Designing city buses with the elderly user in mind

MATILDA SVÄRD
Designing city buses with the elderly user in mind

Matilda Svärd
Abstract

Sweden is a country with an ageing population and as the number of older passengers increase in the future, so will the demands on public transportation. Today elderly persons often experience difficulties when using public bus services. Aside from issues caused by reduced mobility related to ageing reasons, stressful situations, an increased risk of accidents and unequal terms also become barriers making it hard for elderly persons to travel. This project aims to improve the city bus experience for elderly passengers by establishing guidelines for how vehicles can be designed to prevent accidents, reduce stress and support equal terms. To be able to find the deeper cause of stress, accidents and unequal terms, a holistic approach considering city buses in the context of the entire transportation system was adopted.

To develop the guidelines, literature- and user studies were conducted and analysed to find both measures that could contribute to reduced risks and stress, as well as measures to support equal terms. Three main themes were found that describe why and how elderly persons want and need to travel: Independence, Social well-being and Co-existing flows. Based on the findings, design directions to inform vehicle design were developed.

To reduce stress and prevent accidents for elderly passengers on city buses, key measures were found to be to allow passengers to travel at their own pace, to provide passengers with space adapted for them that they have the right to claim, to make sure that passengers can safely bring belongings, to make sure that passengers can have contact with the driver and to allow passengers to use their own personal techniques to make difficult situations easier and safer.

To support equal terms for elderly passengers on city buses, key measures were found to be to make it possible for elderly persons to travel without help or having to accept special treatments, to make it possible to safely bring mobility aids and shopping trolleys, to make it possible for elderly passengers to socialize with each other and with the driver, to allow elderly passengers to travel at their own pace and to provide them with space adapted for them that they have the right to claim.

The final guidelines were created by summarizing the main findings of the project in the form of a brief visual document. To clarify how the guidelines are to be used, three design concepts were also developed as applied examples.
Sammanfattning

Sverige har en åldrande befolkning och i takt med att antalet äldre passagerare ökar, ökar även kraven på kollektivtrafiken. Äldre med rörelsehinder upplever idag ofta svårigheter när de åker buss. Förutom svårigheter relaterade till nedsatt rörlighet på grund av åldrande, kan stressiga situationer, ökad risk för olyckor och ojämlika villkor skapa hinder som gör det svårt för äldre att resa. Målet med det här projektet är att förbättra stadsbussupplevelsen för äldre passagerare med rörelsehinder genom att utveckla riktlinjer för hur stadsbussar kan designas för att förebygga olyckor, stress och för att stödja jämlika villkor. För att kunna hitta djupare orsaker bakom stress, olyckor och ojämlika villkor har ett helhetsperspektiv där bussen betraktas i sammanhanget av hela transportsystemet använts.

För att utveckla riktlinjerna har litteratur- och användarstudier genomförts och analyserats för att hitta åtgärder som kan bidra till att minska risker och stress, så väl som åtgärder för att stödja jämlika villkor. Tre huvudsakliga teman hittades som beskriver varför och hur äldre villkor är: 

1. Socialt välmående
2. Självständighet
3. Samexisterande flöden.

Beräkningar och iakttagelser har gjorts på att utveckla designkriterier för fordonsdesign. För att minska stress och förebygga olyckor på stadsbussar är nyckelåtgärder att låta äldre passagerare resa i sin egen takt, att erbjuda utrymme anpassat för äldre passagerare som de har rätt att göra anspråk på, att se till att äldre passagerare kan resa säkert med sina tillhörigheter, att sees till att äldre passagerare kan ha kontakt med föraren, samt att äldre passagerare kan använda sina personliga tekniker för att underlätta svåra situationer.

För att stödja jämlika villkor på stadsbussar är nyckelåtgärder att göra det möjligt för äldre med rörelsehinder att resa utan hjälp och utan att behöva acceptera specialbehandlingar, att göra det möjligt att ta med rörelsehjälpmedel och dramatenväskor på ett säkert sätt, att göra det möjligt för äldre med rörelsehinder att socialisera med andra passagerare och med föraren, att låta äldre passagerare resa i sin egen takt, samt att erbjuda utrymme anpassat för äldre passagerare som de har rätt att göra anspråk på.

De slutgiltiga riktlinjerna skapades genom att sammanställa de huvudsakliga resultaten av projektet i form av ett kortfattat visuellt dokument. För att tydliggöra hur riktlinjerna ska användas utvecklades även tre designkoncept som tillämpade exempel.
This master thesis project was made as the final part of the Industrial Design Engineering track of the Design and Product Realisation engineering program at KTH in Stockholm. The project was made on behalf of Scania Physical Vehicle Ergonomics.

