PUBLIC TRANSPORT FOR (DISABLED) PEOPLE – THE VIENNA EXPERIENCE

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ABSTRACT

Vienna, capital of Austria, is a city with about 1,7 mio inhabitants. In the last years a series of surveys which measured the quality of life of cities were carried out and Vienna was always ranked in the top group of cities worldwide. Beside factors such as cultural heritage, safety, political stability, economic viability also the transport system forms a major factor for these high quality of life standards in Vienna.
Especially the public transport (pt) system is recognised as one of the best pt-systems in the world. The modal split in Vienna is about one third car usage, one third walking and cycling and one third public transport usage, with a declining trend of car usage and an increasing share of public transport users.
The Viennese pt-system as it is, can be classified as safe, reliable, clean, punctual, accessible for all, and relatively inexpensive (365 Euro for a yearly ticket).
Another important characteristic of the Viennese pt-system was/is the underlying planning philosophy of the responsible persons at the WL (Viennese pt-operator), which put, compared to other pt-operators, very early (some 20 years ago) the focus on barrier free design for the pt-stations and for rolling stock within the Viennese pt-system.
At present all subway stations in Vienna are equipped with elevators to enable access for disabled people, all stations (subway, tramway and bus) are equipped with tactile guidance systems to enable access for blind and visually impaired people, and there exists a city wide, intuitive understandable, visual guidance system based on a simple set of standardized pictograms. Finally an audio information system is installed to inform pt-users in case of emergency or incidents.

With this paper a general overview of the different systems developed and applied in Vienna for mobility impaired people is given. We introduce the evolutionary history of the Viennese visual guidance system and the tactile guidance system, reflect on bad and good practice examples and lesson learnt during this now over 20 year long experience of developing and application of guidance systems.

Finally we present a standardized process, developed in a series of national research projects, which support planers to assess the barrier-free-ness of existing pt-stations and pt-station buildings. These survey forms can be easily adopted to apply the assessment method in other cities and regions around the world to increase the accessibility and barrier-free-ness of existing pt-systems.

Barrier free planning, Vienna good practice, planning for mobility impaired people, public transport (pt)

Background

Austria is country with about 8 million inhabitants in the heart of Europe. Austria is one of the richest countries in the World (GDP per capita is 27.500 USD/2011). The capital is Vienna, where about 1,7 Million people are living. Beside other factors such as cultural heritage, safety, political stability, economic viability also the transport system is a major factor for the high living quality in Vienna.
As mentioned the public transport (pt) system can be considered to one of the best pt-systems within Europe and also within the world. The pt-system in Vienna consists of a light rail system, a subway system (5 lines, 78 km track length), a tramway system (28 lines, 175 km length) and a bus system (85 lines, 625 km length). All these systems, except the light rail system (owned and controlled by the federal state of Austria) are owned, controlled and coordinated by the city of Vienna itself. The responsible company, especially founded to run the pt-system in Vienna, is called Wiener Linien (WL).
In 2011 WL achieved a new passenger record with almost 875 million passengers. More than 450 thousand people own a yearly ticket. Already 37 percent of all trips in the capital are made by public transport. On average, around 2,4 million passengers use WL per day. Each day, vehicles of WL cover a distance of 180,000 kilometres, nearly the same distance as orbiting the earth 4.5 times per day.

Vienna's programme for extending its pt-system is closely linked with innovative approaches to ensure the ecological, economic and social sustainability of transport. WL is committed to efficient and environmentally friendly mobility on public transport. It has a long track record of investing in "mobility for all". So everyone can enjoy the benefits of barrier-free access within Vienna. WL, Vienna's public transport operator, has acquired vehicles with stepless access and modified its stops so that people with impaired mobility can use public transport independently.

The paper starts with a brief history of the Viennese public transport system; then the principles of universal design, which form the basis for of the Viennese pt-system are introduced. In the next section individual person groups of mobility impaired people are specified and quantified for the Austrian context. The main section presents systems and measures implemented in Vienna over the last 30 years to increase the accessibility of the pt-system for all users. In the conclusion section a confrontation of the needs of impaired person groups and the barriers these groups encounter when using the pt-system are listed. In a next step it is shown how the implemented measures mitigate the barriers and problems identified. And finally an outlook regarding future developments is given.

HISTORY OF THE PUBLIC TRANSPORT SYSTEM IN VIENNA:

Vienna Tramway[1]

The first tramway system introduced in Vienna was a Horsecar tramway in the year 1865. It was soon replaced by a steam powered tramway starting in 1883. The last steam tramway stopped its operation in 1922. From 1897 the electrification of the tramways system started and this system is still in operation. World War I and World War II caused severe damage to the tramway system, it took until 1950 that the system was working on the same level as before the war time. In the 1969 Vienna faced, as several cities in Europe a rapid growth in car ownership and rail traffic on the road was seen as a barrier and a relocation of the public transport under the surface (subway) was seen as the vision for the future. Slow decision making processes and the lack of funding saved the existence of the Viennese tramways - it was not possible to replace the whole existing tramway system at this time with a subway system.

Additionally starting in 1958 the practicality of using buses to replace trams was tested. The results of these tests were (fortunately) not very successfully and were not further conducted. However, individual sections in the periphery of the city, and in surrounding communities beyond the city limits were replaced by bus lines.

At the end Vienna decided to stick with the tramway system and improved the vehicle fleet continuously. To increase the accessibility of the vehicles WL decided to replace the existing vehicle fleet with so called ULF (Ultra Low Floor vehicles) from 1995 onwards. The replacement of all existing vehicles will take some decades, so at the moment there is a mixture of high-floor trams and ULFs are in operation.

At the moment (2011) the Vienna tram network consists of 28 Lines and 175 km tracks and serves 1031 public transport stops (Wiener Linien 2011; Wiener Linien 2011).

