THE TRANSFER-NETWORK "EASY.GOING": EXPERIENCES FROM A PILOT STUDY ON BARRIER-FREE ACCESS TO LONG-DISTANCE AND REGIONAL TRAINS

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1. The challenge

Almost all industrialized nations have to cope with rapidly aging populations. Within the European Union's 27 member states, the old-age dependency ratio[1] already exceeds 25% and is likely to increase to 50% by 2050 (Eurostat, 2008). Thus, more people in total will suffer from age-related impairments like vision loss or reduced dexterity. In order to allow all these people regardless of their age and disabilities to participate in social activities and to live an independent and self-determined life, a barrier-free transportation system for the general public is needed.

Barrier-free mobility means that both the structural environment and the transportation system can be used by as many people as possible without requesting external assistance. This is in line with concepts like "design for all" (EU), "Universal Design" (USA, Japan), "Inclusive Design" (UK), "Barrier-Freedom" (Germany) or "Obstacle-Freedom" (Switzerland). In this paper, we focus on the "design for all" approach which is based on the principle of inclusion of the "end users" in all stages of the design process while responding to human diversity (Aragall, Neumann & Sagramola, 2008). The main criteria for design for all of a product or service are (according to Klein-Luyten, Krauß, Meyer, Scheuer, & Weller, 2009 and Leidner, 2007):

- Usable for as many users as possible without any adaptation
- Easy to adapt to specific needs
- Possibility to integrate or to use individual aids and
- User participation in all phases of the development process.

[1] Old-age dependency ratio: projected number of persons aged 65 and over expressed as a percentage of the projected number of persons aged between 15 and 64.

Goal of the “design for all” approach is the inclusion of as many people as possible, regardless of any handicap that they eventually have. Such handicaps evolve if individuals are unable to cope with the demands of the environment. For instance, stairs on the entrance of a train require public transport users to climb at least 2-3 steps, which is an insurmountable barrier for persons using wheelchairs. Reducing the demands of the environment can take away the handicap. In our example this would mean installing a lift or providing a ramp (see also chapter 4).

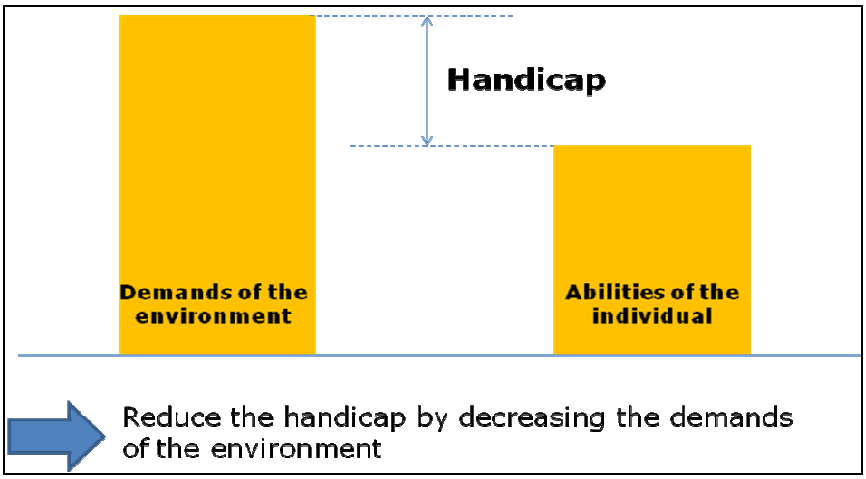

Figure 1: Definition of a handicap as the difference between demands of the environment and the abilities of the individual

Barriers that need to be overcome in the transportation system can mainly be described as physical, informational and social/psychological. Possible solutions to overcome such barriers are given in Table 1.

