminated the need for 'forced' takings of land. When land was needed, the property owner was willing to sell for fair compensation without going through an expensive and time consuming legal process.

Figure 4 presents an example of the design process for a section of the Glattalbahn (Figure 5 shows before and after photos of the same section). The existing situation was a high capacity roadway with two fast lanes and two slow lanes in each direction (top). A bare-bones plan would be to simply add the Glattalbahn tracks and basic landscaping to the street (middle). The bottom part of the figure shows the design developed using the Glattalbahn planning principles. As shown, it is an attractive design providing a 4-lane roadway with significant space for pedestrians, bicycles and landscaping in addition to the Glattalbahn.

Figure 4 also illustrates an important point with respect to maintaining traffic capacity on the Glattal roadway network. At first glance it seems to show that traffic capacity would be reduced (from 8 lanes of traffic to 4). In fact, the actual capacity constraints were the intersections and these were rebuilt as part of the Glattalbahn project so that overall roadway capacity was actually improved.

The main problem with planning façade to façade is that it costs more than bare bones "rail line only" planning. In the case of the Glattalbahn, a clear distinction was made between elements necessary for the transport project (e.g. roadway construction, track construction, etc.) and non-essential costs (e.g. special community facilities, upgrading other infrastructure in development areas, and upgrades at nearby railway stations). The Canton of Zurich paid for the transport costs, those benefiting from the non-essential elements paid for them.

While façade to façade planning does cost more, Glattalbahn planners believe that it does have economic benefits, although these are difficult to estimate precisely. Qualitatively, façade to façade planning helps encourage and focus land development, helps increase ridership (increasing revenues), and increases public support for the project.

A similar façade to façade planning approach has been used successfully in many of France's new light rail systems. The approach, pioneered in Strasbourg, has been used to help revitalize inner cities. As with the Glattalbahn, revitalization occurs both due to the direct investment, but more importantly by how these projects have been closely integrated into the existing urban fabrics.

The careful integration of LRT into the existing urban landscape has been a key success factor for the French systems. For example, Bordeaux used underground electric power transmission to reduce visual impacts in the city's historic center. Not only does this integration support more livable cities and efficient public transport, but it helps increase public acceptance of these massive transport projects. France has also used LRT to improve living conditions in socially disadvantaged neighborhoods outside city centers by providing better transport and upgraded urban environments (e.g. in the suburbs of Rouen). France is a leader in the use of tram systems to improve urban quality of life and increase city identity.

In summary, considering the qualitative benefits of façade to façade planning, one can in good conscience say that if funding is available to pay for the additional costs, then façade to façade planning creates a win-win situation for the public transport operator and the community.

