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Swift, safe and seminal: Innovative passenger information and guidance systems in large infrastructures

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1 ABSTRACT

In recent years, a growing number of people have been utilising transport nodes on a frequent basis, with less and less time available for wayfinding, orientation and the gathering of information. Incidentally, the request for targeted and reliable information systems is immanent and ever increasing. Proceeding urbanisation and the gradual permeation of technology in our society have had a major impact on the transformation of transport hubs to venues of knowledge transfer and innovation. Hence, core transport infrastructures (e.g. railway stations) have gained significantly in importance as providers of platforms for the exchange of information and the implementation of innovative technologies. However, as for the issue of clear communication and design patterns, the practical implementation of innovative and all-inclusive guidance-, information- and orientation technologies has been largely disregarded in Austria.

The main points of interest are, therefore, the following: Which state-of-the-art technologies in terms of passenger information exist, and are they implemented successfully within the national and internatioal transport systems? Furthermore, which technological trends and future prospects can be anticipated?

In this paper, we present the main results of a study which aims at the provision of a technology screening and foresight regarding innovative information systems. Thus, recommendations on the further, prospective research into the improvement of accessibility, availability, security and reliability of innovative information technologies and designs are made. The examination method thereby includes an extensive analysis of relevant literature as well as national and international on-site case studies, including the UK (London) and Switzerland (Zurich).

Important findings involve the necessity to dramatically increase the usage of available technologies, such as inductive loops or barrier-free information terminals. These are not implemented sufficiently in national and international infrastructures, which results in adverse effects for a majority of passenger groups. In accordance with the concept of universal design, the presented solutions for the impartment and illustration of information are of advantage for a majority of passengers, ranging from the physically and sensory impaired to families, tourists and the elderly. Regarding innovative technologies, an emphasis is put on wireless guidance systems based on RFID, WIFI or cellular networks, as for example applied in Gullmarsplan/Stockholm. In particular, wireless technologies are of benefit for vision impaired people. However, as the case study shows, application can be extended to the usage for on-site personnel, supplying up-to-date information when required. Finally, an overview of future key research topics, such as the analysis and simulation of group specific behaviour, ambient intelligence and accessible evacuation systems, is provided.

2 INTRODUCTION

This paper summarises the main findings and perspectives emerging from a research study[1] on innovative technological passenger information and guidance systems in large public infrastructures. The main focus is placed on railway stations and airports. The prime objectives of this paper are to give a short overview over a screening of state-of-the-art passenger guidance and information technologies in the context of recent demographic developments and changes in passenger requirements as well as analysing and discussing trends, perspectives and future research alternatives.

The main motivation for this paper is the examination of current standards in development and implementation of innovative passenger information systems in Austrian infrastructures. Until today, the

[1] MILLONIG, A., Nader, C.; Schechtner, K.; Ray, M.; Pfaffenbichler, P.; Brezina, T.; Emberger, G. (2007): Technologiescreening und Technologieforesight barrierefreie Personeninformations-, Leit- und Orientierungstechnologien für den neuen Wiener Hauptbahnhof zur Ableitung von Gestaltungsanforderungen und von Themenvorschlägen für die Programmline ways2go. Wien

focus is mainly placed on constructional measures, with a disregard of innovative and all-inclusive technological solutions. However, as the analysis of demographic parameters – especially in terms of aging and impairments – shows, the primary implementation of constructional measures will face constraints in the near future. The increasing permeation of technology in our society in combination with a faster, more sophisticated lifestyle in terms of safety and comfort put forth the necessity to support all citizens in actively taking part in and utilizing technological progress. Therefore, technological solutions based on the principles of universal design, bringing benefits to all members of society, receive special attention in this paper.