First of all I would like to thank Fredrik Pehrsson and Scania for entrusting me with the precious opportunity to do this project. During the project I have had the pleasure to work with some amazing people.

I would especially like to thank my KTH supervisor Teo Enlund for inspiration and guidance and my Scania supervisor Maria Jönsson for support, motivation and valuable advice.

Thank you to Stefan Uddholm for your help and support and to Nils Åkerman and Linus Ährlig for your input on vehicle construction.

Thank you also my dear colleagues at Scania Physical Vehicle Ergonomics for your encouragement, support and great company.

And finally to all the people who have contributed to the project with their city bus experiences, opinions and thoughts. Thank you for your time and thank you for being willing to share your stories with me.

Matilda Svärd
Stockholm, June 2017
Listed below are abbreviations and terms used in the report.

**Abbreviations**

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAD</td>
<td>Computer Aided Design</td>
</tr>
<tr>
<td>RKM</td>
<td>Regional Public Transportation Authority</td>
</tr>
</tbody>
</table>

**Terms**

<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Articulated vehicle</td>
<td>A vehicle which consists of two or more rigid sections, which articulate relative to one another.</td>
</tr>
<tr>
<td>Service door</td>
<td>Door intended for use by passengers in normal circumstances with the driver seated.</td>
</tr>
<tr>
<td>Mobility</td>
<td>A person’s possibility and ability to travel, travel options and active traveling patterns.</td>
</tr>
</tbody>
</table>
# TABLE OF CONTENTS

1 INTRODUCTION ........................................................................................................... 1
  1.1 Background ............................................................................................................... 1
  1.2 Problem description ................................................................................................. 1
  1.3 Purpose ..................................................................................................................... 2
  1.4 Research questions .................................................................................................. 2
  1.5 Deliverables ............................................................................................................. 3
  1.6 Delimitations ........................................................................................................... 3
  1.7 Risk analysis ........................................................................................................... 4

2 PROCESS & METHODS .............................................................................................. 5
  2.1 Process .................................................................................................................... 5
  2.2 Method descriptions ............................................................................................... 6
    2.2.1 Literature studies .............................................................................................. 6
    2.2.2 User studies and analysis ................................................................................ 6
    2.2.3 Design process .................................................................................................. 7
    2.2.4 Softwares ......................................................................................................... 7

3 FRAME OF REFERENCE ............................................................................................. 8
  3.1 The elderly user ....................................................................................................... 8
    3.1.1 Age categories .................................................................................................. 8
    3.1.2 Biological ageing ............................................................................................. 9
    3.1.3 The elderly and reduced mobility ................................................................. 9
  3.2 City buses ............................................................................................................... 11
    3.2.1 City bus design and operation ....................................................................... 11
    3.2.2 Regulations and industry standard .............................................................. 12
  3.3 Public transportation .............................................................................................. 13
    3.3.1 Accessibility .................................................................................................... 13
    3.3.2 Accidents, injuries and risks ......................................................................... 16
    3.3.3 Stress and time pressure ............................................................................... 18

4 KEY CONCEPTS ......................................................................................................... 19
  4.1.1 Elderly persons .................................................................................................. 19
  4.1.2 Reduced mobility .............................................................................................. 19

5 DEVELOPMENT OF DESIGN DIRECTIONS .............................................................. 20
  5.1 Researching accidents, stress and equal terms ...................................................... 20
    5.1.1 Accidents ........................................................................................................ 20
APPENDIX F – Insights ........................................................................................................... xiv
APPENDIX G – Requirements Entry/exit support ................................................................. xxxiv
APPENDIX H – Cad variations ............................................................................................. xxxv
APPENDIX I – Requirements Walker seat .............................................................................. xxxvi
APPENDIX J – Mock-up ......................................................................................................... xxxvii
APPENDIX K – One vehicle two buses specification ......................................................... xxxviii
APPENDIX L – Simulations .................................................................................................. xxxix
APPENDIX M – Findings from user studies ......................................................................... xlii
APPENDIX N – Guidelines .................................................................................................. xlv
In this chapter the background, purpose, scope and delimitations of the project, as well as a risk analysis are presented.