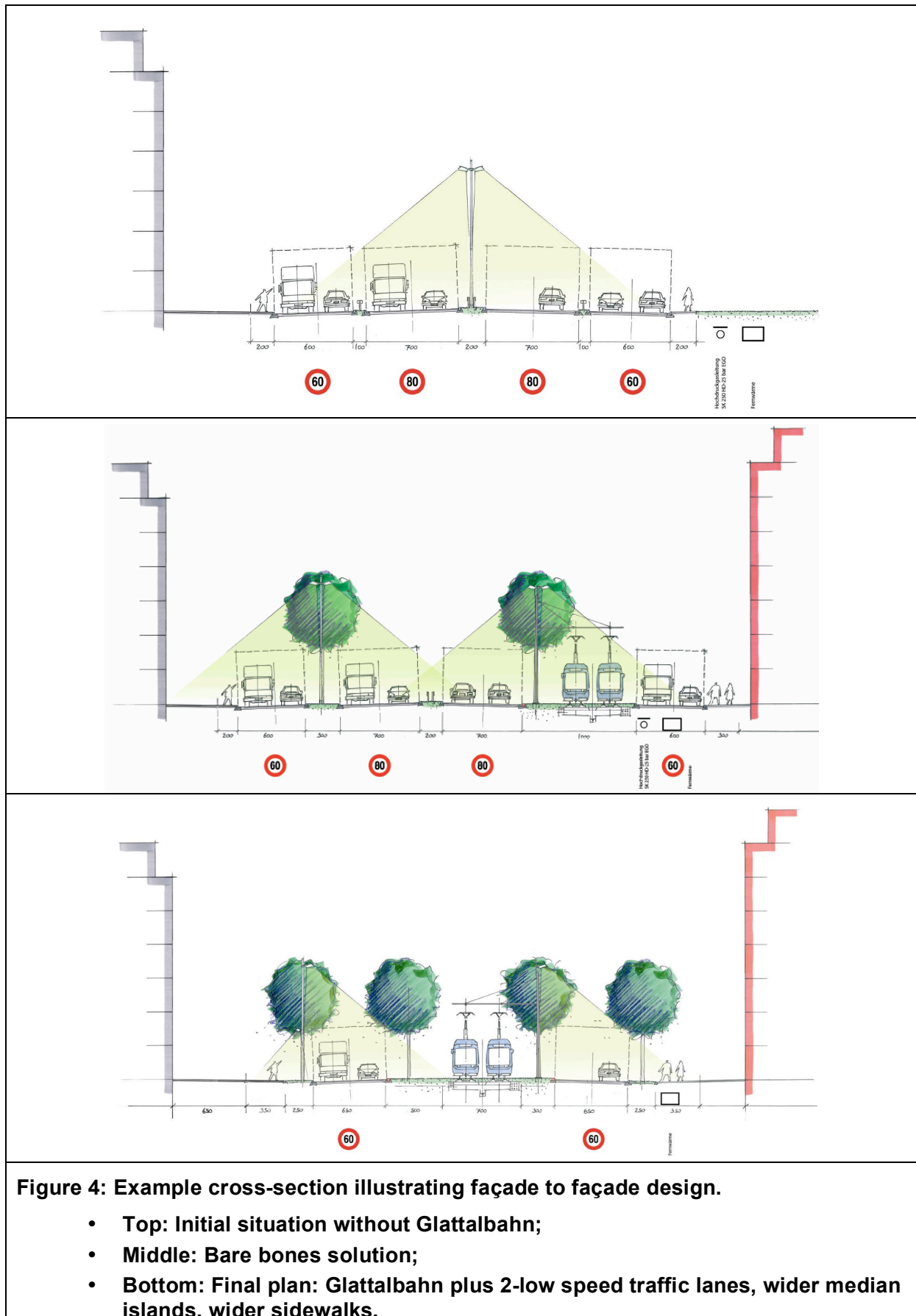




Figure 5: Glattalbahn: before and after photos (same cross-section as Figure 4) – Source VBG.

3.4 – Continuous High Quality Design

The Glattalbahn's fourth innovation is its focus on using high quality components and attractive urban design. Project planners recognized that there could be a conflict between high quality components and attractive urban design (e.g. vandal-proof information boards can look ugly). Therefore, from the start, they looked for both high quality and attractive design in all project elements.

Balancing Quality Objectives

The first step in the design process consisted of developing conceptual plans for system components. To do this planners followed a systematic design evaluation process focusing on six equally weighted quality goals. These consist of the three sustainability triangle goals: social, economic and environmental compatibility, supplemented by the project goals: safety, durability and enhanced serviceability.

The design evaluation process was used for all decision levels; for major decisions all stakeholders were involved, for smaller decisions the project planners made decisions on their own. In all cases the objective was to achieve a balance between all six goals. While it was not always possible to balance these goals equally, just the process of considering all six goals gave a discipline to the design process that led to many improvements.

Life Cycle Cost Analysis

Once the conceptual design had been completed work could start on the detailed design. Given the importance of the Glattalbahn in encouraging new development and serving as a unifying element in the Glattal area, high quality was a key goal, but it was also necessary to keep costs reasonable. The solution was to use life cycle cost (LCC) analysis to identify opportunities for introducing high quality design elements that could reduce maintenance costs.

Developing standardized methodologies for analyzing LCC in rail transport is a subject of current research [7], but no standardized systems were available when the Glattalbahn was being planned. Therefore the VBG asked bidders to include a 20-year maintenance contract in their tender for constructing the railway technical systems (e.g. track, catenary, communication networks, power systems and station infrastructure). This approach forced bidders to offer ideas to minimize costs for the whole life cycle.