[1] Text based on http://en.wikipedia.org/wiki/Trams_in_Vienna

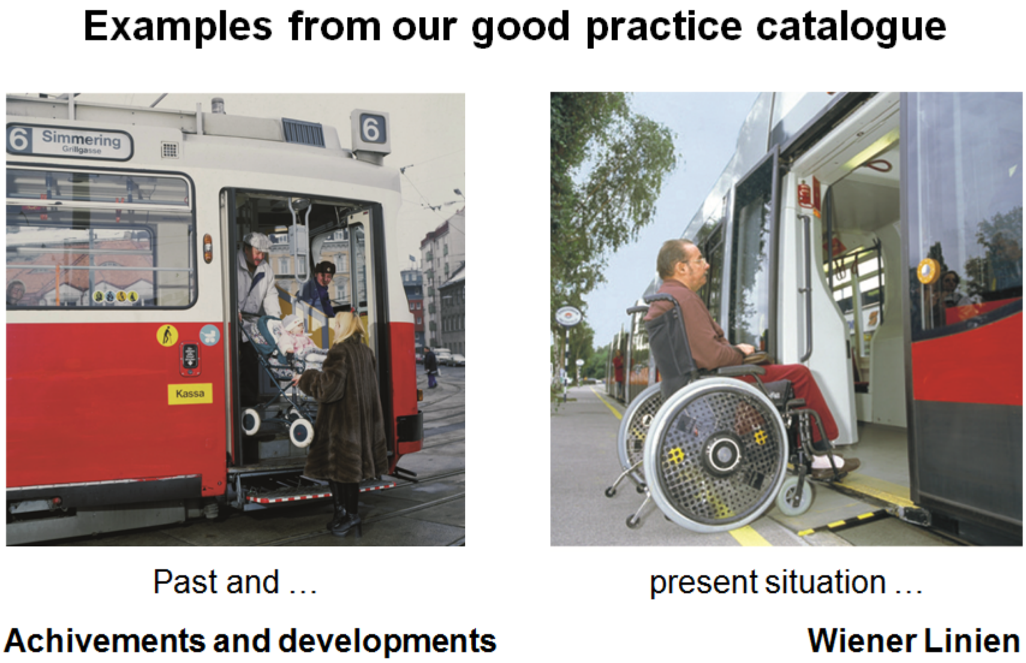

Figure 1: Vienna Tramways - past and present, photo © Wiener Linien 2012

Schnellbahn

The planning for an S-Bahn network for Vienna started in 1954, as a part of reconstruction of the Austrian Federal Railways (ÖBB). Concrete plans were completed by 1955, but financing was not secured until 1958. The S-Bahn era in Austria began on January 17th, 1962 and forms now an important backbone of the pt system in Vienna and connects the surroundings of Vienna with the city center. In total there are 9 lines and 50 stops within the city of Vienna (Sources http://de.wikipedia.org/wiki/S-Bahn_Wien and http://www.schnellbahn-wien.at/).

Underground

Compared to other underground railways worldwide, the Vienna U-Bahn is young. The construction of the Vienna U-Bahn network took place in several phases. The construction works started in 1969, on 25th February 1978, the first Vienna U-Bahn route between Karlsplatz and Reumannplatz, the U1, went into operation. With a total of twelve partial commissionings, the Vienna U-Bahn basic network was completed on 3rd September 1982 (Line U1 and U2). The 2nd expansion phase (1982–2000) comprised the lines U3 and U6. The 3rd expansion phase (2001–2010) comprised the first extensions of U1 and U2. It is worth to mention that for the first time in Europe, a U-Bahn project had to undergo a costly and lengthy environmental impact assessment, as the U2 extension showed a length of more than 10 km.
At present (2011) the Subway system consists of 5 lines, has a track length of 78 km and serves 101 public transport stops (Wiener Linien 2011; Wiener Linien 2011).

Vienna Bus network

The Municipality of Vienna has operated bus lines since the 1920s; they increased in importance after the suburban development increased demand for transport connections and after many tram lines were replaced by bus services. WL bus routes are designated with an "A" (for Autobus) to distinguish them at a glance from tram routes. Additional bus routes which are operated by other companies are designated with "B" to distinguish them.
Currently (2011) in Vienna there are 90 lines running on a network of 650 km and serve around 3320 public transport stops (Wiener Linien 2011; Wiener Linien 2011).

INTRODUCTION OF BARRIER FREE PLANNING PRINCIPLES

Barrier free planning for the public space is based on the more general principles derived in studies and working groups which developed the basic principles for universal design.
Universal Design[2] (Aslaksen, Bergh et al. 1997) is the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design. Universal Design was created by a working group of architects, product designers, engineers and environmental design researchers, which collaborated to establish seven Principles of Universal Design to guide a wide range of design disciplines including environments, products, and communications. These seven principles may be applied to evaluate existing designs, guide the design process and educate both designers and consumers about the characteristics of more usable products and environments:

- **PRINCIPLE ONE:** Equitable Use - The design is useful and marketable to people with diverse abilities.
- **PRINCIPLE TWO:** Flexibility in Use -The design accommodates a wide range of individual preferences and abilities.
- **PRINCIPLE THREE:** Simple and Intuitive Use - Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.
- **PRINCIPLE FOUR:** Perceptible Information - The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

- **PRINCIPLE FIVE:** Tolerance for Error - The design minimizes hazards and the adverse consequences of accidental or unintended actions.
- **PRINCIPLE SIX:** Low Physical Effort - The design can be used efficiently and comfortably and with a minimum of fatigue.
- **PRINCIPLE SEVEN:** Size and Space for Approach and Use - Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

[2] Based on http://www.ncsu.edu/project/design-projects/udi/center-for-universal-design/the-principles-of-universal-design/

Mobility and here especially physical mobility is one of the most important qualities human beings are looking for. Nearly for all human activities physical mobility is a precondition, for example socializing (visiting friends), work, leisure, shopping, etc. Although today some physical trips can be replaced by virtualization (such as teleworking, video conferencing, teleshopping) physical movements will never be completely replaceable through technological inventions. Therefore physical transport systems have to be user friendly as much as possible to fulfil the needs of all humans, including mobility impaired people.

By applying the basic principles of Universal Design for the design of transport systems barriers for mobility impaired people can be reduced. Further on, the application of these principles simplifies every days life of “healthy” people, too.

Very often transport planners are educated as civil engineers and trained to address the needs of healthy people - faster, cheaper are the dominating design principles. But stepping back one step it is astonishing how big the share of (temporarily) mobility impaired people is respective will be in the future.