Commencing with definitions, which are relevant for a clear understanding of the conclusions drawn from the study, an insight into the most relevant findings regarding state-of-the-art passenger information technologies will be given. Included solutions involve innovative wayfinding systems based on wireless networks. Further, due to recent developments in requirements for safety and security, findings on integrative emergency and evacuation systems are highlighted. An analysis of current innovations in the area of swift, reliable and all-inclusive communication of relevant information in large infrastructures closes the first section. Subsequently, conclusions drawn from national and international on-site case studies in core infrastructures (airports and railway stations) are presented and discussed. The last section provides an overview over technological trends and perspectives, whereby the following future key fields of research in terms of passenger guidance and information technologies are identified:

- Analysis of group specific behaviour
- Provision and illustration of information
- Entrance/accession systems and mobility support
- Security and emergency systems

3 SCOPE OF PAPER AND METHOD OF RESEARCH

3.1 Thematic scope

The thematic focus of this paper is laid upon the identification and analysis of technologies and technological trends, whereby the utilized methods and procedures are aimed particularly at telematic solutions. Alternative approaches, such as the examination of constructional or organisational measures, are also considered, however, they do not form the centre of scientific attention within this paper. [2]

3.2 Method

For the purpose of reaching the above stated aims, namely the identification of (a) state-of-the-art passenger information systems and (b) prospective trends in research and development in this respect, the following procedure is adopted:

- Extensive analysis of literature
- Research, discussion and formulation of relevant definitions
- Assessment of development trends based upon demographic parameters and passenger requirements
- Narration of the state-of-the-art in the field of information-, guidance and orientation technologies
- On-site case studies of national and international infrastructures (railway stations and airports)
- Illustration of technological trends regarding the design of accessible, targeted and reliable information systems within the short and medium term
- Identification and devision of future research requirements

4 RELEVANT DEFINITIONS

Within the realm of this paper, different technologies and principles are involved. The following definitions are specified to provide for a clear and correct understanding of frequently used key terms throughout this paper.

[2] For further information on the temporal and spatial scope of the underlying study please refer to Millonig et al. (2007)

4.1 Definition of passenger guidance, orientation and information technologies

Within the analysis of technical literature and on-site examination of core infrastructures, the identification of state-of-the-art passenger guidance-, orientation and information technologies represents a constitutive partition. The subsequent definitions are therefore of particular interest.

Passenger information systems supply relevant information on the concerned infrastructure, e.g. the forwarding of train departure times via display panels and –screens.

Guidance technologies lead individuals to a particular, preassigned location. Examples are continuous signage and visual evacuation systems.

Orientation technologies, such as digital and tactile maps, allow for an overview over the infrastructure as a whole.

4.2 Definition of "Universal Design"

The level of accessibility of a certain technological solution or constructional measure is charecterized increasingly with concepts such as "inclusive design", "design for all" or "universal design". Strictly speaking, these are gradations, which describe the degree of accessibility of a particular solution or measure. "Accessibility", as a general term, circumscribes the total spectrum of accessible alternatives, whereby the simplest case is represented by personal assistance or individual adaptation of methods or solutions. The next level, "inclusive design", encompasses the adaptation of technological or constructional measures on the basis of specific target groups. Hereby, the necessity of individual adjustment is restricted to specific cases. The application of "inclusive design" is of benefit not only for handicapped or otherwise impeded persons, but´already results in an increase of comfort and usability for all users.

The highest degree of accessibility is achieved via the concepts of "universal design". At this stage, neither individual adjustments need to be implemented, nor is there the necessity of special or personalized design. Solutions and measures are designed as to be suitable and of benefit for all participating groups of users. (Mösinger, 2006)

For a clear understanding of this concept, the Center of Universal Design/NC State University established the "principles of universal design" "to guide a wide range of design disciplines including environments, products, and communications". (NCSU, 1997) These are (i) equitable use, (ii) flexibility in use, (iii) simple and intuitive use, (iv) perceptible information, (v) tolerance for error, (vi) low phyical effort and (vii) size and space for approach and use.

5 DEMOGRAPHIC AND SOCIETAL TENDENCIES

Throughout recent years, aspects of life style and demographic parameters have changed and developed significantly.