The Glattalbahn is the first rail line operated by the VBG and therefore, the VBG decided to exercise the maintenance option for track, catenary and station maintenance. After several

months of operation, the VBG is pleased with this decision; the facilities are well maintained and attractive, while the VBG remains a pure management company responsible for monitoring contract performance and quality. The VBG has not had to build a large maintenance facility and instead can selectively order service from specialists. This has enabled it to reduce costs and increase quality.

From the contractor perspective, providing maintenance has enabled them to create new divisions. The maintenance contractors are innovative, flexible, independent and very familiar with the Glattalbahn infrastructure.

Attractive and High Quality Design

Creating an attractive and high quality multimodal transportation corridor was one of the Glattalbahn's most important objectives. The design needed both to provide an organizing element for the suburban communities and to serve as an 'advertisement' for the Glattalbahn, specifically: quality design = quality service. Therefore, the rail line was built using standard design elements throughout the corridor. [8]

Glattalbahn planners developed consistent concepts and design ideas for the following three specific infrastructure element families:

1. **Track Design – Green Right of Way:** The tracks are generally laid on a slab track with concrete sleepers; the space between and adjacent to the tracks is grass wherever possible. The grass fulfills two purposes: it is a pleasant and sustainable design, and it helps reduce noise. Approximately 60% of the ROW is green.
2. **Stations, Tracks and Catenary – Urban Design:** All the Glattalbahn's infrastructure has been designed using the same vocabulary. The main components are anthracite-colored metal; in stations this is supplemented by glass and wood. A competition was held to select the design firm. Then this design firm worked closely with the planning team in developing the infrastructure elements. The use of consistent components all along the corridor reminds customers (and especially potential customers) that this is the Glattalbahn – a high quality way to travel. The Glattalbahn's standard station components were tested by constructing a pilot station early in the project. This station was used to fine-tune the standard component design ensuring that it met the needs of all users, especially disabled passengers. Figure 6 presents a typical Glattalbahn station.

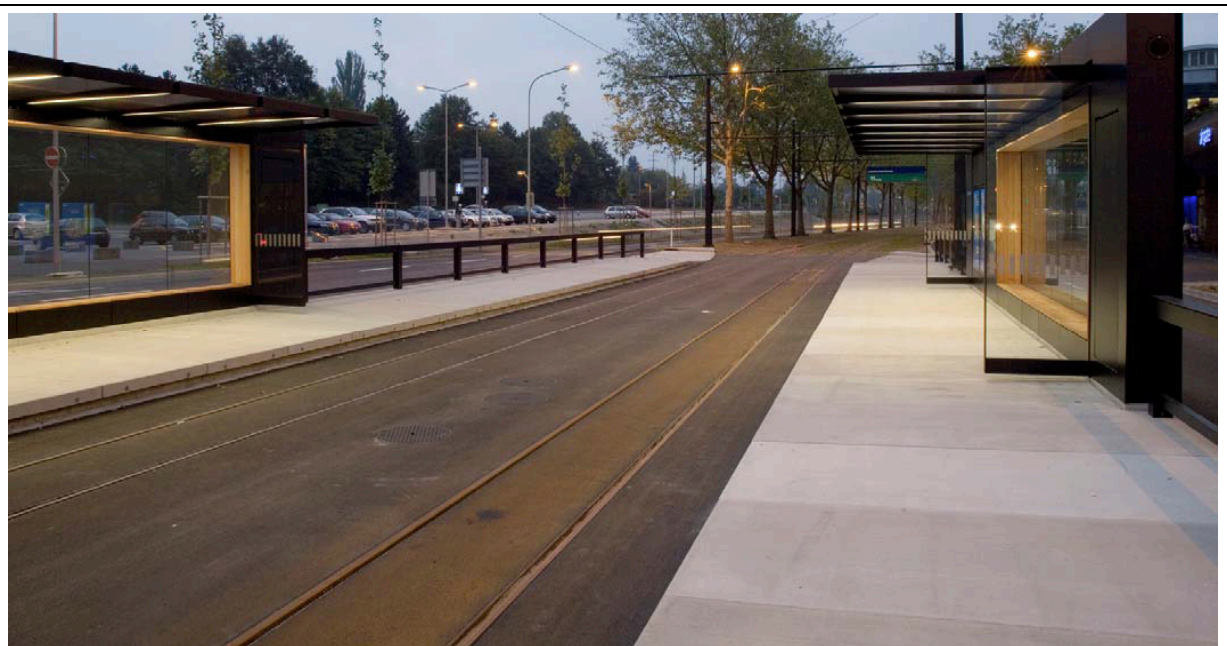


Figure 6: Typical Glattalbahn Station (Source: VBG).

