IMPROVING PASSENGER RAIL ACCESSIBILITY – RESULTS OF A COMPETITION TO DEVELOP NEW CONCEPTS AND IDEAS

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November 12, 2008

4,479 words + 10 figures + 1 Table = 7,479 words

ABSTRACT

Boarding and alighting railway vehicles poses a significant burden for people with limited mobility whether disabled, elderly, traveling with a baby carriage or in other situations. Improving rail vehicle accessibility can help increase railway use and thereby help create a more sustainable and energy efficient transport system. Improving accessibility also benefits rail operators by reducing the time needed for boarding, thus reducing operating costs. This paper describes a competition held in Austria to develop new ideas for improving access to existing passenger rail vehicles. The focus on existing systems is important because rail vehicles and facilities are expensive and have long service lifetimes so simply replacing existing vehicles and facilities would be difficult. Most of the ideas developed in the competition were refinements to existing boarding accessibility systems. These ideas included improved design to make the systems more attractive to use, two-sided lift systems and combining several accessibility features into a single coach. An important project result was increased awareness of the need to improve rail vehicles accessibility by both the competition participants and the general public through competition publicity. The paper summarizes the importance of providing accessibility, presents a framework for boarding assistance systems (BAS), describes the competition and presents conclusions with recommendations for similar competitions.

IMPROVING PASSENGER RAIL ACCESSIBILITY – RESULTS OF A COMPETITION TO DEVELOP NEW CONCEPTS AND IDEAS

1. INTRODUCTION

While most countries have made laws concerning accessibility, there is still a long way to go in terms of providing full accessibility to public transport. [1] An especially difficult case is providing access to existing railway-based public transport.

The process of boarding and alighting railway vehicles poses a significant burden for people with limited mobility whether they are handicapped, elderly, traveling with a baby carriage or in many other situations. [2] Improving rail vehicle accessibility can help increase the use of public transport, thereby contributing to the development of a more sustainable and energy efficient transport system. Improving rail vehicle accessibility is also beneficial for rail transport operators because well designed systems can reduce the amount of time needed for the boarding process, thus reducing operating costs.

The project consisted of organizing a competition for young people under the age of 35 to develop ideas for improving access to existing passenger rail vehicles. The project focused on solutions that can be retrofitted on to existing systems, but participants were encouraged to use their imagination. The focus on existing systems is important because rail vehicles and facilities are very expensive and have very long service lifetimes It will be very difficult to make these systems fully accessible quickly.

The participants developed 34 different accessibility solutions. Many were similar to existing boarding assistance systems (BAS), but several were quite innovative. An important result of the project was increased awareness of the need for improved accessibility both among the participants and in terms of the publicity the competition generated. This was important because a key problem limiting development and implementation of accessibility improvements is that many people do not understand the importance of providing accessibility for all.

This paper begins by describing a framework for categorizing different BAS solutions. Section 3 describes results of the student competition and Section 4 presents conclusions and recommendations.

2. BOARDING AND ALIGHTING RAIL VEHICLES

The process of boarding rail vehicles consists of several connected steps: first, passengers must get to the rail station; next, they must get to the platform; finally, they must get from the platform to the rail vehicle. Once on the rail vehicle they must have an appropriate space to ride and access to various facilities (e.g. restrooms, dining car). The process of alighting follows the same steps in reverse. The project focused only on the third step: getting from the platform to the rail vehicle.

There are two main ways to make rail vehicles accessible: level boarding and boarding assistance devices. This section outlines both options.

2.1 Level Boarding

The optimal solution for providing rail system accessibility is to create level-boarding by adjusting rolling stock and station platforms so that the platform and train floor are at the same level and the horizontal gap between platform and train is minimized (or bridged).

While level boarding is almost always implemented in new rail systems, it is difficult and expensive to implement in existing rail systems. Railways are simply too diverse, spread-out and complex to quickly implement a level boarding solution. Some European railways have thousands of stations, many of which were originally designed over a hundred years ago. This means that railway operators need short term solutions for providing accessibility.