Barrier type	Physical	Social / Psychological	Informational
Examples for good solutions	Low-floor vehicles	Simple and intuitive use, e.g. of ticket machines	Applied two-sense-principle for information and orientation aids
	Ramps or lifts which are easy to operate (ideally by travelers themselves)	Simple and comprehensible tariff scheme	Good readability of written information (e.g. timetables, displays)
	Ticket machine and operating elements accessible in a wheelchair compatible height	Reduce “anxiety factors” such as providing enough toilets in the train or giving the possibility to buy tickets in the train and not only in advance	Additional information provided on barrier-free routes (e.g. as add-on of the online travel information)

Table 1: Possible solutions to overcome barriers in the public transport system

In this paper, we concentrate on disabled people as people with the highest demands (or better the biggest gap between abilities of the individual and the demand of the environment). The European project PTaccess screened many national and international statistics and reports. It was concluded that 30% of the population have mobility restrictions when using public transport (Belter, Becker, Gerike, Schranil,&

Stelzner, 2007) – including the non-disabled persons. Table 2 shows the prevalence of different mobility restrictions in the general population. The shares and percentages may not be added or compared to each other because people can be affected by different impairments or restrictions simultaneously.

	Kind of restriction	Overall possible share of total population (in %)
	Persons using wheelchairs	1
	Persons with restrictions in walking	9
	Persons with a pram	4
	Persons with young children without a pram	4
	Persons with luggage or bike	10
	Persons with visual impairments	16
	Persons with hearing impairments	6
	Persons with other restrictions	9
Persons with one or more restrictions		**30**
Persons with no restriction		**70**

Table 2: Type and share of mobility restrictions (according to Belter, Becker, Gerike, Schranil & Stelzner, 2007)

2. The project "easy.going"

In order to support the vision of a barrier-free public environment, the German Federal Ministry of Transport, Building and Urban Development has launched the project "easy.going" within its "business meets science" initiative in 2008[2]. "Easy.going" brings together scientists and practitioners to unleash creativity potentials in the field of barrier-free mobility. Core of the project work is the development and validation of a technology transfer model that stimulates cooperation between research institutions, associations and small and medium-sized enterprises (SMEs) in the Berlin-Brandenburg area. Technology transfer processes in "easy.going" take place within an interdisciplinary transfer network that stimulates cooperation, the generation of new inventions, and the transformation of innovations into marketable products. The project is led by Berlin Technical University and currently includes 4 research institutions, up to 9 SMEs, and representatives from public transportation providers and governmental agencies.

It is well known that many SMEs have problems to invest in extensive research and development due to financial and manpower restrictions. As a result, they don't have the possibility to cooperate with research institutes and to participate in privately or

[2] For details, see http://130.149.80.38/easygoing/dokumente/Project_Description_English.pdf

publicly funded R&D projects. The idea of Germany's "business meets science" initiative is to change this by supporting research institutes who actively guide SMEs towards joint research projects. Within easy.going, this cooperation approach has been institutionalized in a scalable innovation process (see section 3) and a common, wiki-based knowledge repository with interesting transfer themes and topics. This knowledge repository contains state of the art information (including external links and references) on barrier-free travel information systems, transport infrastructures and vehicle technologies and supports SMEs throughout product developments for barrier-free mobility (Dziekan, Ruhrort, Wenzel, Gilka, Kliemke & Ahrend, 2009).

The easy.going concept has been successfully tested during pilot projects on (a) barrier-free access for regional and long distance trains (see section 4 for details) and (b) mobile guidance-systems for blind and visually impaired persons. Ultimate goal of the easy.going project is the establishment of a permanent and sustainable technology transfer framework for barrier-free mobility in the Berlin-Brandenburg region (Figure 2).