3. **Major Structures:** All bridges, viaducts and major structures use a consistent design vocabulary developed by the station design firm. While many transport systems use a consistent design for passenger facilities, often the major structures and more utilitarian equipment are designed independently, losing the opportunity to create a truly integrated design. The Glattalbahn's four bridges and three viaducts (totaling 2.2km in length) therefore reinforce the Glattalbahn image in the eyes of customers and potential customers.

The uniform infrastructure design also brings significant cost advantages. Thanks to industrial production, economies of scale were achieved and costs were reduced – even for high quality items. These cost savings meant that the Glattalbahn could be built using high quality metal elements with specially equipped graffiti resistant surfaces in the stations and catenary masts. Using graffiti resistant surfaces also provided considerable cost savings and benefits in the maintenance process since the VBG follows a zero tolerance standard.



Figure 7: Low floor trams at the Fracht Station (Source: VBG).

4. CONCLUSIONS AND LESSONS LEARNED

The Glattalbahn is an attractive and efficient public transport system that has helped encourage sustainable urban development in the suburban communities it serves. The Glattalbahn, which operates as a regional rail line in the suburbs and as an urban streetcar in the city, differs from other projects such as building new urban LRT systems or “simple” extensions of existing LRT lines. Thus, the project’s lessons need to be tempered to fit the particular situation. The main lessons are:

Consider network connections - The original idea for the Glattalbahn was to create a stand-alone rail system for the suburban area; however project planners quickly realized that using low floor LRT vehicles would enable them to offer transfer-free trips into the center city. This led them to choose the hybrid regional rail-urban streetcar service. For short extensions of existing systems it’s probably better to simply build to the exact same standards.

Take advantage of bottom-up planning processes – The Glattalbahn’s impetus came from the bottom-up (local mayors and other political stakeholders). They recognized both the need for and potential of a new balanced transport system that was coordinated with land use planning and development. The transport planners took-up this challenge and used the strong stakeholder interest to create a unique new transport system. Many challenges were resolved un-bureaucratically, because the project had built a habit of cooperation. However, even with good cooperation, it’s important to have solid written agreements to fix decisions with so many actors involved.

Explicitly plan for transit oriented development – An important goal of the Glattalbahn project was to encourage sustainable urban development along the project corridor. Therefore, development planning began immediately after the setting the conceptual alignment. Project stakeholders worked closely with project developers to prepare land use and transportation plans that meet everyone’s needs.

Build with high quality components – Since the Glattalbahn project was intended to help encourage sustainable development high quality was always an important consideration. However, the project found that using high quality components can reduce life cycle costs as well. High quality includes both using good designs and increasing serviceability. Developing a high quality design requires close cooperation of planners, architects and engineers to build a highly functional and durable infrastructure. A good strategy used by the Glattalbahn was to obligate infrastructure contractors to not only tender for constructing but also for maintaining the system over a 20-year period.

Take a façade to façade approach to corridor planning – The Glattalbahn, similar to many French LRT systems, took a façade to façade approach to streetscape design. This provided more flexibility in the planning, helped create a more attractive design and encouraged economic development.

Use efficient management processes – The VBG provided only four full time employees for the project, all the other services were provided by outside sources. This means that it was necessary to use very efficient project management processes including careful time management (especially given the large stakeholder planning process). Four persons was the absolute minimum needed, it would have been very difficult to manage the project with fewer staff.

Learn from good practice examples – While conditions in different parts of the world can differ (e.g. land-use planning, costing/funding, laws), there is still a great deal that can be learned from reviewing other systems. The Glattalbahn’s project leaders learned a lot from trips to other LRT-projects (mainly in France). Being open to innovative new ideas from other projects and seeking ways to implement them in your own conditions is a big key to success.

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