Finally, even level boarding raises certain problems for railway operators. Specifically, what level? In a typical European railway station vehicles of many ages and with many different performance characteristics (regional/commuter rail, long-distance rail, overnight trains and high speed trains) all share the same tracks. The situation in other countries, including the US, is similar although generally there are fewer train types operating. There has been a great deal of effort in developing standardized platform heights for railways and transport systems, but the issues of migration (to the new standard) for both rolling stock and the platforms themselves are significant. [3]

Many modern commuter trains offer level boarding because the vehicles are designed with a lower floor. However, most new long distance and high speed trains are conventional high floor vehicles with steel or aluminum bodies on two bogies. This design is needed to provide sufficient strength with minimal weight. There are few existing examples of low floor vehicles in long distance or high speed trains (e.g. Spanish Talgo system).

In summary, given the complications involved with level boarding on railways, alternative devices that help all types of mobility impaired passengers will be needed for many years. The following section presents a framework for evaluating different railway boarding assistance systems.

2.2 Boarding Assistance Systems (BAS) Typology

The alternative to level boarding accessibility solutions is to provide boarding assistance systems (BAS) that enable mobility impaired passengers to reach railway vehicle floor levels from platforms at a different level. There are two main types of boarding assistance systems: ramps and lifts. Each BAS can be deployed either on the platform or on the vehicle; and, there are manually operated ramps/lifts and electro-mechanical ramps/lifts. Table 1 summarizes this typology.

Category	Type	Location	Operation
1. Boarding Assistance Device	Ramp	Platform-based	Manual
			Electro Mechanical (1)
		Vehicle Based	Manual
			Electro Mechanical
	Lift	Platform-based	Manual
			Electro Mechanical (1)
		Vehicle Based	Manual (1)
			Electro Mechanical
2. Level Boarding	This consists of adjusting the platform heights to the same elevation as the rolling stock floor, which eliminates the need to step-up into the vehicle.		
Note: (1) Included in chart, but no known examples were found in the research.			

Table 1: Boarding Accessibility System Typology

It is difficult to develop a standard accessibility solution for railways because of the huge variety in rolling stock and platform heights. Even on a single railway line several different types of rolling stock may be used and platforms may have different heights and profiles. Moreover, the physical dimensions of rolling stock (e.g. height) can also vary depending on its occupancy and wear. Designers must also consider a safety margin between the train and platform to account for train rocking etc. Finally, accessibility devices must work under all types of environmental conditions (e.g. rain, snow, etc.).

The following sections describe examples of these accessibility solutions and outline some of their key characteristics. An excellent summary of how European railways are providing accessibility was developed as part of COST 335 which was completed in 1999. [1] [4]

2.3 Ramps

Ramps are generally the simplest and least expensive BAS devices. However, they can only be used if the vertical difference between the platform and vehicle floor is not significant, since otherwise the ramp slope would be too great to use safely. Most ramps cannot be operated without the assistance of rail operator staff, which is a significant disadvantage.

There are five different types of ramp based BAS solutions: platform-based manual ramps, vehicle-based manual ramps, vehicle-based electro-mechanical ramps, vehicle-based horizontal gap closure ramps and platform-based horizontal gap closure devices. Finally, there is a special case of a high platform/low platform ramp combination. Each solution is outlined below.

Platform-based Manual Ramps

Platform based manual ramps are movable ramps located on station platforms. They require staff assistance to operate, a key problem. Figure 1 illustrates deployment and use of a manual ramp in Minsk.

Manual ramps must have an ergonomic design both for the users' comfort, but also to ensure good operating conditions for the train staff (weight, maneuverability, etc.). If the boarding assistance devices are easy to handle, staff will be more willing to use them.

Figure 1: Platform-based manual ramps in Minsk.

Vehicle-based Manual Ramps

Vehicle-based manual ramps are ramps that are located on the vehicles. They also require the assistance of rail operating company staff to deploy and use. The advantage of vehicle-based ramps is that they provide accessibility to all stations since they are on the train. The ramps may be permanently attached to the vehicle or simply stored on the vehicle.

The Austrian Federal Railways (ÖBB) uses both types of vehicle-based ramps. The ÖBB uses fixed ramps on their low floor coaches. These ramps are attached to the vehicle on one side of the door as shown in Figure 2. In general the fixed ramps are better than mobile (platform-based) ramps since they are more stable as well as being faster and easier to deploy and use.

Ramp in vehicle. | Ramp being unlocked. | Ramp being deployed. | Ramp deployed.

Figure 2: Austrian Federal Railways vehicle-based manual ramp.