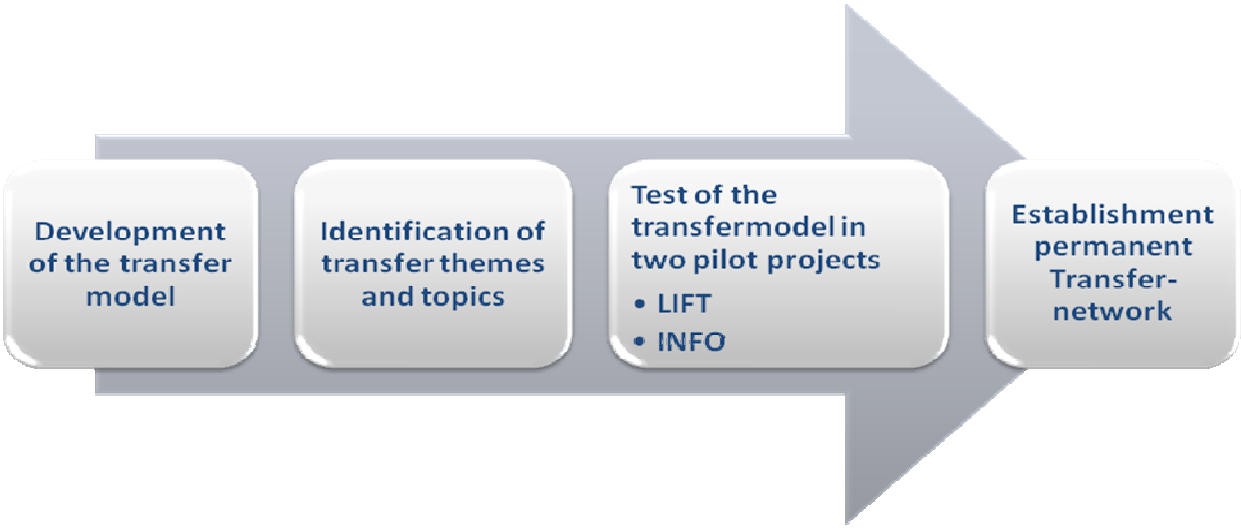

Figure 2: The timeline of the easy.going project

3. The Scalable Innovation Process

The Scalable Innovation Process (SIP, Figure 3) is a four step technology transfer process model for joint research between SMEs and research institutions (Klafft, Pfennigschmidt, Dziekan, Ahrend, Kliemke, Wenzel 2009). Key concept of the SIP is a step-wise escalation of the SME's financial and organisational commitment during the innovation process. This enables SMEs to initiate research activities with very limited ressources and efforts. If (and only if) initial research results look promising and the overall project risk is manageable, the next step of the SIP is initiated. Thus, SMEs can reduce their financial exposure during the whole process to an acceptable level. The Scalable Innovation Process comprises the following steps:

Phase 1: Idea generation. This first phase addresses two goals: (a) identification and specification of relevant project ideas and (b) trust-building between the different actors (SME, research institutions). Phase 1 mainly consists of meetings and creativity workshops and is offered free of charge by the easy.going network so that the entry barrier for the SME is kept at the lowest possible level.

Phase 2: Pilot studies. Goal of the pilot studies is (a) to provide the SME with a deeper understanding of the state of the art in project-related fields, (b) to identify possible challenges that may arise during the product development process, (c) to analyse key requirements of potential end-users, and (d) to test the technology acceptance of different ideas and approaches. As a result, the SME will obtain a clearer view of existing project risks and arising opportunities. Pilot projects are usually carried out by researchers in cooperation with student assistants. Student involvement enables the project partners to benefit from the creativity of young talents, to reduce the costs of phase 2 to an acceptable level (roughly 5,000 €), and to give SMEs the opportunity to assess possible future employees.

Phase 3: Consolidation. If the results of the pilot studies are promising, if a concrete project idea has been specified, and if the identified project risks appear manageable, the research institutions will assist the SME in preparing and submitting a research and development proposal within public research programmes. Ideally, the project bid will be successfull and will result in a joint R&D project. Within such projects, SMEs typically have to cover between 25% and 60% of their project costs whereas the remaining costs are covered by public co-funding.

Phase 4: Implementation. Due to legal constraints (competition law), research projects conducted in the consolidation phase must stop at a demonstrator or early prototype stage (pre-competitive development). Nevertheless, research institutions can still support the SMEs during the implementation phase when demonstrators and prototypes evolve into marketable products. However, within this phase, the SMEs do not only have to cover their own costs, but external research support has to be renumerated at commercially available consulting fees.