Taking Austria as an example in terms of human mobility, an examination of passenger quantities in large infrastructures shows that the number of people accessing different modes of transport is increasing steadily. In particular, the Vienna International Airport reports 18.768.468 passengers in 2007 and forecasts a rise to 20,27 million in 2008. (VIA, 2008). Vienna's major provider of urban public transport, the Wiener Linien, reports more than 770 million passengers each year. (Wiener Linien, 2007) The Viennese "Westbahnhof" currently accounts for 43,000 travellers per day (ÖBB, 2008). Predictions for the number of passengers in the new Viennese Central Station (which is to be opened in 2013) are of even greater scope with an expected 1,000 trains and a daily frequency of 145,000 people accessing the infrastructure. (OTS, 2007)

The proportion of elderly, definded as citizens aged over 65 years, has increased by 0,5% between 1991 and 2001 in Austria. According to the ÖROK trend scenario, which rests upon the assumption of positive annual growth rates, the fraction of elderly will rise from 15,5% in 2001 to about 25% in 2031. Furthermore, ÖROK estimations arrive at the conclusion that the number of "very old"people is to increase significantly in the examined time period (2001 – 2031), with their proportion in total population almost doubling to 3.5%. (Hanika et al., 2005)[3]

[3] For the prognosis of demographic parameters and user group requirements, both the ÖROK Trendszenario (Hanika et al., 2005) and calcualtions of an own model are taken into account. For a detailed description of the applied model, please refer to Millonig et. al (2007).

Both observed developments and predictions confirm the thesis of a "greying society". However, presumably no homogenous group will be formed by the elderly in the future. Rather, wide diversity within the group is expected to occur. Therefore, the affiliation to an age cohort will not be of vital significance as a descriptive attribute for questions on technology affinity or mobility behaviour.

The proportion of people who subjectively feel impaired has risen considerably between 1976 and 1995. Wiedenhofer (1997) attributes this to an increase in health awareness and detailed questioning methods. However, an own forecast[4] of the proportion of disabled or impaired citizens has concluded that the fraction of (i) visually impaired will rise by 21.8%, (ii) hearing impaired will increase by 25.5% and (iii) mobility impaired will rise by 22.3 % in the year 2027 compared to the base year. A summary of the results of the prediction model can be found below.

Group	2012	2017	2027
visually impaired	+ 5.7 %	+ 11.3 %	+ 21.8 %
hearing impaired	+ 6.7 %	+ 13.3 %	+ 25.5 %
physically impaired	+ 6.0 %	+ 11.8 %	+ 22.3 %

Fig. 1: Prognosis of increase in fractions of visually, hearing and mobility impaired people (Millonig et al., 2007)

Speaking generally, the population is turning older and is confronted with a rising number of impairments. At the same time, a differentiation of lifestyles is taking place. Especially the group of elderly and old people does not form a homogenous population group with similar needs, interests and habits. Moreover, societal change can be observed on basis of the usage of technologies and technology acceptance. Whereas in 2000 only 63% of the Austrian population (in particular men and persons under 29 years of age) and merely a third of people over the age of 60 years disposed of a mobile phone, nowadays nine out of ten Austrians own a cellular phone. Especially within in the segment of people over 60 years of age, the amount of those using a mobile phone has more than doubled since 2000, with a significantly increasing annual growth rate in recent years. (Integral, 2007) Regarding the internet, trends are comparable. New information- and communication technologies receive great attention throughout the society. 43% of total population attach great relevance to the internet, while 34% of Austrians expect a further increase in importance of mobile communication technologies. (Integral, 2006)

The rise in technology acceptance provides an important basis for further research into and development of information-, guidance and orientation technologies in large infrastructures. At the same time, new possibilities must be introduced for supporting people who do not have experience in the usage of or are seldom exposed to new technologies. There exists a variety of opportunities for providing effective support for different types of impairments and requirements. New technologies can be both applied for the examination and specification of such requirements and the transmission of information according to the requirements of specific target groups.

Sociological attempts for the definition of target groups and impairment types as well as corresponding technological solution strategies are illustrated by Grafl et al. (2006) in the research project "ÉGALITÉ".