### 1.1 Background

Sweden today has an ageing population and in 2060 every fourth person is predicted to be over 65 years old (SCB 2017). As the number of older passengers increase, so will the demands on accessibility and safety throughout the public transportation system (Trafikutskottet 2013). Elderly persons today often experience difficulties when using public bus services. Aside from issues caused by reduced mobility related to ageing reasons, stressful situations, the risk of accidents and unequal terms also become barriers making it hard for elderly persons to travel (Berg and Levin 2011). Onboard the vehicle, the environment is perceived as stressful. Passengers are under a lot of time pressure and struggle to have time to board, alight or find a seat before the bus takes off. Outside the vehicle, long walking distances, stairs and unsynchronized connections between services can also become barriers, in some cases ultimately preventing elderly persons from making a journey. Recent reports also show that elderly passengers face higher risks of accidents and sustaining serious injuries compared with younger passengers when traveling by bus (Malmström 2015; Berntman, Holmberg and Wretstrand 2012).

### 1.2 Problem description

Being able to use public transportation is ultimately a question of democracy (Trafikutskottet 2013). Everyone able to get to the bus stop should also be able to use bus services on equal terms, see Figure 1.

![Image: Julia Lindemalm via hd.se](image-url)

*Figure 1. Elderly women at the bus stop with the right to use the bus service on equal terms.*
Elderly passengers however face a more difficult situation than younger passengers and to improve the situation the risk of accidents and stress has to be reduced. To fully support equal terms bus services also have to be adapted to meet the needs of elderly passengers to the same extent that they meet the needs of other passengers. While the root cause of the major problems can only be resolved by multiple public transportation actors working together, re-designing the vehicle in many cases still improve the situation. This project will focus on improving the city bus experience for elderly passengers starting from aspect of vehicle design. To be able to understand and counteract the underlying causes of stress, accidents and unequal terms, a holistic approach considering vehicles in the context of the whole transportation system will also be applied.

1.3 Purpose

The purpose of the project is to improve the city bus experience for elderly passengers by establishing guidelines for how city buses can be designed to prevent accidents, reduce stress and support equal terms.

The guidelines are to mediate basic knowledge and understanding of the city bus experience of elderly passengers as well as how Scania can develop bus designs based on elderly passengers’ wants and needs. To clarity how the guidelines can be used in product development, applied examples in the form of concepts of interior designs will also be developed as a minor part of the project.

The guidelines are not only to inform the physical ergonomics design aspect of vehicle design, but to mediate the findings to all departments whose work in any aspect contributes to the city bus experience of elderly passengers.

1.4 Research questions

The following research questions are asked:

i. How can the city bus front passenger area be designed to reduce stress and prevent accidents for elderly passengers?

ii. How can the city bus be designed to allow elderly passengers to travel on equal terms?

iii. How could the findings of the project be mediated through guidelines in a way relevant for Scania bus development?
1.5 Deliverables

At the end of the project, the following is to be delivered:

i. Guidelines composed of:
   Material illustrating the situation and experiences of elderly city bus passengers
   Proposed design directions
   Applied design examples

ii. Project report

iii. Presentation material

as well as other recommendations relevant to the findings of the project, such as:

iv. Recommendations regarding the ramp

1.6 Delimitations

- The project will only consider the situation in Sweden.
- The project will be focused on improving the front section of the city bus, see Figure 2.
- Elderly passengers traveling with wheelchairs will not be a part of the main focus.
- The design concepts will not include technical solutions and detailed specifications.
- The design concepts are to aim to comply with existing regulations concerning bus design and construction.
- Regulations for cognitive ergonomics, such as displays, graphics, signs etc. will not be considered.

*Image: Scania. Image montage

*Figure 2. The front section of a Scania Citywide bus.*
1.7 Risk analysis

The risk analysis is illustrated in Table 1. Risks are graded on a scale of 1, 3, 9, ranging from 1 (unlikely) to 9 (very likely). Consequences for each risk are also graded on a scale of 1, 3, 9, ranging from 1 (Minor) to 9 (Serious).

<table>
<thead>
<tr>
<th>Risk and action</th>
<th>Risk (1-3-9)</th>
<th>Consequence (1-3-9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not able to get enough / useful user input.</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Action: Make sure to have a wide range of potential sources from the beginning.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project becomes too large.</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Action: Make sure to have clear hierarchies of important and less important tasks.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Split focus, not able to keep focus on the main tasks.</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Action: Make sure to have clear hierarchies of important and less important areas.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Secrecy issues, not able to publish.</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Action: Delay publication.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Too subjective results.</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Action: Make sure to use suitable methods.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not able to present on time.</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Action: Finish the guidelines before summer, present after summer.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lack of substance in results.</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td>Action: Elongate project, consider adding more parts.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In this chapter the overall contents and process of the project are presented, as well as detailed descriptions of the methods used.