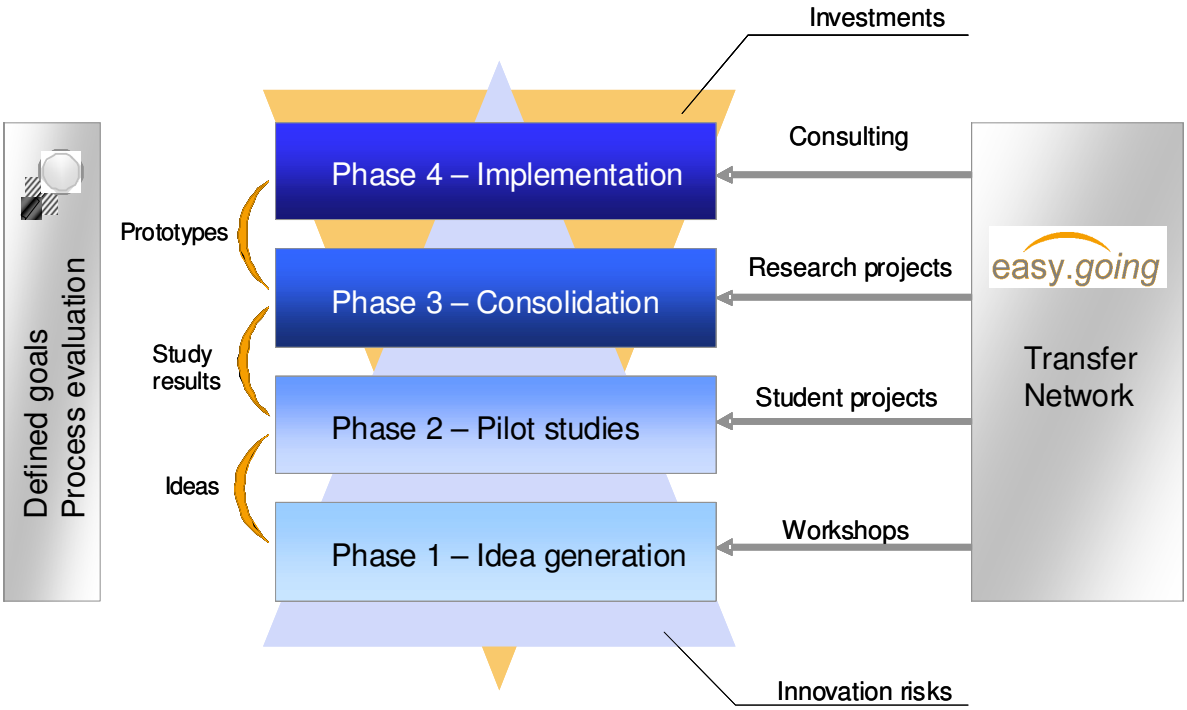

Figure 3: The Scalable Innovation Process (Klafft, Pfennigschmidt, Ahrend, Dziekan, Kliemke and Wenzel 2009)

During the SIP, each SME is supported by a scientific coordinator from the network who acts as a pilot and (a) establishes contacts with the most relevant research establishments for a given topic of interest, (b) manages the pilot studies, (c) guides the SME towards the most appropriate public research programme, and (d) assists the company during the research proposal preparation process. Furthermore, scalable innovation processes can be accompanied by external quality assessment experts who monitor and analyze the progress in the different phases and – by doing so – assure a high quality in the process.
In the following chapter one pilot study within the phase 2 of the SIP will be described.