Furthermore it has to be noted that there exists a series of international and national regulations (ÖNORM 2003; ÖNORM 2003; ÖNORM 2003; ÖNORM 2005; FSV 2006; FSV 2010; ÖNORM 2011; ÖNORM 2011; European Railway Agency 2012) and laws (EU 2000; Deutschland 2002; United Nations 2006; Österreichischer Nationalrat 2013) where the accessibility for mobility impaired person groups are addressed and which (will) have a major impact of the future design and construction of pt-systems.

Disabled people

In the common sense under disable people the most of us think immediately on people depending on wheelchairs or blind people. But this narrow view is not adequate anymore. In a broader sense nearly everyone is at least temporarily disabled, taking into account young toddlers, children, parents with children, people carrying luggage, injured people and elderly people. All these person groups can be seen as somehow impaired mobile. In this broader sense the percentage share of the total population of a country easily can reach up to 40% of the total population.

An Austrian study, called ÉgalitéPlus (Uhlmann 2011) tried to identify and to quantify potential groups of disabled people. In this study the following persons groups with mobility impairments were identified:

Name of group	**Estimation for Austria (2011)**
Wheel chair users	51.000
Mobility impaired people (Gehbehinderte)	1.100.000
Visually impaired people	330.000
Blind people	10.000
Audio impaired people	202.000
Deaf people	9.000
Persons with learning disabilities	400.000
Persons with migration background	989.000
Persons in remote areas without cars	219.000
Persons with 3 or more children	184.000
Single parent families	175.000

Elderly people	670.000
Children (10-14 years)	445.000
Young persons (15-17 years)	246.000
Poor people	1.005.000
Total (incl. double counting)	**6.035.000**

Table 1: Definition and quantification of mobility impaired people in Austria for the year 2011, source ÉgalitéPlus

These mobility restrictions can be classified in severe, medium and slight impaired as shown in Figure 2.

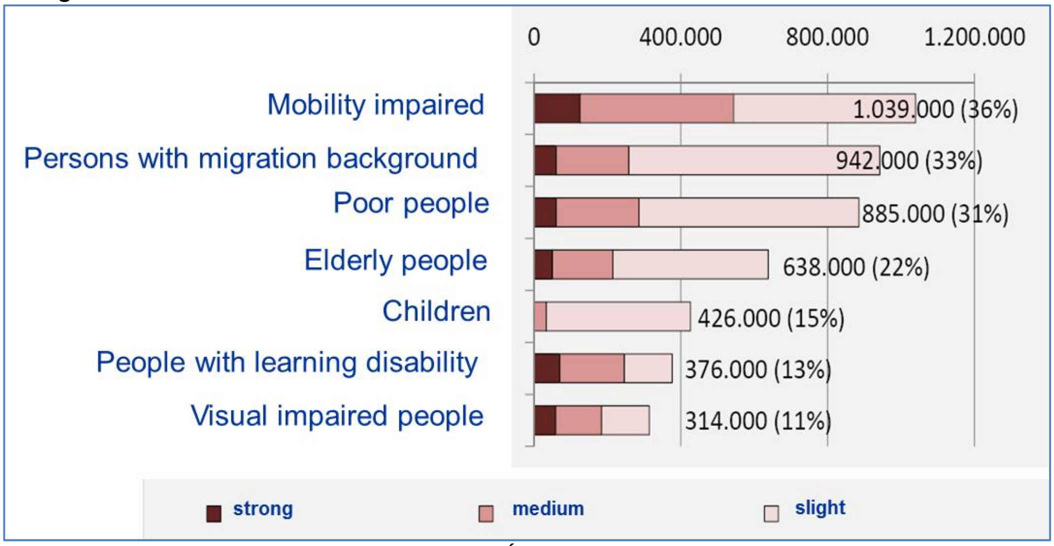

Figure 2: kinds of mobility impairments, source ÉgalitéPlus, it was estimated that in Austria 2011 2,86 mio. people are mobility impaired, in brackets is the share of mobility impaired people

Interesting is, especially in Austrian circumstances, that persons with migration background form the second biggest group of mobility impaired people in Austria. In total, people with migration background have a share of 16% of Austrian's total population (Statistik Austria 2012) (total population Austria is 8.4mio inhabitants) and therefore language difficulties are a major barrier when using public transport in Vienna. For example time tables, information material regarding the pt-system and the most of the announcements are only provided in German language and therefore not understandable for foreigners. It has to be noted that Austria has 8 neighbouring countries and there are spoken 5 different languages (without counting German and none of these languages is English) so for example oral announcements in multiple languages are not feasible options.

A survey carried out within the ÉgalitéPlus project revealed that beside public transport supply physical barriers, such as missing elevators, high pavement edges, unexpected barriers and not barrier free designed road crossings are the most important obstacles for disabled people to carry out their trips on their own (see Figure 3).

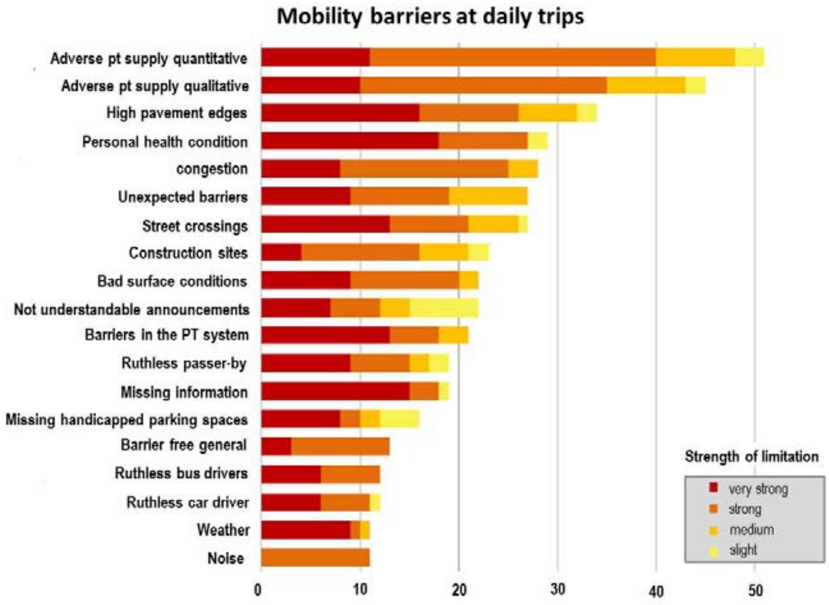

Figure 3: mobility barriers at daily trips in Austria, source ÉgalitéPlus

In general research of the EgalitePlus project (Sammer, Uhlmann et al. 2012) suggests to aggregate the in Figure 3 listed barriers to four main groups of problems or barriers, namely:

1. Problems caused by other traffic participants and those responsible for the pt-operation (Third party[3]) (Figure 3, items 4,5,6,8,12,16,17),
2. Problems caused through an inadequate pt – offer (supply) (Figure 3, items 1,2)
3. Problems caused through inadequate physical environment (Figure 3, items 3,7,9,11,14,15) and
4. Problems caused through missing or poor quality of information (Figure 3, item 13).