Vehicle-based Automatic Ramps

Vehicle-based automatic ramps are ramps carried on the transit vehicles that can be deployed simply by pressing a button. Automatic ramps can be installed under or in the vehicle floor. Figure 3 illustrates a vehicle based automatic ramp.

Figure 3: Vehicle-based automatic ramp.

Vehicle-based Automatic Horizontal Gap Closure Ramp

Many rail transport systems with level-boarding have the problem that the horizontal gap between the platform and the vehicle floor is too wide for comfortable and safe access (this gave rise to the famous London Underground slogan “mind the gap”). This is especially true for stations built on curves.

Many new rail vehicles (railroads, metros, trams) use vehicle-based horizontal gap closure ramps to address this problem. These ramps deploy automatically when the vehicle doors open and retract when the vehicle doors close. The ramps can also adjust for minor height differences between the platform and rail vehicle floor.

Platform-based Automatic Horizontal Gap Closure Ramp

In some older rail systems platform-based electro-mechanical ramps are used to reduce horizontal gaps. Perhaps the most famous example is on the New York Subway’s City Hall Station in Manhattan. The station is built on a sharp curve and the platform has a metal grating that moves towards the rail vehicles once the train has stopped in the station. It is a relatively slow system but has been in operation for almost 100 years.

High Platform – Low Platform Hybrid Ramp

The University of Pennsylvania has developed a hybrid boarding system for the Southeast Pennsylvania Transport Authority commuter rail system. The system rotates the stairs into a level boarding platform for high level platforms and includes a horizontal gap closure bridge. The system allows passengers to board using the steps at low platforms and via the platform device at high level platforms. While this system is a very clever approach for SEPTA's particular railway, as it is currently designed, it would not provide accessibility for mobility impaired passengers at stations with low platforms nor would it address the problem of varying high platform heights since its design is based on a specific high platform height. [5]

2.4 Lifts

Lifts are mechanical lifting devices either attached to the vehicle or placed on the platform. Lifts are used in cases where the difference in height between the platform and rail vehicle floor would create a slope that is too great for ramps.

A key advantage of lifts is that they are very flexible. Platform-based lifts can adapt to almost all types of rolling stock and stations since they can be moved around on the platform and can bridge variable horizontal gaps as well as vertical changes. Similarly, vehicle-based lifts can adapt to many different platform heights. While lifts are very popular, they have several disadvantages including:

- Most lifts are oriented almost exclusively for wheelchair users, making it difficult for other passengers with mobility difficulties (e.g. persons with baby carriages, elderly, etc.) to use them.
- Lifts block the entire train entrance. This can increase station dwell time by interfering with other passengers boarding and alighting.
- Lifts can make users feel conspicuous, creating negative social feelings.
- Electro mechanical (i.e. non human powered) lifts are expensive to buy and maintain (which reduces willingness of railways to implement them).

Platform-based Lift

Figure 4 illustrates two platform-based lifts. Platform-based lifts are operated by railway operator staff and are often pushed around the platform to the train door and then hand-cranked. Similar to manually deployed ramps, these lifts must be ergonomically designed, not only for the user, but also for the staff who must move and operate the lift.

Figure 4: Platform-based manual lift.

There are a wide variety of platform lifts available. They differ in terms of maximum lift capacity, lift method (hand crank, foot pedal hydraulic drive and battery assisted hydraulic drive, etc.). The main problem with these lifts is that they all require the assistance of staff to operate. [6]

Vehicle-based Lift

Vehicle-based lifts are connected to the rail vehicle and normally require assistance from railway staff to operate. Most vehicle-based lifts are mechanically powered.

The Caltrain commuter rail system on the San Francisco Peninsula uses mechanical lifts on some trains. On these trains, a coach with a mechanical lift is included in the train at the same relative location (second coach from the north). [7]

The ÖBB will use a similar type of mechanical lift on its new railjet high speed train. The lift must be operated by ÖBB staff. The lift is electrically driven, but can be operated with a hand pump in emergencies.

The Regina Crusaris (Sweden) designed by Bombardier provides a lift integrated in the train to provide improved access (Figure 5). This lift is particularly interesting since it is contained totally within the rail vehicle.

