Introducing New Commuter Rail Service on Busy Routes – Case Study: Stadtbahn Zug

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ABSTRACT

Regional rail service is a cost effective way of improving public transit. In December 2004 the canton of Zug successfully introduced a new regional rail service, Stadtbahn Zug, on two existing rail lines. The Stadtbahn's vehicles, infrastructure and operations were carefully planned to meet the small operating window available on the heavily used existing tracks. The project was also used as the basis for reorganizing the canton's entire public transit network by constructing train-bus transfer facilities and introducing a timed transfer system at four major stations. An important part of the project is an innovative real-time passenger information system intended to show actual bus and train arrival times on video monitors located on trains and at stations. The project provides many lessons for other regions planning to introduce new commuter rail service including the importance of good marketing, careful planning, teamwork and having a comprehensive overall approach.

1. INTRODUCTION

Regional rail service on existing rail lines has been identified as a cost effective way to improve public transit service in small to medium cities and as an opportunity to reorganize an area's transit network. [1] In the mid-1990s the canton of Zug (Switzerland) began planning a new type of regional rail service, this service, called Stadtbahn Zug, began operations in December 2004. This paper presents a case study of the project's planning and implementation.

The canton of Zug is located in central Switzerland between the cantons of Zurich, Lucerne, Schwyz and Aargau. It contains eleven different communities (cities and towns), and is about 240 square kilometers in area (Figure 1).

Zug is an extremely attractive place to live and work. It is generally rural in character with several small cities, the city of Zug being the largest. Due to an attractive tax system the canton has attracted many new businesses during the last few years. It is about forty minutes to Zurich's international airport and close to cultural opportunities and jobs in Zurich and Lucerne; it is also close to the countryside and outdoor activities (e.g. Swiss Alps).

This excellent location has attracted a significant amount of growth. The canton's population doubled between 1960 and 2000 and is now approximately 103,000 residents; at the same time the number of jobs increased three-fold to 56,000 and the number of companies increased ten-fold to 19,000. The canton has a very high average household income and high auto ownership (there were approximately 60,000 cars in 2000, eight times as many as in 1960). [2]

In general, development density is higher in Zug (and Switzerland) than in the U.S., but new development is frequently located outside the urban areas in, albeit more densely developed, office parks and housing estates. The canton's population is expected to grow by 20% to 35% and jobs are expected to increase by 10% to 30% during the next fifteen years. [3]

FIGURE 1 Canton of Zug, Switzerland. [2]

Traffic congestion is a growing problem in Zug. Most of the region's roads are small by U.S. standards, often only one lane in each direction and very rarely more than two lanes in each direction (this is true throughout Switzerland). As the growing population and jobs have spread outside the traditional centers and auto ownership has increased, commuting demands on these small roads has risen. Today many of the main roads experience traffic congestion in peak periods, which has also hurt public transit as buses are also caught in the congestion. Population and employment growth is expected to increase traffic by up to 45% in the next twenty years.

In the mid-1990s, government officials from Zug realized that they needed to address growing traffic problems. Ultimately they developed the idea of the Stadtbahn Zug. This research describes the project design, planning and implementation.

The process used to plan and implement the Stadtbahn Zug is a specific example of the general approach to rail network planning used in Switzerland. Therefore the next section outlines that general approach, the following section describes the Stadtbahn Zug's planning in detail and the final section presents conclusions (lessons learned). These lessons should be particularly interesting to other small to medium sized regions struggling to develop innovative public transit solutions.

2. RAIL PLANNING IN SWITZERLAND

Rail planning in Switzerland is focused on creating a network that connects the entire country with frequent service rather than building a limited set of high-speed rail lines. This is a result of Switzerland's geography and its deliberative government process brought about through direct democracy.

Switzerland's rail service is based on the concept of an integrated clock-face timetable (Integraler Taktfahrplan in German), essentially a timed-transfer system for the entire country. [4] In this system trains arrive at hub stations a few minutes before the hour, passengers transfer between trains, and then trains leave a few minutes after the hour.

The Swiss Federal Railway (SBB in its German abbreviation) began developing the Taktfahrplan system following the rejection of an east-west high-speed line proposed in the 1970s. The first hub was created in Zurich (1982) and in 1985 planning began for the Bahn-2000 project. Bahn-2000 extended the hub-system to the cities of Chur, Olten, Basel, Bern, Biel and Lausanne, and created half-hourly timetables in the larger cities (i.e. the timed transfers occur both on the hour and half hour throughout the day). [5] [6] The Bahn-2000 program required improving the rail system to enable trains to travel between hub cities in less than one hour.