We will come back to these four groups in the summarising section of this paper.

HISTORY OF BARRIER FREE PLANNING IN VIENNA/ AUSTRIA

1989 the Vienna Lines (WL) started a dialog with the newly founded handicapped movement and discussed its transport supply in regard to the demand for barrier free access. A first outcome of this dialog was a measure catalogue in combination with an action plan split into short, medium and long term. An example for short term measures was the use of taller font sizes at information panels to improve the readability of the visual guiding system. A mid-term measure for example was the lift retrofitting program of existing old subway stations. A long term project was the development of new low floor vehicles for all busses, tramways and underground trains.

But still for some user groups suffering on reduced mobility there was no suitable solution available on the market. For those cases WL formed working groups with stakeholders and solutions were developed through research and development projects funded by the Austrian ministry of transport, innovation and technology.

[3] In the paper (Sammer et.al., 2012, p.52) it is stated that nearly all person groups encounter problems with other people who are inconsiderate or unwilling to support mobility impaired persons in certain situations. Many of these situations are caused by other traffic participants but also by staff of pt-providers.

A main advantage in Vienna is that the pt-system is completely owned and controlled by the city authorities of Vienna. The planning, construction, operating and maintaining of the public transport system is in one hand and the result is a strongly integrated network of bus-, tramway- and underground-lines in Vienna. Therefore as soon barrier free accessibility was recognised as a desirable public goal the WL got the order to develop a barrier free pt-system and to improve the acceptance of their services (EU 2000).

The following improvements were an output of this process and will be introduced within this paper:

- Visual Guiding System of WL developed in 1969
- The Lift Retrofitting Program (1985-2010)
- Barrier free station furniture (1990 till today)
- Tactile Guiding System within the WL (1988 till today)
- Development of new low floor vehicles (1990 till today)
- Redesign of accessible tramway and bus stops (1990 till today)
- POPTIS - a navigation system for blind and visual impaired users (2004)
- Real time information accessible even for blind and visual impaired users (2009)
- Qando - a web based route-planer (2009)
- Quo Vadis feasibility study (2006)
- MofA or mobility4all (2011)
- Ways4all - Barrier-free mobility for all! (2012)
- Multi-Sensorial Info Point (2012)

Visual Guiding System of WL developed in 1969

Visual impaired persons call for a clear structured visual guiding system. The development of the visual guidance system started 1969. Since then several typefaces were tested concerning readability and contrast. Empirical studies carried out showed that fonts such as Helvetica and Frutiger deliver good results, so that the WL are using now Helvetica and standardised pictograms to overcome language barriers (see Figure 4, Figure 6). The colour based logotype structure enables even illiterate users easily to find their ways. All spot identification panels are based on white while exit panels are black. A different colour is dedicated to each individual pt-line. Blue is reserved for the Austrian Railway Company lines. The primary system level presents the line signalisation, the secondary level the station signalisation (see Figure 6). Finally electronic operated displays represent a back-up level and are reserved for signalisation in the case of an incident.
In research studies optimal positions for information panels were identified and these findings were used to place the information panels on platforms, stairs, escalators and passage levels within the whole pt-system in Vienna (Figure 5).

Figure 4: Vienna visual guidance system, photo © Wiener Linien

Figure 5: visual angle studies

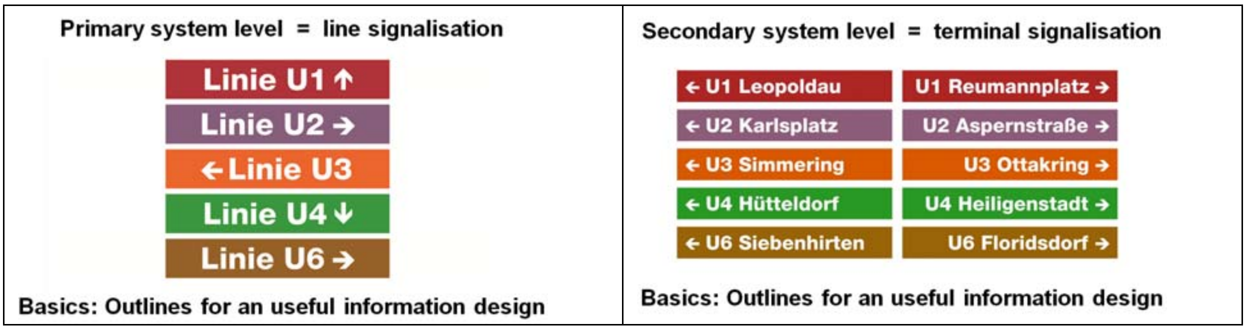

Figure 6: Guidance system - Vienna subway system

The Lift Retrofitting Program (1985-2010)

As mentioned before in 1968 Vienna decided to implement a subway system and since then the network was growing rapidly. During the first construction phase the old Stadtbahn system was adapted to the new underground system and renamed to line U1. Unfortunately accessibility was not a major concern at this time and not all stations were designed to be barrier free accessible. Instead Vienna decided to introduce a special taxi service for handicapped citizens and so the underground planning department gave priority to escalators instead of elevators, mainly because of their higher transport capacity. Lifts were only built in down town areas and major stations.

The special taxi service was not accepted by the mobility handicapped people because it was unreliable and uncomfortable and they felt excluded from public transport. So their perpetual claim on an equal treatment could no longer be ignored. In 1985 when the second construction phase of the underground network begun one main target was to improve passenger comfort by implementing a user centred equipment standard. In the new architecture of line U3 lifts had to be installed in all new stations. Additionally it was decided to equip all existing stations with elevators, too. With this decision the lift retrofitting program was born. Finally in the year 2010 all subway stations were equipped with elevators (see Figure 7).