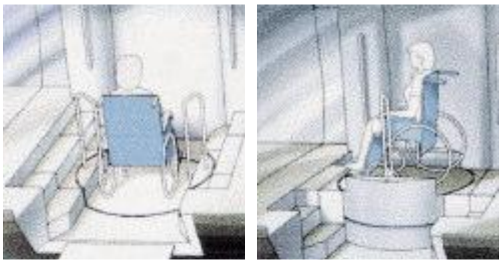


Figure 5: Integrated vehicle-based mechanical lift in Regina Crusaris train.

3. VIENNA UNIVERSITY OF TECHNOLOGY STUDENT COMPETITION

In 2006, the Austrian Federal Railways together with the Institute for Railway Engineering of the Vienna University of Technology organized an engineering student competition to develop new ideas for improving accessibility to railway vehicles. The project's main goal was to develop new solutions for improving accessibility, but the project also helped teach students techniques for accessible design throughout transport networks.

The goal of identifying new solutions came about since many designers are so focused on their work that they can be blind to new and creative ideas for improving the boarding and alighting process for mobility impaired passengers.

The following section describes the competition process. It is followed by a description of some of the best competition entries.

3.1 Competition Process

The competition was opened to everyone in Austria under the age of 35. The main goal was to obtain creative new conceptual ideas for increasing rail vehicle accessibility by inviting young people from all different disciplines to think about the problem. A second very important competition goal was to sensitize young people to the special problems and needs of providing accessibility to the mobility disadvantaged.

The first part of the competition consisted of providing participants with detailed information about railway operations, facilities and rolling stock, as well as on the special needs of different kinds of reduced mobility passengers. This also included tours of railway stations organized with experienced technical staff from the railway. The goal was to ensure that ideas developed in the competition could be implemented. All the information was public and available on a competition web page.

During the competition the Institute for Railway Engineering at the Vienna University of Technology provided help for participants over the telephone and via e-mail. Institute staff either answered the questions or forwarded them on to experts of the ÖBB.

Participants had two and a half months to develop and submit their ideas. Each participant had to submit a report (maximum length 7 pages), which fully explained the conceptual idea in words and illustrations. Most of the participants worked alone on the projects. But there were also two groups of two people and two groups of four pupils from the same school class.

The competition resulted in 34 entries. The solutions varied widely, but most could be grouped into one of 3 main categories: vehicle based, platform based and non technical solutions. Most of the ideas were for vehicle based systems; they included ideas for adding additional features to existing lifts, new types of lifts, solutions integrated into the steps and ideas of new entrance areas.

The platform based ideas were generally new and advanced design studies. But there were also ideas for incorporating boarding devices into the platform itself. Finally, the non-technical solutions included people providing service rather than new devices or technology.

It became evident that most of the participants were students of technical oriented schools or universities who had both a technical feeling for the problems and for developing practical solutions.

A jury evaluated the entries. It consisted of 5 ÖBB staff members (including the ÖBB's accessibility coordinator), the TUV Railway Engineering Professor, experts from the transport ministry (BMVIT) and experts from Austrian handicapped organizations. The judges were highly qualified experts and together covered railway operations, infrastructure, rolling stock and accessibility. The judges evaluated entries using the following criteria:

- Creativity
- Chance of technical realisation (complexity)
- Ease of operation
- Maintainability
- Reliability
- Cost effectiveness
- Safety

The jury considered each entry and ultimately ranked the top entries based on how well they met the criteria.

The top five entries were awarded cash prizes. The winner received 4,000 EUR the others reduced amounts. The award ceremony was attended by more than 150 persons and the awards were presented by the managing director of the ÖBB's passenger traffic company.

Since the competition, the ÖBB has been looking at some of the best ideas in more detail. As is evident in the descriptions below, most of the entries described conceptual solutions and therefore require significant engineering development before they could be implemented. However, the entries did provide several interesting ideas that can be used to improve accessibility. The competition results are outlined below.

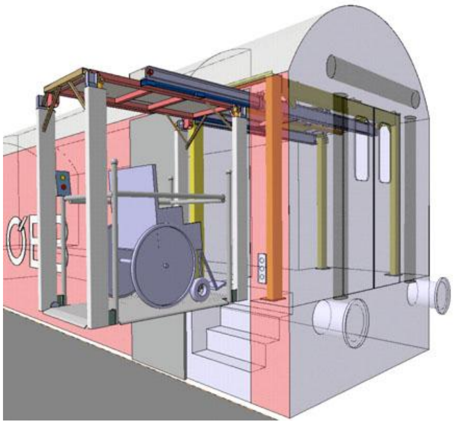
3.2 Vehicle based boarding assistance systems

Many of competition entries (20 out of 34) proposed vehicle-based boarding assistance systems some of them similar to today's “classical” boarding lift. These types of lifts offer the big advantages that they are well known and relatively safe to use and operate, but have the disadvantages described in Section 2.4. The competition entries used different techniques to address these problems. Several tried to make the devices more efficient and faster. Others tried to increase the number of people who could use the lifts by adding devices like tip-up seats on the lift. Three interesting ideas from the competition are outlined below.