Planners carefully evaluated the options for achieving this goal on the different routes and adopted differing strategies depending on the particular conditions.

Railroad improvement strategies fall into three major categories: infrastructure, rolling stock, and operations. Improvements in each category must be evaluated against improvements in other categories to develop an optimal improvement plan for each route. The SBB illustrates this process as a Planning Triangle (Figure 2) with three elements at the corners: products (i.e. operations or schedules), rolling stock, and infrastructure. The circular arrow in the center indicates the use of iterative techniques to evaluate changes in each of these three elements to optimize the system as a whole. [7]

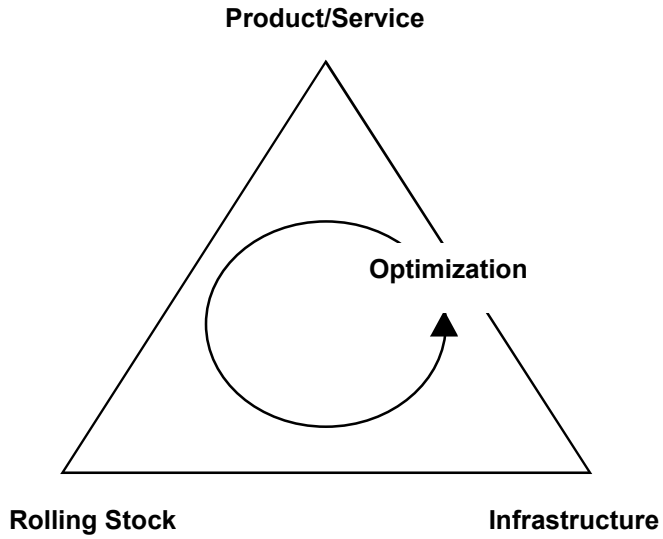

FIGURE 2 – Swiss National Railroad planning triangle.

The Bahn 2000 Plan was originally oriented to long-distance trains without being directly concerned with regional trains. However, the success of Zurich's S-Bahn (which opened in 1990) meant that the Bahn 2000 Plan was extended to include improved regional service in larger cities. [6] In most cases this meant rationalizing existing regional service so that it operates on a regular half-hourly headway throughout the day and marketing the service as a unified system.

The first stage of the Bahn 2000 Plan was completed with the introduction of the new timetable on December 12, 2004 (this timetable increased the number of trains operated by about 12% and significantly reduced travel times on many routes). Initial results show an increase in patronage of between 7% and 8%, although the increase varies significantly by route (larger increases have been achieved on lines with more improvements). [8]

3. STADTBAHN ZUG: FROM IDEA TO IMPLEMENTATION

This section outlines the planning and implementation of the Stadtbahn Zug. It describes the political process and initial planning, the canton's integrated public transit service concept, infrastructure, rolling stock, marketing and initial results. [9] [10]

3.1 Political Process and Initial Planning

The canton of Zug began considering options for addressing growing traffic congestion and air quality problems in the mid-1990s. The canton already had a good public bus system and good inter-regional rail service, but buses were increasingly being caught in the traffic congestion and service quality was deteriorating. Planners considered several different ideas including underground rail lines, elevated rail lines and monorails, but ultimately rejected these in favor of a "Stadtbahn" concept, which mixes the characteristics of tram (streetcar) and S-Bahn (commuter rail) systems to various degrees.

One familiar Stadtbahn concept is operating in Karlsruhe (Germany), where "light rail" trains operate over streets in city centers and on long-distance rail lines outside the centers. [11] [12] A recent study of regional rail systems in Germany found that this type of service is a cost effective way to increase patronage. [13] On the other end of the spectrum is service similar to U.S. commuter rail, with standard "heavy rail" trains operated on the long-distance tracks only. In between these two service concepts are numerous variations.