Figure 7: Elevator design in Vienna, photo © Wiener Linien

Barrier free station furniture (1990 till today)

To enable barrier free access also the station furniture and facilities have to made barrier free. For example the restrooms in the stations had to fulfil these requirements, too. Standards had to be defined for the accessibility for wheel chair users (see Figure 8). Notable is here that monitoring during the construction phase is very important, since the engaged craftsmen do not have always the necessary skills.

Figure 8: layout of wheel chair accessible restrooms, photo © Wiener Linien

Another example of barrier free station furniture are ticket vending machines. Again barrier free design was developed for the Vienna public transport system and all stations were fitted with this kind of machines (see Figure 9).

Figure 9: barrier free ticket vending machines installed in Vienna, photo © Wiener Linien

Tactile Guiding System within the WL (1988 till today)

In the beginning of the underground construction a yellow so called security strip was installed on the edge of each platform. This line was also used by visually impaired people as an orientation help but were soon recognised to be too dangerous. In 1988 the WL in collaboration with the Association of the Blind and Visually Impaired developed in pilot projects and empirical studies the basics of the tactile guiding system of the WL, which in a later step and became the basis of the Austrian standard V 2102. At that time apart of some pilot projects in Japan no standards or relevant international examples existed.

In Vienna different tactile indicators on different surfaces were tested before 1993 the first pilot project was implemented in the U1 station Taubstummengasse. Gray stripes made of plastic, usually used for zebra crossings, were welded on a black tar surface. Tactile security lines of 7 stripes, 3 millimetres high, 3 centimetres wide and 3 centimetres apart from each other were placed along the two platform edges. After a test phase of three years without any significant incident all critical arguments of some members of the board of surveyors were eliminated. Their main argument that persons of other user groups might stumble because of those indicators was proven wrong and so the permission for construction was granted to the WL. Consent within the blind people association was reached and some other discussions concerning the layout of turn offs and crossings came up. For that reason in 1997 a further test program at U1 station Heiligenstadt took place. With this 2nd test program the last doubts disappeared and the basis for a system wide implementation of a tactile guiding system was set.

Stripe indicators are used as guidelines pointing the direction to go and doted indicators mark turn offs and crossings (see *Figure 10*). For all different platform and stop types lay out patterns were defined (see *Figure 11*). Within the working group all experts agreed on this outlines. So it was decided to install tactile lines in all areas where the existing orientation aids such as handrails, lateral walls or parapets were not sufficient.

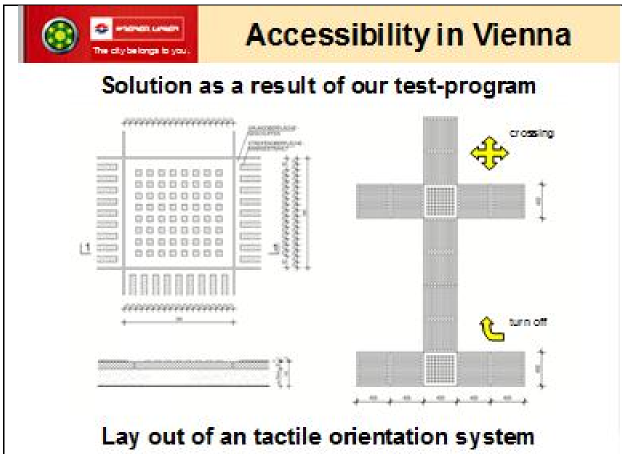

Figure 10: Vienna tactile guidance system

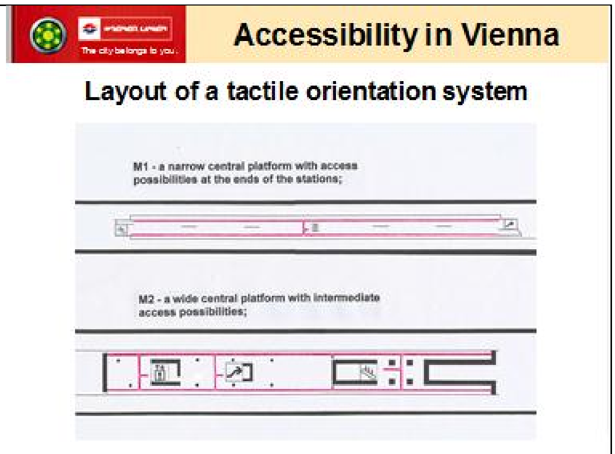

Figure 11: Station layout tactile guidance system in Vienna

1998 the retrofitting program started and in 1999 the WL were honoured by the Austrian Board for traffic security with a safety award. Up to 2009 about 97% of all stations were equipped with a tactile guiding system. Only in some old Otto Wagner[4] stations certain problems appeared. Those stations were protected by the National Trust and all solutions had to be accepted by this authority. For those reasons it took some time to find an agreeable solution for all. But in the year 2011 the WL succeeded and a further action plan to achieve 100% coverage is under progress.

Development of new low floor vehicles (1990 till today)

A milestone in public transport history was the development of the ultra low floor tramway vehicle (ULF) starting in the early 1990ies. In a public private partnership between the WL and Siemens Austria the lowest low floor tramway all over the world was constructed. A vehicle floor just 19,7 centimetres above the road level allows an almost even access from the stop areas (see *Figure 12*). The remaining gap is covered by a mechanical ramp.
The WL are operating after Zürich and Saint Petersburg the third largest tramway network all over the world. The first tests of the ULF prototype started in the 1995, since 1998 the ULF is used regularly in the Vienna tram network. Actually (2011) there are 191 Ulf's in operation; this is equivalent to a rate of 30% of the total number of tramway vehicles. The ratio will be improved until 2014 up to 60%. The realisation of a 100% accessible tramway network remains a long term objective because of economic reasons (the long lifetime of tramway vehicles does not allow a faster replacement).
The Viennese bus network operates 90 bus lines on a total network length of 650 kilometres. Since 2008 the complete bus fleet consist of low floor vehicles equipped with ramps (see *Figure 15*). The shorter lifetime of buses enabled a quicker replacement.