6 ANALYSIS OF LITERATURE

The present section provides an insight into the main findings of an extensive analysis of literature and projects on innovative passenger guidance and information technologies in key infrastructures. According to Ramel and Steindl (2007), who define the term "media" as the (system-technical) arbitrator for passenger information, our findings can be categorised either as "secondary media" (one communication partner utilises technical devices for the exchange of information), "tertiary media" (both communication partners utilise technical devices) or "quarternary media" (additional to the system requirements of "secondary media", a largely independent communication system is necessary, such as the internet). Communication, thus, is defined as the forwarding of relevant information for the passenger in public transport. Thereby, interpersonal communication represents the "lowest" level, with the exchange of information between single individuals. Mass communication, on the other hand, involves communication – mostly via technical devices

[4] Regarding the prognosis of impairments within the population, no adequate sources could be obtained. Therefore, the age group specific proportions of different impairments from the microcenscus 1995 (Wiedenhofer, 1997) were combined with the own cohort model of the population prognosis. For further information please refer to Millonig et al. (2007)

–without restricted or organisationally defined recipients. The amount of reachable users of passenger information increases in line with the application of technical devices. (Ramel and Steindl, 2007)

6.1 Wayfinding

Gill (2007) analyzes the question on how technologies can support the blind and visually impaired. Following the concept of universal design or "user centered design", Gill (2007: p. 27) states: "Good design for people with disabilites is frequently good design for everyone". In this context, different technological solutions, which are particularly focused on the haptic and acoustic cognition, are presented as well as analyzed on grounds of their practical utility. Radio frequency identification (RFID) thereby provides for many opportunities for the blind and visually impaired. A geographically relevant point, location or person is equipped with an electronig tag, which allows for their clear identification. Furthermore, specific information can be assigned to the tag. Thus, target groups, which are equipped with mobile receiver devices, can identify important locations or persons and retrieve relevant information via audio transmission. Significant fields of application are guidance systems, whereby a combination between RFID and near field communication (NFC) can be utilized. In turn, the benefit of NFC lies in the fact that not every tag is scanned, which, according to Gill (2007), results in a reduced risk of violating privacy.

Fig. 2: Application of RFID-tags as guidance system for the blind and visually impaired (Gill, 2007)

For reasons of wayfinding and the detection of obstacles, electronic devices and aids to orientation furthermore involve infrared transmitters and –receivers. "Talking Signs" (or "Remote Infrared Audible Signage") consists of short audio signals, which are sent by infrared from permanently installed transmitters to handheld devices. The terminal equipment decodes the signals and reads out a verbal message via headset or speakers to the user. "Talking Signs" is the first system based on infrared which is fully functional in both interior and exterior zones. The mode of operation rests upon mobile receivers which – when aimed at a specific point – provide verbal information on the targeted location. Messages are short and incomplex. Information is repeated and steadily updated with relevant characteristics of the environment. (Talking Signs, 2007). Talking signs are already adopted successfully in Portland/Oregon (USA) (Hunter-Zaworski, 2007). A similar concept is currently being tested in public transport in Dresden/Germany. Infrared transmitters are integrated into white canes, and relevant information on time schedules, number of means of transport and destinations are communicated on demand via external speakers. In addition, "BLIS" informs drivers of public transport in the case that a blind passenger is about to board. (Grafl et al., 2006)

6.1.1 Integrative emergency and evacuation systems

Special attention is called to the adoption of technology based, accessible emergency and evacuation systems. The approach by Ruhe (2007) involves the priorisation of technological and design measures in terms of security and accessibility. Integrative emergency and evacuation systems are accordingly ranked highest.

State-of-the-art technologies, which are to be applied within emergency systems, should be designed with respect to universal design principles and the concept of "two senses": the linkage of both visual and acoustic signals represents a vital basis for all measures taken. Examples involve emergency call facilities, which are equipped with a visual display for instructions. All-inclusive warning installations require both optical elements, e.g. flashing alerts to attract attention, and audible alarm. Visual screens should be equipped with text identical, electronic voices (for more information on text-to-speech systems please refer to section 6.2). Furthermore, information regarding the infrastructure and its organisation should be obtainable via digital info system, which in turn should be accessible by mobile phone. (Ruhe, 2007)

An example for an integrative, all-inclusive emergency orientation system is made available by ILIS (2007). Significant support is provided for the seeing, blind and visually impaired as well as hearing impaired and deaf. Complementing existing fire alarm and safety systems, a combination of lights and acoustic signals is applied for safe and effective guidance. In situations which necessitate prompt evacuation, a continuous tone is activated. Through varying tone pitches, obstacles such as staircases are signalised. Rising and falling sound levels indicate the distance to the exit. Learning processes are not required, as the identification and interpretation of signals takes place intuitively. Furthermore, deaf and hearing impaired can be guided to the exit by vibration and distinct lighting signals.