(Note that current regulations in the United States severely limit the development of different rolling stock options since the Federal Railroad Administration only allows operation of trains that are fully compatible with standard railroad trains on tracks where standard railroad trains operate. This is different from the European practice of operating lighter trains on tracks shared with standard railroad trains. [14])

In April 1997, based on results from preliminary studies, the canton's legislature provided funding for a more detailed study. This study evaluated route alignment, logical locations for stations and implementation possibilities. A critical element was working closely with SBB planners to determine to what extent joint use of existing tracks would be possible (given the existing and future regional, national and international services) and to develop a long term approach for joint use of the main line tracks in the Zug region.

During this phase planners determined that the Karlsruhe model of operating trains through the city's main streets was not practical for Zug. The main reasons were expense and operational complications; streets were already too congested to add trams and it would be difficult to get the trams up to the main rail lines which are elevated several meters above surrounding ground levels. Instead they decided to focus on increasing the amount of train service provided on the main line rail system by adding additional trains and building additional stations.

In order to minimize infrastructure costs, planners focused on ways in which modern rail safety technology and minor infrastructure improvements could be combined to increase the main line rail capacity sufficiently to add the new service and stops. The study result was a concrete plan for Stadtbahn Zug that described the market, service, operations, rolling stock and infrastructure. The plan also included an environmental assessment, cost analysis and a business evaluation.

This plan envisioned service on two lines, one operating every 15 minutes between Baar and Cham (with two trips continuing to Lucerne) and the second between Zug and Erstfeld operating once per hour. The service would use six existing stations and nine new ones (Figure 3). New fast and easily accessible trains would be operated on the line and service would be closely coordinated with bus service. Zug's cantonal legislature approved 70 million Swiss Francs (CHF) ($55 million) funding for the project in August 2000.

FIGURE 3 Zug rail network and proposed Stadtbahn system. [10]

Unfortunately, a citizens committee opposed to Stadtbahn Zug collected enough signatures to require a referendum on the project. The committee argued that everyone should vote on such a large investment, raised questions about the project's costs and benefits, and argued that the project had not been adequately publicized. [15] All the political parties and the most important business organizations supported a large "Yes" campaign. In the election on March 4, 2001, 66% voted to support the project.

Following approval by the voters, more detailed planning continued. In November 2001, the SBB signed an agreement with the canton to operate the Stadtbahn service. One factor that helped seal this decision was the SBB's ability to provide twelve new trains (at a cost of approximately 100 million CHF) for the operation. The agreement also committed the SBB to work closely with Zug's public transit company (Zugerland Verkehrsbetriebe AG or ZVB) in coordinating rail service with bus service. The infrastructure planning was completed during 2002, construction started in mid-February 2003 and service started on December 12, 2004.

3.2 Integrated Public Transit Service Concept

Stadtbahn Zug's guiding principle is to provide a fully integrated canton-wide public transportation network. This was done by re-orienting local bus service to the Stadtbahn stations and improving access to longer distance rail service (using the Stadtbahn to access the main stations rather than buses). This coordinated approach was called "Train and bus from one mould" (which sounds better in German). [16]

Timed-Transfer System

Figure 4 presents a schematic illustration of bus and rail service before and after implementation of Stadtbahn Zug service. As shown in the left side of the figure, before Stadtbahn buses provided service from throughout the canton to the city of Zug where people could work, shop and/or transfer to long distance trains (e.g. trains to Zurich). However growing congestion meant that buses were becoming stuck in traffic making passengers late for appointments and miss train connections. The new system, shown in the right side of the figure, re-oriented local bus service to the four main Stadtbahn Zug stations (Baar, Zug, Cham, and Rotkreuz) with a timed-transfer system. As part of the project, bus layover and passenger waiting facilities were constructed at the transfer stations.