2.1 Process

The main steps of the process were to define the project, understand key concepts, to create a frame of reference as well as to develop design directions and concepts to create guidelines. An overview of the contents of the project is illustrated in Figure 3.

![Figure 3. Overall project contents.](image)

To inform the guidelines, literature- and user studies were conducted. To develop concepts to use as applied examples for the guidelines, an iterative design process was used. An overview of the process of the project is illustrated in Figure 4.

![Figure 4. Overall project process.](image)

For an overview of the time schedule, see Appendix A.
2.2 Method descriptions

During the project the following methods were used.

2.2.1 Literature studies

To find relevant articles, reports and other material reviewed during the literature studies, web searches were made on different topics related to elderly persons, city buses and public transportation as well as topics related to the concept development.

2.2.2 User studies and analysis

Two sets of user studies were carried out, the first to get an overview of the focus areas from the users’ perspective and the second to find information related to the concept development. Results of both sets of user studies were used to inform the guidelines.

The following methods were applied during the user studies and analysis:

**Observations** – Observing behaviours or experiences while trying to remain as unobtrusive as possible. (Stickdorn and Schneider 2011)

**Shadowing** – A method where researchers follow users through a scenario to observe behaviours and experiences. (Stickdorn and Schneider 2011)

**Contextual interviews** – An interview conducted in the real environment or context, which allows interviewers to observe and probe behaviours of interest. (Stickdorn and Schneider 2011)

**Unstructured interviews** – Interviews where interviewees are typically asked a series of open-ended questions. (Milton and Rodgers 2013)

**Semi-structured interviews** – Interviews where the interviewer use prompts to ensure that certain specific areas and points are covered, while still allowing unstructured comments. (Milton and Rodgers 2013)

**Trigger material** – Sketches or prototypes visualizing an idea to make it more concrete and real. (Transformator Design 2017)

**Post-it clustering** – Sorting post-it notes with statements from interviews and observations into clusters to be able to form insights around common themes. (Transformator Design 2016)
2.2.3 Design process

For the concept development an iterative design process based on the Double diamond (UK Design Council 2015) was applied, see Figure 5.

![Iterative design process diagram]

Figure 5. Iterative design process.

The following methods were applied during the different stages of the process:

**Brainstorming** – A method to generate ideas individually or by building on to the ideas of others. The aim is to get a large number of ideas and no criticism is allowed. (Österlin 2011)

**Sketching** – Sketching is a development tool that makes it possible for designers to evaluate their ideas on paper and to store or make iterations of concepts. (Milton A. and Rodgers P. 2013)

**Solution matrix** – Different factors are listed along the matrix axes and combined with each other to illustrate possible variations. (Österlin 2011)

**Matrix evaluation** – A method to evaluate ideas through a matrix by scoring different solutions based on how well they meet requirements or criteria. (Österlin 2011)

**Mock-up** – Mock-ups are life-size physical models constructed from easily fabricated materials. (Milton and Rodgers 2013)

**Desktop walkthrough** – A small-scale 3D model of the environment that let designers act out scenarios. (Stickdorn and Schneider 2011)

**3D-modelling** – Drawing three dimensional volumes or surfaces using a 3D-modelling software such as CAD. (Österlin 2011)

**Simulation** – Producing a computer model of something for the purpose of study. (Oxford University Press 2017)

2.2.4 Softwares

*Adobe Photoshop CC*, Adobe (2017)  
*Solid Edge ST8*, Siemens (2016)  
*Keyshot 5*, Keyshot (2015)  
*Pathfinder*, Thunderhead (2015)
3 FRAME OF REFERENCE

In this chapter, the reference material used for the report is presented under the main topics elderly users, city buses and public transportation.

3.1 The elderly user

In this section, different ways of categorizing elderly users is reviewed, as well as medical conditions related to biological ageing and what reduced mobility means for elderly persons.

3.1.1 Age categories

In many official contexts, ‘elderly’ refers to a chronological age category. For example a category of persons who have reached retirement age, cohorts of persons born the same year sharing similar views and values, or generations, persons who have lived through the same period of time (Levin 2007; Berg and Levin 2011). When categorizing by chronological age, the variation of needs and abilities of the individuals in the group however become very widespread. An old chronological age does not translate directly to an old biological age and while some may develop conditions related to biological ageing processes early, others may live healthy their whole lives. An example is illustrated in Figure 6.