6.2 Passenger and staff information

Wireless access points do not only provide for state-of-the art wayfinding technologies, but also can be utilized for passenger and transport staff information systems. The Stockholm authority for public metropolitain and suburban transport in cooperation with the companies Veolia Transport and Appear networks introduced a communication system for mobile staff within the tube station Gullmarsplan. (Rechtsteiner and Lindström, 2006). Via this system, station-based personell can retrieve personal and localised information from wireless access points provided in the different station levels, platforms, the service counter area and the connected bus station. With simultaneous consideration of location, time and the person placing an inquiry, specific data is sent to the user. In addition, a silent alarm with concurrent localisation of the trigger is possible. According to location, personell only receives required information. Passengers benefit from this system, as – for example in the case of delays – precise transport information can be forwarded in situ without the necessity of consulting the information centre. The described technological solution, having been conceived as both device- and networkdiagnostic, operates in combination with Smartphones, PDAs or laptops and with Wi-Fi- or cellular networks (GPRS, UMTS).

A further possibility of providing up-to-date information in situ is represented by so-called acoustic or "speaking" request columns. These columns dispose of an individually definable number of buttons, whereby spoken information can be accessed via keystroke. The acoustic data content can be adjusted and updated arbitrarily, e.g. via connection to a network involving centralised control with fast and flexible methods of update. Furthermore, external data storage media, e.g. USB-sticks, can be utilized to transcribe present information. (Baum Retec, 2007) Positioned in important decision-making areas, such as route partings or platforms within railway stations, acoustic request columns allow for easily accessible and precise information on potential obstacles, path alternatives and updates on means of transport (e.g. delays) without the requirement of additional human staff. This technology is currently adopted in the Berliner Hauptbahnhof, whereupon the identification of the present location for blind and visually impaired is of particular concern. (ABSV Berlin, 2006)

Speech synthesis has gained major importance in recent years. Speech synthesis describes the artificial generating of speech via support of a processor. As complete text passages can be reproduced by this technology, it is also often referred to as "Text to Speech (TTS)". Modern TTS-systems are very efficient and provide naturally sounding voices which are not at all comparable to the synthetic vocal tone of early personal computers (e-teaching.org, 2007). In Austria, TTS-systems are already applied successfully, as for example in the "Dynamische Fahrgastinformation – DFI" (dynamic passenger information) initiative of the ÖBB-Postbus. Bearing many benefits, TTS can not only be employed in combination with individually operable elements (e.g. info terminals). Moreover, TTS can be used together with dynamic info-screens, which is of major importance concerning a better communication of departure and arrival times in waiting areas and lounges. Relevant information in terms of security as well as exceptional changes in operating

schedules thus should be read out automatically. For further support of clear communication and understanding, inductive loops should be installed in all areas.

In contrast, speech-to-text systems (STT) have rarley or not been introduced in public space. The transformation of acoustic in visual information is particularly relevant in cases of emergency. In this particular field of application, announcements can be transformed automatically and in real-time to written information on dynamic screens, thus emphasising on the importance of the transmitted message. Furthermore, the possibility of interaction between an individual and computerised systems or information media has been of increasing interest. By STT, tedious and for impeded persons complex steps to derive passenger information could be avoided. The "Typetalk"-system in Great Britain already applies STT, allowing for hearing impaired and deaf passengers to communicate by telephone. (RNID, 2007) An operator thereby converts spoken text to written messages and vice versa. The transmission is effected anonymously. This particular application is also of relevance for Austrian providers of public transport, as spontaneous telephonic information requests could be carried out by deaf and hearing impaired persons. Concluding, the challenge lies – besides the adoption of existing technologies such as "Typetalk" - in the design and application of automatised technologies for both speech synthesis and -cognition.