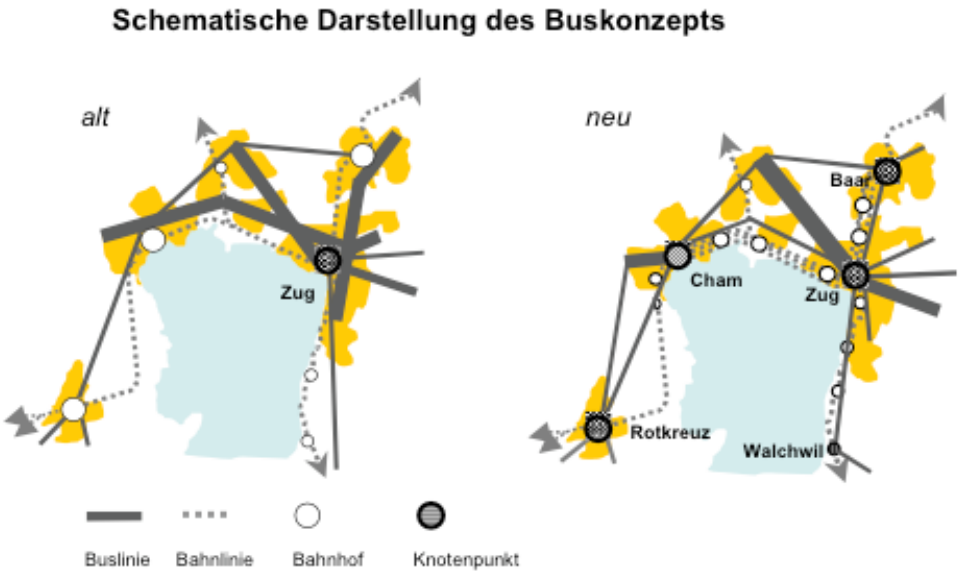

FIGURE 4 – Reorientation of bus system to Stadtbahn Zug stations. [10]

In addition to re-orienting service, planners used this opportunity to make systematic changes to the bus network by adding service to some routes and extending lines. Interestingly, by creating the timed transfer at Stadtbahn stations passengers were also able to conveniently transfer between buses making local travel easier.

Reorienting the bus service and coordinating the schedule with the Stadtbahn added a transfer for many passengers, but balances this problem by increasing the speed and reliability of travel. Table 1 presents travel time comparisons for selected trips using the Stadtbahn (with or without bus connection), auto, and bus (only).

Representative Trip	Stadtbahn	Bus	Auto
Cham (Center) to Baar (Neufeld)			
Uncongested	11	25	12
Existing Peak	11	30	17
Future Peak	11	37	25
Future Savings		236%	127%
Huenenberg - Zug (Center)			
Uncongested	17 (bus x-fer)	22	13
Existing Peak	17 (bus x-fer)	25	17
Future Peak	17 (bus x-fer)	32	25
Future Savings		88%	47%
Walchwil - Zug (Center)			
Uncongested	14	22	14
Existing Peak	14	24	16
Future Peak	14	30	22
Future Savings		114%	57%
Rotkreuz - Zug (Center)			
Uncongested	16	32	16
Existing Peak	16	35	20
Future Peak	16	45	30
Future Savings		181%	88%

TABLE 1 Travel Time Comparison (in Minutes) [10]

In addition to schedule coordination fares are also coordinated. This means that passengers can buy a single ticket covering travel through a specified number of zones on the buses and Stadtbahn. Tickets can be purchased on buses, automated vending machines or at sales outlets.

Passenger Information System

As part of the Stadtbahn project, the canton decided to provide a sophisticated passenger information system that would use video monitors to display the latest information about bus and train arrivals at stations and on vehicles (buses and trains), in addition to the normal signs, maps and schedules (Figure 5). This information helps passengers better plan their trips, for example, the monitors allow passengers on the train to find out if their connecting bus is going to be late. The information also helps bus drivers decide whether to wait for a (slightly) delayed train or leave on schedule in the case of a (very) delayed train.

Unfortunately although the passenger information system is slowly being introduced, it is not yet operating as it was intended. As of October 2005, the system provides schedule information, but the real time information is only available for some of the vehicles.

FIGURE 5 – Stadtbahn Zug passenger information video display.

Operating Costs

The improved public transportation service is more expensive to operate then the system it replaced. The original rail service was subsidized by approximately CHF 7 million per year. This subsidy was provided by the national government (CHF 3 million), canton (CHF 3 million), and local communities. The subsidy from the canton and local communities increased by CHF 2 million per year to pay for the increased Stadtbahn service. As part of the referendum campaign, the canton stated that bus operating costs would increase by a similar amount without the Stadtbahn due to increasing congestion on the main roadways. Thus, it argued that it made sense to spend the money on a project that would really benefit passengers. [15]

In terms of bus service, the vehicle-kilometers increased by approximately 10% after introduction of the new network and schedule. Initially it was expected that bus service could be re-organized without increasing costs, however detailed planning showed that costs would increase by approximately CHF 2.5 million annually for the new network. The new plan was presented to the cantonal legislature along with several less expensive alternatives; the legislature chose to pursue the full network restructuring since this was the most attractive alternative for improving the canton's livability and economic attractiveness. [17] Passenger fares were increased by approximately 10% to help pay for the cost increase.