Figure 12: ULF Vienna, photo © Wiener Linien

Figure 13: Low Floor bus in Vienna, photo © Wiener Linien

To ease the access to the Vienna subway system additional ramp profiles were fixed below the entrance doors to reduce the remaining gap at the rolling stock of underground line U6 an (see *Figure 14*).

[4] Famous Austrian architect, 1941-1918

On the other lines with the development of the new V-vehicle the gap between the platform and the vehicle edge is covered by an electrical ramp located at the first and the last door of each train. Additionally these parts of the vehicles are designed to be large sized multi-purpose areas which enable a comfortable placing and reversing of wheel chairs, prams or bikes (see *Figure 15*).

Figure 14: wheelchair ramp – Vienna – new V-vehicle, photo © Wiener Linien

Figure 15: Vienna – new V-vehicle, photo © Wiener Linien

Redesign of accessible tramway and bus stops (1990 till today)

In parallel with the development of low floor vehicles for all means of public transport the redesign of tramway and bus stop areas was forced in a special retrofitting program. The main objective was to reduce the distance between platform level and vehicle floor level. Further targets were the improvement of passenger information and the realisation of more comfortable waiting areas at public transport stops (see *Figure 16*). New modern shelters using a corporate design indicate from far away a stop area of the WL. At 90% of WL stops the platform level including the whole waiting area is lifted by 15 centimetres above road level. Ramps at the end of each stop area enable a smooth passage to pavement or zebra crossings. The low level of stop areas allows a very flexible planning of different types of stops such as island stops in the middle of roads, usual side stops or side stops with a lifted road lane between the stop area and the tramway track.

Meanwhile 1995 the new RBL-system was developed. This computer aided operational control system enables the operation management to realize an optimal guidance of vehicles in the whole network. In the central control centre and in four local traffic control centres the operation managers are informed about the exact position of each vehicle, delays, all kind of disturbances, failures or traffic jams. They are monitoring all services and are able to react immediately on irregularities. A part of this information delivered by the computer aided operational control system was transferred to displays in the stop areas and became a part of the new WL real time passenger information system (see Figure 17).

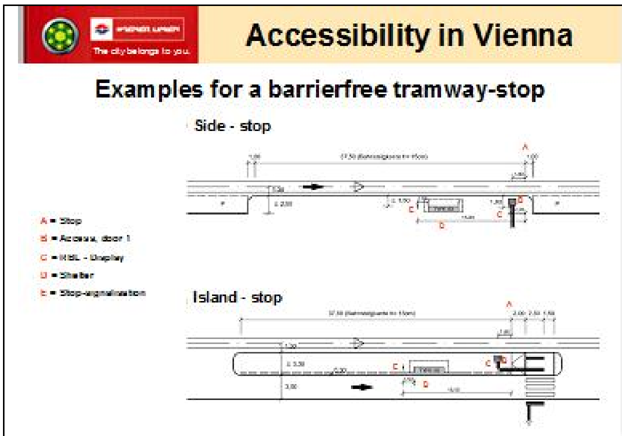

BILD einfügen INFO Screen at PT Stop

Figure 16: Design fo a barrier free public transport stop in Vienna

INFO Screen at PT Stop

Figure 17: Info panel at public transport stop - Vienna, photo © G. Emberger, 2013

POPTIS - a navigation system for blind and visual impaired users (2004)

Starting point for this project was the existing tactile guiding system of the WL. This system enabled visual impaired people to use safely the public transport facilities. But they still need someone who tells them where to go. The intention of the **P**re-**O**n-**P**ost-**T**rip-**I**nformation-System (POPTIS) was to support their demand to realize a better orientation in public transport stations.

The declared objective of POPTIS was the development of an efficient information system for blind and visually impaired transport users, which enables a better use of the existing orientation devices. The developed solution should be based on existing, inexpensive technologies, such as computer, internet, mobile phone and mp3-players.

How the POPTIS system works: All possible trips within the Viennese pt-network were determined and then their way descriptions were stored as audio files in the POPTIS data base. The use of a clear navigation structure enables the users to find easily his/her trips. A trip query in the POPTIS database delivers recommended routes and suggests alternative routes according to the demand of blind and visual impaired users. To ensure a high quality all routes are tested by mobility teachers and other experts.

The POPTIS data base can be found at http://www.wl-barrierefrei.at/index.php?id=8034. All information on those pages is prepared for screen reader programs, too.

The pre-trip function of POPTIS is designed to be used at the home pc. After selecting the POPTIS data base, the user can download respective listen the way description from a certain subway platform to a certain exit or vice versa. This enables the user to prepare his/her trips in advance by listening to the audio description.

During a trip POPTIS can be accessed with a smart phone in the same way as with a pc at home in the case there is a screen reader program installed. A faster solution is to load down the chosen trips to your smart phone or mp3-player.

In the post trip function a user can put several trips together. A typical trip will start with the access trip in the first station, the interchange trip from one to another line in the next station and exit trip in the last station. These audio files can be stored at a mobile device as a personal trip collection for future use. For unskilled users mobility trainers might prepare those collections.

Real time information accessible even for blind and visual impaired users (2009)

Count down information delivered by the computer aided operational control system was not only transferred to displays in the stop areas, as mentioned before. They became as well a part of the new WL real time passenger information system. Everybody might get the required information about the real time departure time of all lines and all stops, if there will be a low floor vehicle or not on the homepage of the WL www.wienerlinien.at. All this information is available pre trip on the computer and on trip at mobile phones. And grace of the structures developed by POPTIS this information is available on the barrier free web pages and prepared for screen reader programs, too. In Vienna even blind users have an access to this information. Additionally, for wheel chair users information when the next low floor tram is arriving is provided, too.

At major interchanges of underground lines with several tram and bus lines a new information unit was developed. At flat screen monitors the departure times of the pt-connections are displayed above a surrounding map in which all stops are marked with unique alphabetic characters.

Qando - a web based route-planer (2009)

On the homepage of the WL www.wienerlinien.at or on www.qando.at the multi-language (German/English) web based public transport route planer for Vienna and its surroundings can be found. This service is designed to find the quickest way from where you are to where you would like to go to by public transport. It delivers real time and time table information within the VOR-region. (The VOR-region – Verkehrsverbund Ostregion - represents the transport union of the eastern region of Austria, it comprises the counties Vienna, Lower Austria and Burgenland.)