Alternative vehicle based boarding assistance systems

Figure 6 shows an interesting idea for a vehicle-based mechanical lift. The lift uses the same mechanical lifting equipment on both sides of the coach. The lift mechanism is mounted on cross bars attached to the coach ceiling. This is an advantage since only one lift is required and the coach can be used at platforms on both sides of the car.

However, the two-sided device still blocks the coach entrance and it would be difficult to install in the restricted space available in normal entrances. Therefore, a compromise solution was developed to install this system on the ÖBB's open saloon coach with baggage compartment (shown in right side of Figure 6).



Wide doors on existing baggage car.

Two-sided vehicle based lift.

Figure 6: Two-sided vehicle-based lift and possible location on baggage car.

These coaches have a wide door on both sides of the vehicle. One advantage of installing the two-sided lift in the baggage coach is that it can be much wider which means that it could be used by other types of mobility impaired passengers (e.g. elderly). Furthermore, the lift would not block a conventional entrance.

The disadvantage of using the baggage car opening is the negative impression of being associated with a baggage car (i.e. treating mobility impaired persons as if they are baggage). This could possibly be addressed by fully renovating the car to include facilities for all types of mobility disadvantaged passengers (e.g. space for large luggage, accessible toilets, etc.).

Lifts integrated in the steps

Several competition entries proposed to integrate lifts into the vehicle steps. Figure 7 shows one conceptual design. There were other similar ideas including foldable steps that can be configured as a lift.

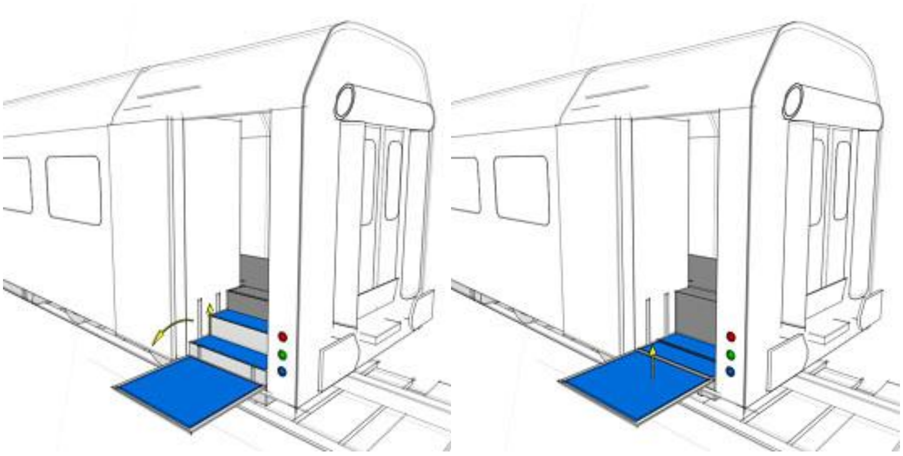


Figure 7: Vertical moveable steps build a lifting ramp.

Unfortunately these ideas would be very difficult or impossible to implement on existing coaches because of the vehicle structure. Another disadvantage is that it requires some device for bridging the horizontal gap and that it can be complicated to design in cases where platform heights vary significantly.

While these types of systems are difficult to implement on existing rolling stock, they are an interesting solution for new vehicles. As shown in Figure 5, a similar system has been installed in the Swedish Regina Crusaris designed by Bombardier. A similar system (without the lift) has been used by the San Francisco Municipal Railway's light rail vehicles for many years; in these vehicles the steps mechanically rise to provide level boarding at high level stations.

Alternative entrance areas with level boarding

The third main type of vehicle-based solution consisted of conceptual designs for providing alternative entrance areas. Again, the idea behind the competition was to seek creative solutions and looking beyond the traditional vehicle entrance helped broaden the perspective solutions.