3.3 Infrastructure

Rail

One of the main objectives of the Stadtbahn Zug project was to take full advantage of the existing rail infrastructure. Therefore, rather than building a new rail line, improvements were made to the existing line to increase its capacity enough to allow operation of the planned Stadtbahn service.

Zug is located at a critical point in Switzerland's national and international rail network. The city of Zug's Hauptbahnhof (main train station) is the point where trains from Zurich branch east towards Lucerne or continue south to Erstfeld and Arth-Goldau on their way to the St. Gotthard Pass and Italy. Therefore these lines are heavily used by passenger trains; 60 long-distance (Intercity, Inter-Regional, International) trains operate daily in each direction between Zurich and Zug as well as 23 Zurich S-Bahn trains.

The rail network consists of a double-track line between Baar and the city of Zug, from Zug to Erstfeld the line is mostly single-track, and from Zug to Lucerne is partly single-track and partly double-track line.

The process of determining what track improvements would be necessary is outlined in Section 2. It starts with a description of the desired service level, in this case trains every fifteen minutes on Line 1 between

Baar and Cham stopping at the three existing stations and five new stations (two of the trains continue from Cham to Lucerne per hour), and trains every hour on Line 2 between Zug and Erstfeld stopping at two new stations and four existing stations.

Next, the vehicle operating characteristics (e.g. acceleration and braking rates, station dwell time characteristics) were used to model how long it would take the trains to make the trip. These trains were then added to the future schedule for long distance trains to determine what additional infrastructure would be needed. As outlined above, this process is iterative and planners compare the costs and benefits of infrastructure improvements (e.g. new track), vehicle characteristics (e.g. acceleration/braking rates, passenger boarding/alighting rates) and service (e.g. schedule) to identify the most cost effective solution.

Stadtbahn Zug planners spent a significant amount of time considering different infrastructure-vehicle-schedule combinations during the initial planning process. The final plan required very minor improvements to the track infrastructure. A key reason this was possible is that the Stadtbahn schedule was adjusted to reduce the need for expensive improvements. For example, while there are four trains per hour they are not all exactly 15-minutes apart, one train per hour departs slightly later to accommodate an intercity train (which has higher priority); similarly, while two Stadtbahn trains per hour serve Lucerne, only one serves the Lucerne main station, the other stops at a suburban station since the track entering the main station has insufficient capacity.

Stations and Stops

The infrastructure program's largest element was construction of nine new stops and renovation of six existing stations (stations are larger and serve longer distance trains, while stops serve Stadtbahn only and are un-staffed). Planners recognized that the new stops would play an important role in defining the system and so carefully considered their design.

The new stops consist of four main elements: a pile supported foundation, a concrete understructure and platform access, platforms and platform elements. The stops were designed to be highly functional, safe, transparent, attractive and easy to maintain (Figure 6).

FIGURE 6 – Stadtbahn Zug stop design.

The main design element consists of bright red colored concrete used in the understructure walls. Red was chosen to contrast with the generally green color of the surrounding environment and to help create a distinct identity for the new system. Platform access is provided by a stairway and a ramp.

Since the stops were being built on a heavily used railroad line, the platforms themselves (and platform elements including railings and shelters) were prefabricated and then installed at the site. The platforms are 150 meters long and consist of prefabricated concrete sections that were delivered to the worksite by train at night. The platform elements are simple and light, they consist of a shelter made mostly of glass, ticket machines, passenger information systems and lighting.

Six existing stations were improved to accommodate Stadtbahn trains. The improvements consisted of improving disabled access, raising station platforms, and in one case adding a platform. In several cases, stations were already being improved as part of Switzerland's Bahn2000 program, which reduced the scope and cost of improvements needed for the Stadtbahn project.

The station renovation and stop construction were completed in a 22-month period between February 2003 and December 2004. Complicated work that could not be done while trains were in operation (such as construction of the pedestrian underpasses) was completed in a window between 12:30 and 5:00 in the morning. Given the project's construction complications and short timeline, the canton decided to use a single contractor and give this firm total responsibility for building all the stations. The SBB served as construction manager since the work was being done on an operating rail line and, since, the SBB would own and maintain the stations.