![Image: Todd Fraser via New York Times](image)

Figure 6. Old chronological age, young biological age.

To describe a group of individuals with similar needs and abilities, categories can be created by functional age based on personal abilities, including biological-, physical- as well as psychological aspects. Functional age categories are also commonly used in transportation research contexts. (Levin 2007; Berg and Levin 2011)

When integrating functional age and the aspect of social interaction another more holistic kind of category can also be formed. The course of life was once described through three stages; before, during and after work life, “the first-, second- and third age”. As life expectancy has increased and many remain healthy longer, “the third age” has been redefined and a “fourth age” has been added. The “third age” can now be used to describe seniors still heathy and
mobile, while “the fourth age” can be used to describe the stage where one finally becomes unwell and dependent on extra care. (Levin 2007; Berg and Levin 2011)

3.1.2 Biological ageing

Common medical conditions associated with biological ageing include changes in bone-, muscle- and soft tissue, balance ability, eye-sight and hearing, see Figure 7. With increasing biological age, muscle mass decreases causing reduced muscle strength. Soft tissues, such as ligaments and cartilage, become stiffer and the long term wear and tear on joints and cartilage increase the risk of developing arthrosis. Bone density also deteriorates with increasing biological age, according to Vårdguiden (2013) about half of the women older than 80 years old suffer from osteoporosis. As balance ability is reduced, the risk of falling is simultaneously increased. In combination, elderly women are at an increased risk of sustaining fractures when falling. Eye-sight and hearing can also become impaired with increasing biological age, causing difficulties to see clearly without proper lighting and hear speech in noisy environments. General cognitive changes associated with biological ageing include individuals becoming slower and having a harder time learning new things. Memory and perception can also be affected, causing it to take longer to remember things and become harder to interpret sensory impressions (Levin 2007).

Image: Colourbox via Senioren.se (left), Dreamstime via Vetenskap&hälsa (middle and right)

Figure 7. Signs of biological ageing.

The combination of temporary- and commonly occurring conditions can be also be very problematic for elderly persons. As elderly persons might not have the strength to recover completely from a period of temporary illness, the risk of temporary disabilities becoming permanent is higher than for younger persons. (Levin 2007)

With increasing biological age an important tool to keep healthy is physical activity. For example in the form of taking walks, doing gymnastics or gardening work. By maintaining strength and balance ability through physical activity, fall injuries can in many cases also be prevented. (MSB 2015)

3.1.3 The elderly and reduced mobility

In the current age of information technology, society has shifted towards a structure based on a higher level of mobility. Through infrastructure and public transport systems, individuals are provided with possibilities to be mobile with a varying degree of freedom depending on personal capability and available options (Levin 2007). Elderly citizens are in some social and cultural contexts expected to be active and take part in society, but the health effects of ageing may also prevent them from doing so and reduce the number of available options (Berg and Levin 2011). Reduced mobility, is what can be described as limitations in a person’s possibility and ability to travel, travel options and active traveling patterns (Levin 2007).

According to conclusions of the EU-project SIZE (2003) there are two kinds of mobility, “non-arbitrary” and “freedom-of-choice”, suggesting that mobility can be either voluntary or
necessary depending on the direction of the goal. According to Levin (2007) an increased voluntary mobility has in several studies been linked to increased life quality, while necessary mobility can have a negative impact on life quality. If a high level of mobility is required to perform essential activities, elderly persons unable to maintain the required level of mobility risk becoming dependent on help from others. According to Berg and Levin (2011) in some cases the economic cost of mobility or the physical strain of travelling itself can also become a burden. An individual may thereby be required to economize and choose only some trips and when prioritizing, social trips are at risk of being undervalued and skipped in favor of other trips, such as appointments and errands, see Figure 8.

![Image: Svt Nyheter](image)

*Figure 8. Everyday mobility, running errands.*

**Loneliness**

According to statistics from SCB (2012), 32% of everyone above the age of 60 years live alone, including the approximate 5% living in retirement homes. Above the age of 80 years, a majority of women live alone and above the age of 90 years, a majority of men also live alone. When living alone the risk of becoming lonely or involuntary isolated can also increase. Among the risk factors for loneliness are for example physical barriers making a person become unable to freely get in and out of their home, or experiencing a loss of a loved one (Seniorerna 2016). Involuntary loneliness can also have direct implications on health and well-being. According to Peter Strang, professor in palliative medicine, research shows that long term involuntary loneliness can be connected to depression, anxiety and decreased life quality, as well as dementia, cardiovascular disease and an increased risk of dying prematurely (Strang 2015).
3.2 City buses

In this section the design and operation of city buses is reviewed, as well as the current regulations and industry standard for vehicle construction.