A first prototype, called "Zielleitung" for orientating, guiding and informing based on STT ans TTS has been developed at the Viennese Westbahnhof in Austria. The system was specially designed for elderly people who can use their own mobile phone for navigating without the need of pushing buttons. The user calls a general information number and is welcomed by an automatic voice system that asks the user what he wants to do by offering a few options. (eg. Finding a specific track or point in the station, buying a ticket, shopping etc.or a combination thereof). Then the systems identifies the position of the caller by asking him for visual cues that he can see at the momement. These "landmarks" have been identified in the area of the station and all possible routes leading from any point to another have been computed. To simplify the system the station has been sepaprated into several areas and "route decision points" have been identified. After having established where the caller is located and which points he wants to reach the TTS system gives him the according information, guiding the caller from landmark to landmark. This information can be told at once or the caller can stay on the phone and ask for new guidance whenever he reaches a specific station along his way. During the test phase the prototype worked well, some consideration has to be given to the audio system, which has some problems to understand the user when the surrounding noise level is to high. One of the major benefits of the system is that it can be easily updated if changes in the infrastructure occur (new shops, new info points, etc.). (Millonig and Schechtner, 2007)

In terms of Location Based Services (LBS), relevant research work is conducted with focus on the problem of information overflow and the personalisation of information: Millonig and Gartner (2007) investigate the comprehension of active and passive sensors within ubiquitous or smart environments, respectively. Furthermore, the issues of increasing demand for bandwidth and memory capacity are being dealt with.

7 ON-SITE CASE STUDIES

The analysis of state-of-the-art technologies with focus on all-inclusive information and guidance technologies in infrastructures was supported by on-site case studies conducted in national and international railway stations and airports. For this reason, in the forefront of the case studies a standardised investigation form, which comprised essential criteria for the evaluation of existent technologies was drawn up. The inspection of predefined routes was carried out as unbiased as possible and in particular consideration of accessible technologies and measures. The following section summarises the main findings of the case studies conducted in France, Belguim, Great Britain, Switzerland and Austria.

Innovative technologies

Gare Montparnasse in Paris, France, participated in the French programme "Gares en mouvement", which was introduced to support the disabled in terms of free mobility within infrastructures. The third and final phase of this project involved the introduction of various constructional and technical measures for the enhancement of accessibility. A detailed press kit provides information on the actions taken. (SNCF, 2006) Measures in the "experimental station" Gare Montparnasse were adopted on a test track within the station, leading from the main entrance to the platforms, information desks and taxi stands. According to station information, implemented technologies comprised a touch screen at the entrance, which was developed in

cooperation with France Telecom and enables a direct and visual establishment of contact with station staff. Furthermore, according to the information brochure, audio signals which run on a frequency of 860 MHz were installed alongside tactile guidance routes. These can be activated via remote control and signalise different routes and crossing points. On the test track, new TFT monitors, which partly can adjust themselves to the size of the operating passenger, were installed. Real-time information on departures and arrivals can be downloaded from an internet site or directly accessed by GPRS or PDA via the stations WiFi-network. (Further enhancement for the usage in combination with Smartphones is planned) Finally, a system, which directly translates acoustic announcements into sign language with support of a virtual avatar ("Clara") will be introduced.

However, at first sight, the innovative guidance and information technologies seem rather scarcely applied. Throughout the in situ examination, only a small variety of measures were observable. The corpus of innovative technologies was already deinstalled by the time of the case study. Furthermore, the purpose of an application of specific measures, such as the translation into sign language via avatar, can be questioned. Many hearing impaired may not be proficient in sign language, which makes a translation from speech to text (STT) more reasonable. According to staff, the results of the effected test route are not available (yet).

The central railway station in Zurich, Switzerland, provides a great variety of guidance and information systems. These comprise screens with spatial and temporal overviews, such as an overall view of the Swiss train network with "taggings" of expected delays and hold-ups on the different lines. Additionally, internet terminals, which enable passengers to plan and print out their chosen routes, are installed. Both ticket offices and information desks are equipped with inductive loops, which are clearly labelled.