All information are delivered in German and English. Wheel chair users can choose just rides on low floor vehicles. Additional, tourists might get information about the cultural surrounding of their hotel, maps, programs, price lists, the way to the next bus or tramway stop, how and when to move from the hotel to wherever they want to go to within the eastern region of Austria (see Figure 18).

Figure 18: Print screens from Qando, photo © Wiener Linien, 2011

Qando is available for Java-Mobiles, WIN-Mobiles, Blackberry, IPhone and enables mobile ticketing per SMS. New releases are planned monthly. Since January 2012 more than 25 mio queries were performed using Qando. Qando was already honoured by two Austrian awards.

Quo Vadis feasibility study (2006)

The intention of the feasibility study Quo Vadis is to improve communication on board or at stops between the users and the board computers of public transport vehicles. Users with a reduced mobility might inform the driver about their demand by a “simple” device. A wheel chair user might ask for the ramp on next stop, blind users might inform the driver in double stops used by several lines on which they intend to get on.

The feasibility study of Quo Vadis is already finished a proof of the feasibility of the concept and provided a cost estimation for a system wide implementation. At the moment in the project “Ways4All” further investigations are in progress to improve the “simple” device to became an app(lication) on a standard smart mobile phone.

MofA or mobility4all (2011)

MofA is a self-examination methodology, developed 2011 by the WL and some partners, which delivers a set of basic planning tools to create accessible entrance areas for pt–stops as well as accessible pt-buildings. Key attention was put on mobility in public space and on a assessment of already realised solutions. The MofA approach comprises a standarised description-, observation- and classification-methodology to carry out accessibility-checks for pt-entrance areas and station buildings including recommendations to solve discovered problems.

Plenty of people - wheel chair users, blind and visual impaired transport participants - are suffering because of constructive barriers which hinders their mobility. They are limited in their choice on means of transport because for example they cannot get hold of a driving licence, and so they have to use public transport. Presently there exist still a huge number of worse designed public spaces, so they experience barriers even before they reach public transport facilities. The objective of MofA therefore was to discover all the obstacles on their ways to a certain pt-stop and to eliminate them in further projects.

Departing from the status quo and a proof of demand WL developed an examination methodology for an accessibility check of entrance areas, bus- and tram stops, stations as well as public transport buildings. The checklist and the description-, observation- and certification methods were defined in collaboration with a group of passengers suffering on a reduced mobility.
The classification scheme (Table 1) used to assess the accessibility of a certain case study is derived from a signal light. Green and light green means that a pt-station building is barrier free respective almost barrier free. Yellow means only accessible with foreing help and red means not accessible, even with foreign help.

Green	Light green	Yellow	Red
without foreign help accessible	**almost without foreign help Accessible**	**only with foreign help accessible**	**even with foreign help not accessible**
barrierfree	**almost accessible**	**not accessible**	**not accessible**

Tabelle 1: Classification scheme used in MofA to assess pt-stations

The classification was/is/should be carried out for the following pt user groups:
walking impairment (elderly persons, rollator users, etc.), wheel chair users, visual impairments, blind users, hearing impairments, deaf users.
Figure 19 depict one example of the assessment sheets derived within the MofA project.

MofA criteria catalog - barriere free environment				
station surrounding	Status qou		suggestions for improvement	
	* orientaion in walking direction of the street			
crossing area	street name xx		street name xx	
	Gasse			
Street	right side of street	left side of street	right side of street	left side of street
orientation for blind people	yes, pavement curb	yes, pavement curb	tactile guiding system	tactile guiding system
barriers on the pavement	car parking reduces pavement width	no	reorganisation of parking	ok
orientation at crossing area	no- only sound of car traffic	no- only sound of car traffic	sound traffic light	sound traffic light
zebra crossing	etc	etc	etc	etc
traffic light sign post	etc	etc	etc	etc
pavement level at crossing				
tactile floor markers at zebra crossing				
bike lane				
etc				
etc				
others				
comments				

Figure 19:Example sheet for street assessment, source MoFa-project 2012, 1st column criteria, columns 2 and 3 description of status quo, columns 4 and 5 suggestions for improvement

In total more than 70 criteria have to be surveyed to describe the status quo of a certain public transport stop area and suggestions for improvement have to be made. At the moment WL has carried out this target – performance comparison for 66 public transport stations and pt-buildings including a photo-, map- and measure - catalogue. This measure-catalogue is different to former studies, because it does not express only general statements; it contains additionally very detailed proposals and solutions for problems identified during the carried out investigations.

The MofA methodology is already used by the Austrian Railway Company and the WL responsible for the public transport in Vienna. Additionally the method forms the basis for a lecture taught at the Technical University in Vienna.

Ways4all - Barrier-free mobility for all! (2012)

The main goal of the project “ways4all” was to develop an indoor navigation system for visually impaired and blind people. The project uses the existing tactile guidance system as a backbone for routing. Low frequency passive RFID-tags are built into this guidance system at strategic points. With a foot-mounted RFID-reader (see Figure 20) the unique code of the RFID-tags are read and sent to a smart phone. Inside the smart phone the route is calculated and by means of short messages the visually impaired and blind person is routed through the building. One of the great advantages of this system is that no absolute coordinates and building plans are necessary. The relation and distance between the tags are stored in a general database on a server. Before travelling or when a building is entered this database is downloaded to the smart phone. Thus, the costs of the system are relatively low.

Figure 20: Ways4all – RFID chip – prototype of a receiver, photo © Wiener Linien, 2012

Multi-Sensorial Info Point (2012)

For a long time, one of the key issues for WL has been to make passenger information accessible for all user groups. The multi-sensorial info point is the logical continuation of this process and is expected to be a fix component within the re-design of the new WL bus and tramway stops.

At a multi-sensorial info point (see Figure 21) users receive real-time information about public transport in Vienna based on their location. This information is available in multiple formats, such as visual, audio, tactile and via sign language. Besides Austrian and international sign language, the prototype also is currently available in a German and English version.

In 2015, when the new construction of the Vienna central station will be finished, the Vienna Central Station will become an important multimodal transit hub. Numerous routes in different directions may cause problems for tourists and passengers with visual impairments. So in addition to the foreseen manned info- and ticket-counters the multi-sensorial info points will extent this service for the costumers to 24/7.