4. Barrier-free access to regional and long distance trains

4.1 Ramps and lifts as the main boarding aids to enter the train

Mobility impaired people favour public transport over private cars. A questionnaire-based study among wheelchair users revealed that the access to the train has the highest priority with approximately 48 % (Rentzsch et al. 2008) among 4 aspects included in the test (perception of information, use of control elements, entrance area, access to the train). That means the barrier free access to the train is the most important point for physically impaired people. Therefore the vehicles of the local public and long distance traffic have to be designed in such a way that they can be used by all interested persons in the sense of a barrier free travel chain including elderly and mobility impaired people. Especially physically impaired people have problems to enter the train in case of vertical and horizontal gaps. Unfortunately the level access between platform and vehicle is realised only in some cases. Often the wheelchair users have to handle a combination of door width and gap, which makes the boarding more difficult to them. Based on recent results it can be stated that gaps between platform and train shall be as small as possible, since already 50 mm vertically and horizontally can not be managed by all wheelchair users on their own.
In this context ramps and lifts integrated in the train are the main boarding aids to overcome these gaps and to enter the train successfully (see Figure 4).

a)

b)

Figure 4: Ramps and lifts as the main boarding aids (Pictures by Manfred Rentzsch)
a) Hoisting lift stored on the platform b) Electro-mechanic ramp integrated in the train

In order to be more flexible and independent from the distance between platform and train floor, lifts are the preferable solutions. In the following the methodology and the main results of a pilot study regarding a hoisting lift for long distance trains according to Figure 3, phase 2 in the SIP model of the easy.going project will be represented. Apart from IAS, students studying at TU Berlin and TU Berlin scientists played an important role in conducting the field tests.

4.2 Field test of a hoisting lift for long distance trains

4.2.1 Methodology

Basic structure

Fig. 5 illustrates the basic structure of the methodology used in the project. The starting point of the investigation was to analyze the current access situation for disabled and elderly persons in passenger trains, considering the relevant regulations and standards as well as the large volume of research work that has already been carried out at international and national level.

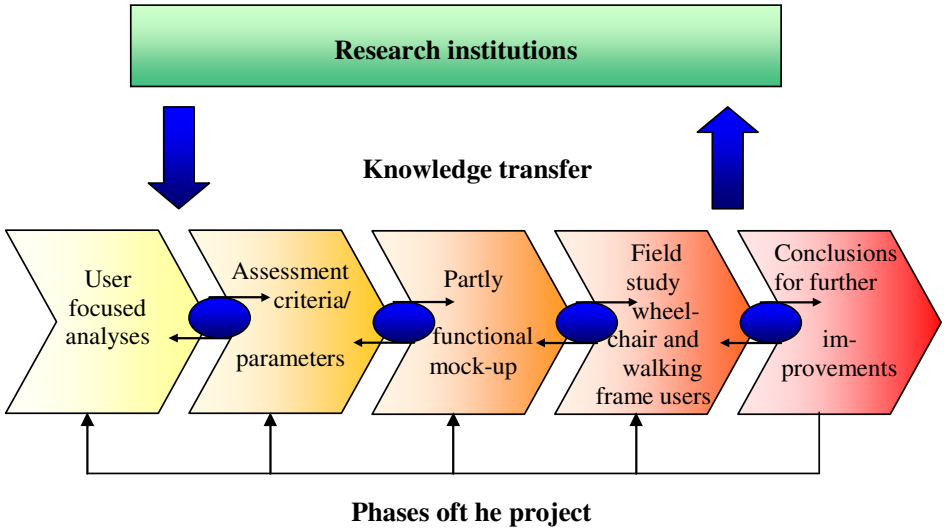

Figure 5: Basic structure of the methodology

A user-focused analysis based on an interview manual was carried out. The results of the user-focused analysis were used as input for the derivation of assessment criteria and parameters.

Test equipment

The test equipment is based on a partly functional mock-up of a hoisting lift in a scale 1:1 (see. Figure 6). A hoisting lift for wheelchair users to enter the high speed train without any troubles was developed by the SME MediVent in Berlin. The lift can be operated by the user on his/her own. He/she activates a button on the door marked as the access for wheelchair users. At the same time the engine driver is getting a warning signal in order to monitor the kneeling or lifting procedure by a video camera. The lift swivels out and drops down. The front door opens up and a little ramp moves down. The wheelchair user can enter the lift cabin and run up to the level of the train floor. Then the side walls of the cab opens up and the wheelchair user can move to his/her final position. Based on this technology the railway operator can save time caused by self-operation of the lift.