The railway station in Linz, Austria, disposes of acoustical and visual transmitters for information on public transport connections. Furthermore, an information and emergency communication stele, which is accessible for blind and visually impaired as well as handicapped persons, is installed. The stele provides the possibility of accessing information and requesting support. The bus station is equipped with a station based passenger information system, which operates via text-to-speech. The announcements are linked to the dynamic passenger information system of the "Linz Linien" and inform about the current and next bus lines, route and arrival times. Additionally, a locating signal can be released by using a radio transmitter (operation mode comparable to light signal equipment). The vocal announcements can be activated either via radio transmitter at close range of the speakers or by a push button in the station area.

Fig. 3: Solution for information and communication via tactile signage and specific requesting keys for people with different impediments, Linz (see Millonig et al., 2007)

Further comments on case studies

Generally speaking, innovative guidance and information technologies were scarcely applied in the majority of examined infrastructures.

The international airport in Brussels, Belgium, provides its passengers with pre-trip information via internet[5], whereby particulars concerning transport connections to and from the infrastructure as well as information for disabled passengers are supplied. However, the provided data is only available in French.

The Victoria Station in London, Great Britain, did not exhibit any particular innovations in guidance and information technologies at the stage of the on-site examination. Constuctional equipment does not meet the latest standards for accessibility. However, the general orientation and guidance system, which is composed of large signage, rich in contrast and visible from all angles, was considered very positive.

[5] www.worldairportguide.com/airport/292/airport_guide/Europe/Brussels-Airport.html

In Austrian railway stations, particularly innovative technologies such as guidance systems on the basis of RFID or infrared tags could not be detected. Furthermore, "basic" requirements, such as induction loops, are either not clearly marked or not in operation at all, as for example within the railway station building in Wiener Neustadt. In Linz, the so called "barrier-free" info or ticketing terminals are accessible for wheelchair users. Yet, the terminals are not equipped to suit the requirements of blind or visually impaired passengers.

Regarding general measures, such as lighting, tactile guidance systems and visual elements, accessiblity is gradually enhanced in line with the systematic constructional revision of Austrian railway infrastructures. An example thereby is provided by the station in Baden, Austria, which was renovated and partly refurbished with the aim of all-inclusive usage.

8 TECHNOLOGICAL TRENDS AND PERSPECTIVES

8.1 Technological trends regarding the design of accessible, targeted and reliable information systems within the short and medium term

Currently available trend reports (Microsoft, 2006; Future Network, 2004; ECIN, 2004) highlight the following key technologies, which will be considered increasingly within the next few years and are capable to effect significant developments of accessible, secure and reliable information and guidance systems:

The frequent usage and acceptance of technology are essential factors in view of the development of innovative systems which are to be implemented for the support of elderly and mobility impaired people. In this respect, the term "ambient assisted living" gradually gains in importance. Thereby, the developments of technological systems for the support of mobility hampered population groups with focus on the homely area are described. In parallel, assessments of technological trends consider developments in the area of ambient intelligence as relevant key technologies. The "intelligent" embedding of electronic systems into so-called "smart environments" permits the exchange of information at arbitrary points and can also be applied for the optimisation of security systems. In this context, new forms of man-machine communication have been gaining in relevance. Apart from human voice, also facial expression, gesture and surface feel can be adopted as somatic interfaces. In future, even the line of sight and emotions will be operationalisable.

The development and implementation of sensor technology on one hand enhances the usability of systems and, on the other, allows for fundamental research into the - thitherto largely unexplored – human behaviour within different groups and under differing situational circumstances. In this respect, wireless communication technologies as for example WLAN (Wireless Local Area Network) and especially RFID (Radio Frequency Identification) will receive particular attention. In terms of the provision of information and the simplification and optimisation of operational procedures, these technologies are considered highly relevant.

Finally, developments in the field of three-dimensional printing (development of concept models based on CAD-data) should be emphasised. Findings and innovations in this area allow for further research and advancements with the aim of a simple and cost-effective development of tactile information and maps.

8.2 Identification and devision of future research requirements

Demographic tendencies account for the increasing necessity for the provision of accessible and reliable information in the transport sector. The anticipated rise in life expectancy results in a growing number of citizens with gradually developing impairments. Additionally, these groups may not have sufficient practice in utilising new technologies, whereby trainings and instructions may put forth unsatisfactory results.