This first prototype of this multi-sensorial Info point was introduced at the ITS World Congress in October 2012 in Vienna.

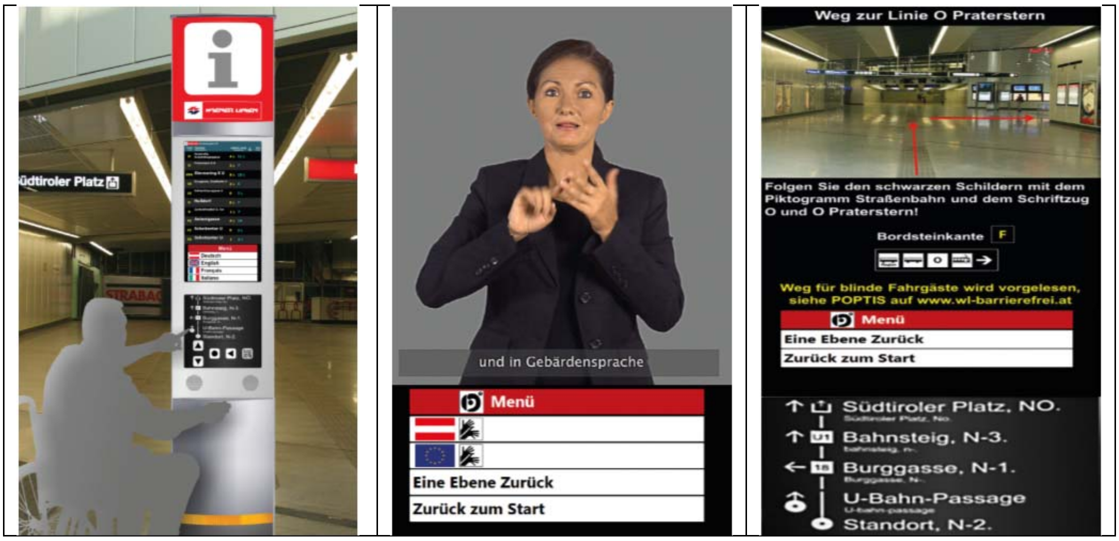

Figure 21: Impressions of the Multi-Sensorial Info Point, photo © Wiener Linien, 2011

ACHIEVEMENTS AND FURTHER DEVELOPMENTS

In section headed Disabled people, page 7 the different groups of impaired people were identified, their quantity estimated and their specific needs for accessibility improvement were identified. The following Table 2 represents a confrontation of these individual groups of impaired people and the problems and barriers they encounter when they would like to use the existing pt-system (green colour). In the second lower part of the table (red colour) it is shown how the within this paper introduced implemented solutions of the Wiener Linien contribute to the mitigation of the problems and barriers impaired people face in everyday life.

Mobility impaired person groups	**Problems and Barriers**				**Wiener Linien - implemented solutions**
encounter this kind of problems and barriers	Third party	PT offer	physical environment	Information	**try to mitigate this kind of problems and barriers**
Wheel chair users					
Mobility impaired people (Gehbehinderte)					
Visually impaired people					
Blind people					
Audio impaired people					
Deaf people					
Persons with learning disabilities					
Persons with migration background					
Persons in remote areas without cars					
Persons with 3 or more children					
Single parent families					
Elderly people					
Children (10-14 years)					
Young persons (15-17 years)					
Poor people					
					Visual Guiding System of WL developed in 1969
					The Lift Retrofitting Program (1985-2010)
					Barrier free station furniture (1990 till today)
					Tactile Guiding System within the WL (1988 till today)
					Development of new low floor vehicles (1990 till today)
					Redesign of accessible tramway and bus stops (1990 till today)
					POPTIS - a navigation system for blind and visual impaired users (2004)
					Real time information accessible even for blind and visual impaired users (2009)
					Qando - a web based route-planer (2009)
					Quo Vadis feasibility study (2006)
					MofA or mobility4all (2011)
					Ways4all - Barrier-free mobility for all! (2012)
					Multi-Sensorial Info Point (2012)

Table 2: Confrontation person group – problems encountered; problems encountered – WL implemented solutions

The colour code used in Table 2 expresses the intensity of the relation – the darker the colour the stronger is the relation. For example the row "wheel chair users" can be interpreted in that way that this group of impaired people encounters major problems with "third party" issues, major problems with the transport offer and physical environment and medium problems with information provision. The same colour code is used for all other rows, too.

As it can be seen problems related to physical environment is a major barrier for disabled people in the narrow sense, where as "third party" barriers and Information provision issues are widely spread over all impaired user groups.

Going down in Table 2 the confrontation between problems and barriers with in this paper introduced solutions is shown. It can clearly be seen that the introduced solutions mainly improve the physical environment and the information provision for all groups of impaired people. No policy instruments are listed which reduce the barriers regarding "Third party" and "PT-offer". At this place it has to be mentioned that the WL have a very well recognised driver and staff training program where WL-staff is trained to be supportive whenever a passenger (impaired or not) needs assistance. Relating to "PT- offer", again it has to be mentioned that in Vienna special kinds of taxis exist to enable mobility for persons with special needs.

Summarising it can be concluded that Vienna has a long history of the development of accessibility tools for all kind of handicapped people. Over the last 3 decades a continuous process took place which removed accessibility barriers step by step and improved the access of the Viennese public transport system. In several cases (tactile guidance system, visual guidance system, development of ultra-low floor vehicles) Vienna was a pioneer and forerunner EU and worldwide. A lot of these improvements are today common standards and taken for granted also for "normal" pt-users. Elevators implemented in all subway stations, an universal intuitive understandable visual guidance system, a complete fleet of low floor busses, etc. are improvements in the quality of the pt-system no Viennese inhabitant would accept to miss anymore.

As mentioned in the introduction section Vienna is one of the most popular cities around the world. To a great extent the easy accessible, high quality and reliable pt-system is responsible for this fact. The WL together with the University of Technology Vienna and other institutions will also work in the future to reduce barriers in the public space to improve further the quality of life in Vienna.
We hope that the here in the paper presented solutions will encourage pt-operators in other cities around the world to improve their pt-systems towards barrier-free-ness for the benefit of their inhabitants, too. We authors are happy to support them on their way!

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