To verify the findings of the tests and to eliminate possibly existing shortcomings, a test scenario was set up. For the first time it was possible to test the accessibility of long distance trains under “real life conditions” and the usability of the cabin design itself.

Figure 6: Photomontage hoisting lift in ICE (left) and partly functional mock-up of a hoisting lift at the test site (right) (Source: left: MediVent, right: K.Dziekan)

The tests were focusing on the access situation of the lift cabin (e.g. clear throughway, slope and width of the ramp in front of the cab, available space inside the cab), on the perceived safety and self-determination of lift-users, on the cycle time to enter the train and on the overall impression of the lift.

Subjects
Altogether 5 subjects (3 females and 2 males) took part at the tests, 2 subjects have used an electrically, 2 subjects a manually operated wheelchair and one subject a walking frame. The test duration was about 45 minutes.
The subjects have had to answer a questionnaire according to the items mentioned above. The assessments of the different aspects were made on a 4 graded scale from 1 (very bad) up to 4 (very good).

4.2.2 Results
In the following the most important results were summarized:

- The general assessment of the barrier-free design of the cabin lift by the wheelchair and walking frame users is good. The subjects are very satisfied with this version to install the cabin lift inside a separate segment of the vehicle in order to be independently from the ordinary access/egress.
- The subjects rated the feeling of safety inside the cabin lift including its operational procedure described in section 4.2.1 as good but with restrictions concerning the ergonomic and industrial design of the cab. They want to have additional handholds/grips and possibilities to use the cab and to fix the wheelchair during the journey. Also better designed control elements to operate the lift are required.
- The feeling of self-determination of the subjects to operate the lift on their own without external help is a remarkable step forward in the direction of the barrier-free design of railway vehicles.
- The majority of the wheelchair users included in the tests have indicated problems with the throughway of the access and the dimensions of the test cab that was constructed corresponding with the values of the European

Technical Specification of Interoperability for persons with reduced mobility (TSI PRM). The length and width of the cab have to be increased. The TSI values are not sufficient. The slope of the ramp in front of the cab should be reduced by an increased depth of the ramp.

- Based on the used technology in terms of the cabin lift the cycle time to enter the train by wheelchair users was reduced remarkably. This is an important argument to convince the railway operators to ask for this kind of boarding aids.

4.2.3 Conclusions

The partly functional mock-up has to be optimized based on the critical points mentioned above. The completed functional model should be tested by a higher number of subjects later on.
The field test realized within the Phase 2 of the SIP was very helpful for the SME, the evaluation was positive - probably the cooperation will continue with a step forward into phase 3.

5. The future: Sustainable network for barrier-free mobility for all

This paper provided an overview to the design for all concept that was applied to the barrier-free mobility approach. Cooperation with and knowledge transfer to SME are the focus of the activities in the project “easy.going”. The above described pilot study illustrated typical working processes within our technology transfer network. The challenge for the future is to make the easy.going network for barrier-free mobility sustainable in the long term.

One next step is to make the easy.going wiki – a knowledge repository – openly accessible. It will hopefully grow into a knowledge exchange platform for all stakeholders involved in the field of barrier-free mobility. This will create more interest in the topic by SMEs. One current problem is that the number of interested SME in the topic is somewhat limited. One reason might be that the market is perceived as rather small. Here more marketing, knowledge transfer and networking activities might be necessary.
Another challenge is how to finance the easy.going network since SME do not have financial power to support such a network strongly and continually. Maybe one solution could be to extended it to other stakeholders.

The network for the barrier-free mobility for all is of very high relevance – there will be a growing market for services and products that are designed for all. The easy.going project shows a possible successful path towards such a sustainable network.

6. Acknowledgements

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