At the same time, transboundary mobility, and thus, the diversity of languages, is increasing. English, the current "lingua franca", might become less important in the near future, which emphasises the necessity of providing information in several different languages and via graphical illustrations.

For these reasons, an inevitable need for research into the specific requirements of affected persons in respect to orientation and guidance information is immanent. The provision of information has to take place on a low level and address a majority of – if not all – passengers by different communication channels in comparable quality. Furthermore, a minimisation of highly specific solutions, which require special trainings, is to be aspired. Adopted technologies should be self-explanatory and intuitively usable.

In this context, the following future key research topics were identified and devised:

Analysis of group-specific behaviour

The increasing multiple-shift usage of key infrastructures as combined shopping, entertainment and travel centres require an exhaustive examination of effects of information overload on orientation behaviour and the ability of different population groups to extract relevant information. Special attention should be given to visibility circumstances and group specific restraints in the fields of vision, especially in terms of 3D simulation of pedestrian flows.

Provision and illustration of information

Efficient communication of information in essence comprises the provision and ascertainable illustration of up-to-date and for the specific location relevant information without disturbance through non-relevant or mistakable data. Thereby, redundancies do not represent a loss of quality, but – in line with the principle of addressing multiple senses – result in (a) the safeguarding of communication of targeted and reliable information to impeded persons and (b) a rise in comfort and security for those not affected by impairments. Information should be accessible through a variety of communication channels and technologies, thus taking into account the different abilities and attainments of passengers. For instance, focus can be placed on accessible multimedia info points, the advancement of speech synthesis and STT systems or the development of tactile 3D models of the infrastructure which change their formation according to the requested information on guidance and orientation within the building or its surroundings.

Entrance systems and mobility support

Spatial growth and increasing complexity of key infrastructures lead to particular consideration of great (walking-) distances, which represent an obstacle of varying extent to certain groups of population. Additionally, different accession systems must be regarded. Internationally, check-in areas, such as in airports, gain significantly in importance. Here, the accessible design of check-in and entrance systems and the support of people with physical mobility impairments are emphasised. Examples include innovative solutions for comprehensive mobile ticketing or “intelligent” passenger conveyance systems which adapt their speed according to identified users and historical data on passenger behaviour.

Security and emergency systems

Currently, emergency scenarios lack a sufficient response to various limitations and abilities of different passenger groups. However, especially in cases of emergency, all-inclusiveness is vital. This does not only enhance security and efficiency of emergency systems, but also provides the basis for an increase in confidence in public infrastructures. For this reason, the analysis and simulation of group-specific behaviour in emergency scenarios and the accessible and intuitive design of alarm and evacuation systems should form major future research requirements.

9 RÉSUMÈ

The national and international screening and analysis of state-of-the-art guidance and orientation technologies shows that a variety of new approaches has been developed and partly applied throughout the last years. Best practice examples, such as the “Talking-Signs” project or guidance systems based on wireless technologies attest that R&D have progressed increasingly considering accessible, reliable and effective passenger information. In particular, new approaches and developments clearly certify that the concept of universal design is increasingly incorporated in scientific work on and practical implementation of innovative technologies. This can be justified by demographic data (tendencies of an “aging society”, rise in proportion of population faced with various impairments).

However, as concluded in the paper, the actual implementation of existing innovative technologies is lacking. The on-site case studies in Austria show that, although measures were adopted to improve accessibility on the basis of technological solutions, many approaches were not yet taken into account. Primary reliance has been put on constructional measures up to today. Internationally, innovative theoretical and tested solutions exist, yet the majority of inspected transport hubs seem as if not actively participating in the adoption (and thus the benefits) of innovative guidance and information technologies.

The intensive examination of literature and inspection of large, international infrastructures has therefore lead to the identification of essential future key-research topics in the fields of (i) the analysis of group

specific behaviour, (ii) the provision and illustration of information, (iii) entrance systems and mobility support and (iv) security and emergency systems.

It has to be mentioned very positively that, by the date of submission of this paper, Austria has taken major steps in the context of the above identified key research topics. Potential shortcomings in the field of all-inclusive passenger information and guidance systems have been recognised. Thus, to the benefit of all, the Austrian government has agreed to provide substantial funds for research and development in this respect.

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