Infrastructure Costs

The referendum allowed the Canton to spend CHF 70 million ($55 million) on the Stadtbahn project. This sum was divided into approximately CHF 67 million for constructing the nine new stops, improving the six existing stations, and making network improvements to allow more frequent service (e.g. track improvements). The additional CHF 3 million was used as matching funds for construction of four track pedestrian/bike underpasses; the local communities were responsible for providing the additional 50% funding for these underpasses. Communities also made additional minor improvements to their stops (e.g. bicycle parking, sidewalks); the cost of these improvements is not included in the CHF 70 million cost, but was not significant.

The new stops ranged in cost from approximately CHF 1.5 million to CHF 5.6 million ($1.2 to $4.5 million). The cost of improving the six existing stations to accommodate the Stadtbahn trains ranged from CHF 0.3 million to CHF 5.6 million, although in several cases, particularly in the case of the Zug city station, since these stations were also being improved as part of the Bahn2000 program, the Stadtbahn project only needed to pay a share of the total project cost.

3.4 Rolling Stock

Vehicle design was a critical part of the Stadtbahn project. Not only did the trains need to meet specific performance goals (acceleration/braking and passenger boarding/alighting rates) so that they could meet the planned schedule, but they also needed to be attractive.

The SBB was responsible for procuring vehicles, but allowed representatives of the canton and the association for disabled persons to participate in the design process. The SBB prepared the vehicle specifications, evaluated proposals from competing vehicle manufacturers, and eventually selected vehicles from the Swiss company Stadler.

It was clear from the beginning that the vehicles needed to have level boarding and wide doors – to reduce station dwell time to the minimum possible. The final design consists of a four-part low-floor train 74 meters long with eight wide doors on either side (Figure 7). The platforms at new stops are long enough to allow two-train consists. In order to further reduce station dwell times, a wide red line is painted on the station platform at the location where single consist trains stop, this tells people where to wait so that they do not waste time walking down the platform to board the train.

Trains have an operator cab at both ends to allowing them to be operated in either direction. Their maximum speed is 160 km/h with an acceleration rate of 1.2 m/s2.

The trains are bright and attractive inside. The interiors have been designed to facilitate passenger boarding/alighting and movement within the vehicle. There is space for about 400 people per train (about 149 sitting and 250 standing). The vehicles have systems that visually and audibly provide passengers with a variety of travel information (Figure 5). The trains cost approximately CHF 8 million ($6.25 million) each. They are called FLIRT, which is short for the German words: Flinker, Leichter, innovativer Regional-Triebzug (fast, light, innovative, regional train). The vehicle is similar to that used on several other regional rail systems. [18]

FIGURE 7 – FLIRT train (source Stadler).

3.5 Marketing

Often marketing is considered at the end of the planning process. In contrast, marketing has been an integral part of the Stadtbahn Zug process. One reason is Switzerland's direct democracy, where citizens vote on large issues and expenditures. Therefore advocates need to think from the start about selling their project to the public.

In the initial planning several ideas were considered and rejected mainly for financial reasons. This is because direct democracy means that the citizens would eventually vote on the project investment. In contrast to other countries where higher levels of government provide large amounts of funding for public transit investments, in Switzerland, most of the funding for local projects comes from local sources. This imposes fiscal discipline on planners and forces them to think about how to justify project cost in a public campaign.

The word marketing is often construed in a negative light, in the sense of someone trying to sell you something that you do not need, but marketing done correctly can be a process planners use to help identify what people really want, develop a product that meets that need and then tell people about the product. This is the approach followed successfully in Zug.

The first step in the process was for planners to discuss transportation problems and possible solutions with political, business and interest group leaders throughout the canton. These contacts were maintained throughout the process and helped officials refine ideas and plans. These contacts also helped form the basis for the "Yes" campaign committee that was formed to support the project in the 2001 referendum.

The Stadtbahn planners also staged a party called "Lust auf Stadtbahn" during an international conference held in Zug during May 1999 on the theme "Innovation in Regional Transportation during the next Century". Over 1,000 citizens came to see the latest in vehicle technology and see examples of other projects. The planners also staged exhibits at other conferences and events (even the automobile show) to keep the Stadtbahn in the media. The canton also created a detailed website (www.stadtbahnzug.ch in German) to keep people informed about the project.