One very simple idea submitted in the competition was to place a low floor vehicle in the middle of a conventional train similar to what is done on many light rail systems. The low floor coach could provide level boarding for everyone including elderly, wheel chair users, people with heavy luggage or baby carriages etc. This coach could also be designed to provide appropriate space for all these users (i.e. wheelchair spaces, luggage racks) and services such as accessible toilets. This is exactly the solution used on several US regional railways including some of Caltrain's trains. [6]

This solution does provide accessibility, but it imposes constraints on operations and passengers who use the accessibility systems. For example, passengers needing to use the accessible cars must wait in a specific place on the platform and all stations must be adjusted in the same relative locations (so the accessible car stops at the right part of the platform). Furthermore, platforms (or parts of platforms) must be adjusted so that they are the same height as the low floor coach. However, in spite of these problems, adding a low floor coach to each train is a quite good solution when possible.

3.3 Platform based boarding assistance systems

The second main category of competition entries was for platform-based boarding assistance systems (12 of 34 entries proposed these systems). There were two main types of ideas: platform-based BAS similar to today's hand cranked manual systems; and, second, systems that were integrated into the platform itself. Both types are outlined below.

Movable platform based boarding lifts

As was true for the vehicle-based BAS, many of the ideas submitted for platform based boarding devices are similar to current solutions such as hand cranked manual lifts. The main advantages of these systems are that they are the least expensive and safest solutions currently on the market. Therefore they are very popular with railway operators.

However, these BAS have several disadvantages. Similar to vehicle-based lifts, they are only designed for wheel chair users, they block the whole entrance when they are used and they take a long time to operate.

The ideas submitted for improved platform-based movable lifts can be split into two groups. The first one tries to improve the image of these BAS by making an attractive design and the second adds features to make them handle more easily and make them useable for a larger number of passengers.

Figure 8 shows an example of how a manual lift can be made more attractive. It is important that boarding devices need not only to be functional. An attractive design reduces the fears of many wheel chair users that they will be conspicuous when they are moved into the coach by an old hand cranked lift. The design shown is modern, everyone wants to use it. And it works for other passengers in addition to wheel chair users.

The idea behind this concept is to have a modular device that can be provided with an automatic or with a hand cranked lift. The device’s sidewalls could be used for lighted advertisement and so on. The system would be parked on the platform similar to luggage trolleys and could be used by everyone on their own. After being used to board the train, the device would use an internal guidance system to automatically return to its storage location. There are many interesting ideas in this concept. While all of them might not be realizable, the basic idea of making manual lifts more attractive (and thereby dignifying the boarding process) is excellent.

Figure 8: Attractive design solution for platform boarding devices.

The second main group of improvements to movable manual lifts consisted of developing ideas that could improve the ability to use the lift in different situations. A good example is illustrated in Figure 9.

Figure 9 shows a concept of a rotate-able lift. This construction can be used on very narrow platforms because it is possible to go on the lift in parallel direction to the train then make a 90° rotary lift up and board the train.

Figure 9: Rotate-able manual lift.

Platform integrated boarding devices

The second idea for improving platform-based BAS was integrating the boarding devices into the platform itself. While this idea is not new, it is interesting. The basic idea is that a section of the platform itself could be moved up or down so that it provided level boarding with whatever type of rolling stock was being used on the train. Ramps can be used to provide access from the actual (non moving) portion of the platform to the moving part.

This type of solution has several advantages. First, it improves access for all types of mobility impaired passengers from wheelchair users to people with baby carriages. Second, level boarding can speed the boarding process especially when combined with wider doors. However, it has the disadvantages of high cost and mechanical complexity. Furthermore, as a platform-based solution, it provides no guarantee that if you can get on a train in one station that you will be able to get off in another (i.e. a station with a different BAS or no BAS). Figure 10 illustrates one of these solutions. This solution combines a mobile lift and ramp. It has the advantage of being able to be used by everyone, but the disadvantages of blocking the entrance door and taking-up a lot of space.