3.2.1 City bus design and operation

There are four types of modern buses: City or transit, suburban, intercity or tour and school bus (Encyclopedia Brittanica 2017). City buses are designed to be used in urban transportation systems and are characterized by the low-ride platform, low maximum speed, accommodation of standing passengers and wheelchairs, as well as several doors on the curb side, low-back seats and no luggage space. Suburban buses are similar to city buses, but are also adapted for shorter intercity trips and therefore have high-back seats and luggage space.

Two common platforms for city buses are Low Floor (LF), with a single low-ride platform throughout the vehicle, and Low Entry (LE), with a low-ride platform in the front section of the vehicle, illustrated in Figure 9.

![Image: Scania. Image montage](Figure 9. LF (left) and LE (right) floor types.)

Depending on the conditions of the urban environment the length of buses can vary, ranging from shorter rigid vehicles to longer articulated vehicles, see Figure 10.

![Image: Scania.com](Figure 10. Shorter rigid city bus (above). Longer articulated city bus (below).)

For information about Scania city buses, see Appendix B.

City bus operation

In the application of city and suburban transport, city buses are commonly used within public transportation systems. In Sweden public transportation is divided into two segments, the general public transportation obligation, Allmän trafikplikt, contracted by the regional public transportation authority, RKM, and commercial public transportation contracted and operated by commercial actors (SLL 2017a). The RKM plans, contracts and reviews the transportation system while detailed planning and operations are carried out by entrepreneurs (SLL 2017b). In Stockholm, the entrepreneurs currently operating SL, Storstockholms Lokaltrafik, bus services are Arriva, Keolis and Nobina.
3.2.2 Regulations and industry standard

City bus design and construction in Sweden is currently regulated by the European Union through ECE-R 107/06 (2014). Recommendations are also provided through the common industry standard Buss 2014 (Partnersamverkan 2014).

ECE-R 107/06

The general requirements for approval of vehicles adopted by the European Union were first issued through the 1958 Agreement of technical harmonisation of vehicles by the United Nations Economic Commission for Europe, UNECE. The requirements serve to eliminate technical barriers in trade of vehicles worldwide, as well as to ensure a high level of safety, environment protection, energy efficiency and protection against theft. (European Union 2014)

Buss 2014

“Buss 2014 – Branschgemensamma funktionskrav på bussar” (Partnersamverkan 2014) is the current industry standard for buses in Sweden. It was commissioned by Partnersamverkan, an organisation comprised of the national public transportation organisations, and developed by Svensk Kollektivtrafik and Sveriges Bussföretag. The standard describes common functional requirements agreed to be of interest for the passengers, in addition to the current legislation. The purpose of the standard is to provide parties contracting entrepreneurs for bus services with recommended requirements regarding safety, seats, boarding and alighting, comfort, communication, exterior features and the driver’s working environment.
3.3 Public transportation

In this section, accessibility of public transportation is reviewed. Accidents, risks and injuries of older passengers traveling with public bus services are also addressed.

3.3.1 Accessibility

To make public transportation usable for persons with reduced mobility is ultimately a question of democracy, but there is still a lot left to do in order to make public transportation accessible for everyone (Trafikutskottet, 2013). Overall, public transportation is still mainly adapted for the needs of the working community, but there are also examples of services that are designed to accommodate more a diverse range of passengers, such as SL Närtrafiken (SL 2017). For recent development in policy, see Appendix C.

"The whole journey"

In order to make the public transportation system accessible and useful for elderly persons with reduced mobility, it is important to consider all parts of the transport chain (Berg and Levin 2011). For example, long distances or stairs at connection points and unsynchronized timetables can become barriers preventing persons from traveling. Barriers can also be located outside of the public transportation system, for example walking paths suddenly ending in a height difference or stairway. Trafikutskottet (2013) also underlines the importance of that the whole journey works the whole year around, see Figure 11.

![Image: Niklas Larsson/TT via Sesam.nu](Image: Niklas Larsson/TT via Sesam.nu)

Figure 11. Walker user in snow.