In addition to this type of marketing for the planning process, officials considered carefully how to make the product they were developing more attractive. One of the most important elements in attracting customers to public transit is the vehicle itself. Therefore, planners focused on developing a vehicle that would communicate a sleek modern image, be comfortable for passengers and be efficient to operate. Similarly, the real-time passenger information system was designed to make the service more attractive by addressing one of the chief complaints about public transit – uncertainty over transfers. Finally, the new stop design was developed with the idea of creating an image for the service; the bright red concrete walls and light transparent platform shelters succeed in communicating an attractive and bold impression.

3.6 Initial Results

The Stadtbahn Zug started operating on December 12, 2004, when the Bahn 2000 timetable went into effect. The system was well patronized from the start but experienced several problems. First, there were only four FLIRT vehicles available on opening day, so older vehicles were used to operate the full schedule. These

vehicles could not maintain the tight schedule (boarding/alighting were too slow, too little acceleration). In June enough FLIRTs were available to operate all trains and delays were reduced.

Second, several operating problems including longer than expected train turning times that led to delays. These types of problems were addressed by appointing a manager to serve as a troubleshooter between the SBB and Stadtbahn Zug focusing on solving each specific problem. For example, an extra driver is assigned to speed-up turnarounds during the peak hour. Finally, the real-time passenger information system did not work as designed, but its problems are being systematically addressed and it is expected to be in full operation by the end of 2005. [19]

As of October 2005, ridership on the total system (bus and train) is up by about 5% and by 30% on some segments of the rail service. These figures are expected to increase as ridership in the October – December period is generally higher than average. Canton officials are happy with Stadtbahn operations and ridership. They believe that the project is good example of efficiently implementing an innovative concept for improving public transportation.

4. CONCLUSIONS/LESSONS LEARNED

Many regions would like to improve their public transit networks by adding commuter rail service to existing railroad lines. Zug's Stadtbahn system is an excellent example of how this can be done successfully. The following factors were critical to the Stadtbahn's success:

- **Stadtbahn Concept** – The overall concept for the project is extremely attractive, by closely linking bus, Stadtbahn and long distance rail service, it provides an extremely efficient public transportation network for the entire canton. The system's design and public information system makes using the public transportation system easy. Finally, through careful planning and use of existing tracks, it was relatively inexpensive.
- **Careful Planning** – The importance of strong technical analysis and good planning cannot be overemphasized because adding new trains to an existing track is never easy. All aspects of the proposed service (infrastructure, rolling stock and operations) must be designed together in an iterative process that includes existing and other future service.
- **Teamwork** – All the different agencies involved in the Stadtbahn project worked together as a team to plan and implement the project as efficiently as possible. A good example is that each agency took responsibility for the project elements that they were best qualified to complete, but also involved the other partners in the process. For example, the SBB was responsible for designing the vehicles, but they worked closely with the canton and representatives of disabled groups in the process.

One potential improvement recommended by the manager appointed to help reduce delays and improve service is to pay more attention to vehicle procurement, especially from the perspective of schedule. The lack of vehicles at the start of service led to frequent schedule delays (caused by overcrowded trains and the use of inefficient older rolling stock) and did not provide enough time for driver training (which caused additional delays since drivers took longer to turn vehicles and perform other regular operations). [19]

Finally, one of this paper's anonymous reviewers suggested that it would be "nice to discuss how a community of 100,000 individuals finances a local passenger rail system when a similarly sized community in North America generally feels that it can barely afford to operate a bare bones local bus network." This, of course, is not a simple question but there are several points that can be made including:

- Stadtbahn added rail service to an existing passenger line, a much easier (and less expensive) proposition than adding passenger service to an existing freight-only line.
- Land development, even in what U.S. residents would consider small or rural towns, is often relatively high density and is concentrated in specific areas making it easier to serve by transit.
- Many people in Zug already used public transit, the project would (and was sold as a way to) improve public transit throughout the canton, thus providing benefits to many people.
- The project was relatively inexpensive both in terms of capital and operating costs. Capital costs were held down by maximizing the use of existing resources. Operating costs, while higher than before the Stadtbahn, provided a higher quality of service (i.e. more reliable trains rather than buses caught in traffic).

In summary, the Stadtbahn Zug project demonstrates that through the focused planning of rolling stock, infrastructure and service it is possible for a middle sized region to introduce a cost effective regional transit network.

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