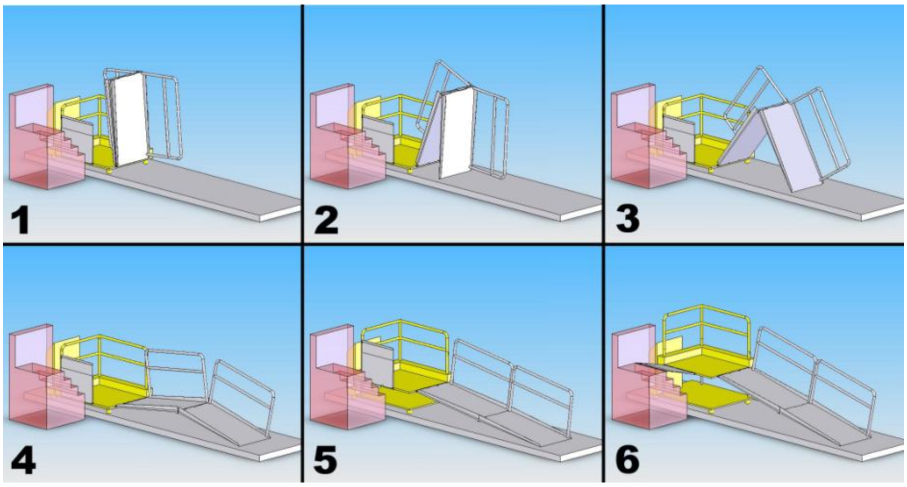


Figure 10: Combination ramp-lift accessibility solution.

3.4 Alternative non technical solutions

Most of the ideas submitted were technical solutions for improving accessibility. However two ideas were non technical. They consisted of providing people to help mobility impaired passengers into trains. This is the approach used today; railway employees operate the lifts and ramps. The new ideas consisted of using either persons doing community service (Zivildienst) or passengers (who would be rewarded for helping with e.g. coupons for discounted trips).

The Zivildienst approach would be expensive since railways would need to have another person at each station. The fellow passenger approach would be hard to depend-on (what if no one were willing or able to help?), would take longer (it's unreasonable to expect that the passengers would be trained in the use of lift devices), and would raise liability issues if the helper or mobility disadvantaged person were injured (issues different from those faced if a person trained and employed by the railway or Zivildienst offers help).

Finally, a key problem with using people is that it is undignified and stigmatizes those who need to ask for help. While it's possible that an approach where the 'helpers' would always offer help just as a hotel doorman does (rather than waiting to be asked) could reduce this problem, the ultimate goal is independence for mobility disadvantaged and independence rules out the use of people helping. (Although, clearly, people are needed today to operate the existing lifts, which is a recognized disadvantage of existing systems.)

4. CONCLUSIONS AND RECOMMENDATIONS

This paper describes results of a competition held to identify new and innovative ideas for improving accessibility to rail vehicles. The young people participating in the competition developed 34 ideas for improving access and the competition helped focus attention on the need to improve access to rail transport in Austria.

Most of the most feasible ideas developed in the competition are refinements of existing ideas. This was partly the result of requiring that new ideas be compatible with the existing rolling stock and station facilities. While this requirement limited the range of ideas that could be developed, none the less many of the ideas were creative and helped focus attention on ways to improve the existing systems for improving access to rail vehicles. The most interesting ideas to come out of the competition were:

- Using good design to reduce the negative image of existing manually cranked platform-based boarding assistance systems;
- Rebuilding existing baggage cars to combine the two-sided vehicle-based lift and facilities for all types of mobility impaired passengers in the remodeled car; and
- Adding new low floor cars with facilities for all types of mobility impaired passengers to trains made-up of existing coaches (an idea often used on LRT systems),

In addition to developing interesting ideas for improving access to rail vehicles, the competition helped the participants gain a better understanding of the issues involved in providing improved access to rail systems and of its importance in society. Finally, the competition generated publicity that helped raise the issue of access by mobility impaired persons to the general public.

The competition organizers make the following recommendations for others planning to hold similar competitions:

- Make use of the young peoples' high motivation and creativity to gain new insight on problems because experts often are often blind to new ideas.
- Involve young people from different backgrounds rather than only engineering students, since cross-fertilization leads to more ideas and everyone should be exposed to the need for improving accessibility.
- Provide competition entrants with as much detailed information about the topic and the technical basic conditions as possible in order to gain realistic solutions.
- Do not restrict ideas too severely; otherwise the opportunity for creativity is reduced. Furthermore, often ideas that cannot be immediately implemented can be the basis for new research.

- It is important to have well qualified experts to help prepare the program information and to judge the competition entries.

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