To achieve a public transportation system that is easy to use and efficient through the whole journey, information systems, timetables, taxes and physical environments need to be coordinated (Regeringen 2003). Since transportation is a complex area where many different actors with different roles and responsibilities are involved, it is absolutely necessary that the branch and other actors cooperate in order to make the whole journey work (Trafikutskottet 2013).
Vehicle design

When it comes to accessible vehicle design, efforts are continuously made to make vehicles accessible for persons with reduced mobility (Trafikutskottet 2013). Features considered to be necessary to accommodate passengers with reduced mobility are regulated by the EU framework ECE 107/06 (2014), requiring specific means for accommodation of passengers with reduced mobility, wheelchairs and prams or push chairs. Some guidelines for accessibility are also provided by the industry standard, Buss 2014 (Partnersamverkan 2014).

When contracting entrepreneurs for public transportation, RKMs may also have other special requirements. In Stockholm, requirements on accessibility are described in RiTill (SL 2012), a summary of legal requirements and guidelines for SL operators. The new Tvärbanan car model A35 is an example of accessible vehicle design contracted by the terms of RiTill (SLL 2017c), see Figure 12.

Definitions of accessibility

When working on making public transportation accessible for everyone one problem causing confusion in both acting and governing authorities is the absence of a clear definition of what for example a “fully accessible connection point” is (Transportstyrelsen 2016). The definition and practical meaning of the term accessibility can differ between different fields and organizations, even within the handicap movement. According to the Swedish Disability Federation HSO, a central organization representing 39 Swedish handicap organizations, no official definition or common language to describe accessibility has yet been adopted (HSO 2006).

In an article discussing accessibility, usability and universal design a definition of accessibility is put forward by Iwarsson and Ståhl (2003), highlighting important differences between accessibility and usability. Accessibility refers to the user’s ability to meet the functional demands of the environment when aspiring to perform an activity. Accessibility is mainly objective, describing what a user can and cannot functionally do. Usability on the other hand is
mainly subjective and refers to the extent that the user’s need can be fulfilled by performing an activity. It describes how efficient or satisfactory something is perceived to be. While accessibility can be implemented by providing an environment that meets the functional capacities of the user, usability has to be put into context considering the user’s needs, desired achievement and perceived accomplishment. To frame the difference between accessibility and usability the following example (HSO 2006) can also be used:

“It’s not enough to have access to the laundry room if I can’t use the washing machine” – Maria Johansson, DHR Bygg klokt

**Design approaches**

When designing for accessibility and usability, different approaches can be applied. Two of the methods available are traditional accessible design and Universal design. Traditional accessible design originates from the principle of the existence a normal population and a population diverging from normal (Iwarsson and Ståhl 2003). First, the basic design of the product or environment is created and afterwards it is then adapted for the diverging population. Universal design on the other hand, is based on the principle of a single population consisting of individuals with different characteristics and abilities. Universal design describes the concept of designing products and environments to be aesthetic and usable for everyone to the greatest extent possible (NCSU 2008). An example is illustrated in Figure 13.

![Image: Trond Heggem via inclusivedesign.no](image)

**Figure 13. The entrance of St Olav’s Hospital, Norway.**

According to Iwarsson and Ståhl (2003), apart from making things useable for as many people as possible, Universal design is also about changing attitudes in society by emphasizing equal terms, democracy and social inclusion throughout the process. While traditional accessible design promotes exclusion and stigmatization by implementing accessibility measures after the basic design has been created, universal design promotes social inclusion by designing for diversity. A quote by the Swedish Disability Federation HSO can be used to highlight problems of traditional accessible design from the perspective of equal treatment:

“Everyone should be able to go see a soccer match without having to enter through the back door” – HSO (2017)
3.3.2 Accidents, injuries and risks

The Swedish Traffic Accident Data Acquisition STRADA, has since 2003 collected data of injuries and accidents in the entire road transportation system through police and health care sources (Transportstyrelsen 2017).

A brief overview

The following overview is focused on the situation of older passengers and based on two reports. “Hur säker är bussen? Skador och risker i samband med bussresor i tätort.” by Berntman, Holmberg and Wretstrand (2012) is the first, focusing on the Helsingborg, Kristianstad, Lund and Malmö area using data from STRADA as well as survey responses and “Sjukvårdsrapporterade olyckor ombord på buss inom Stockholms län under perioden 2011–2013 – en översikt” by Malmström (2015) is the second, focusing on the Stockholm region using data from STRADA. A more thorough comparison can be found in Appendix D.

Both reports found older passengers to be the more likely to sustain injuries than younger age groups. Women were also found to be more likely to get injured than men. According to Malmström (2015), the increased risk for older passengers can also be underlined by that while almost half of the injured passengers were 65+ years, only 4% of the SL passengers during 2013 actually belonged to the age group (SL 2013), see Figure 14.

According to both reports, slight injuries were the most common, but in the group that did sustain more serious injuries older passengers were overrepresented. In the Stockholm region a clear majority of the serious injuries were fractures of the lower extremities, such as hip, femur, knee and foot fractures and hip- and femur fractures exclusively found in passengers over 70 years old (Malmström 2015).
The majority of injuries were sustained when passengers were on board the vehicle and due to sudden decelerations or accelerations. According to Berntman, Holmberg and Wretstrand (2012), most fall accidents caused by sudden decelerations were sustained by passengers standing or getting up from the seat. However, cases where a seated passenger was injured due to a sudden deceleration also occurred. Almost half of those injured while on the bus were older than 75 years and many of the injured older passengers had walkers to maneuver onboard.

Injuries were also found to be sustained when boarding and alighting. According to the survey responses (Berntman, Holmberg and Wretstrand 2012), sustaining an injury while alighting the bus was twice as likely as when boarding. The oldest passengers experienced a lot of difficulties while alighting, especially if the bus had stopped far from the curb. The height difference was described as a contributing factor to accidents, along with snow and slippery conditions. According to Malmström (2015), passengers also described becoming injured when doors closed on them, either due to getting stuck or falling over as a result of getting pushed.

When considering other parts of the transportation chain in the areas in the south of Sweden, Berntman, Holmberg and Wretstrand (2012) also highlighted that the transport to and from the bus stop is a critical part of the chain and increases the total risk of injury of the whole trip substantially.

**Suggested improvements**

Through the survey by Berntman, Holmberg and Wretstrand (2012), more than half of the respondents provided suggested improvements for how the accident could have been prevented. In many cases passengers said that the accident could have been prevented by the bus standing still until everyone was seated. Another recurring theme involved the bus driver and a need for the driver to be more observant. All of the most common suggestions were related to the driver and the behavior of the driver, such as waiting until passengers are seated, being more observant, reducing stress, driving more smoothly, placing the vehicle closer to the stop and providing better support in case of an accident.

Suggested improvements were also put forward by Berntman, Holmberg and Wretstrand (2012) regarding re-designing timetables to cause less time pressure and encouraging drivers to be more observant and show more consideration, especially to the elderly, see Figure 15.

![Image: Fredrik Sandberg/TT via sr.se](Image: Fredrik Sandberg/TT via sr.se)

*Figure 15. Driver showing consideration by stopping the bus close to the curb.*

Regarding the interior design of the vehicle, Berntman, Holmberg and Wretstrand (2012) also suggest that measures are needed to make sure that the bus interior design will not make injuries sustained in a fall accident worse because of placement or shape of interior details.
3.3.3 Stress and time pressure

In a public transportation context, stress can in many cases be caused by trying to keep up with time pressure. According to Berg and Levin (2011) elderly persons also describe being under a lot of pressure to be able to board and find a seat before the bus takes off. Among the survey respondents of Berntman, Holmberg and Wretstrand (2012) especially older persons above the age of 75 were the ones who found it hard to cope.

Stress can sometimes also be caused by fear or worries. According to Berg and Levin (2011) elderly persons described that after hearing stories of others getting injured, they themselves also started to worry about having accidents.

For elderly persons, another thing connected to stress is feeling unable to meet one’s expectations on oneself. According to Bo Netterstrøm, senior stress researcher at Bispebjerg Hospital, a lot of persons over the age of 75 experience stress when feeling unable to do something they expect themselves to be able to do, but fail do because of poor health. (Felholt 2014)
Two concepts central to the project are “elderly” and “reduced mobility”. To arrive at a clear understanding of who belong to the user group, as well as what reduced mobility means for them, the first step of the project was to research and define the two concepts.

4.1.1 Elderly persons

To find out what is commonly referred to by the term “elderly”, literature studies were conducted on different ways to categorize elderly users. Ideally, the target group would include all users with reduced mobility related to biological ageing. To also include users with reduced mobility related to biological ageing of younger ages than normally considered “elderly”, the initial attempt to define the target group was by a large chronological age span, persons 55+ years with reduced mobility. However, when defining the group only by chronological age and reduced mobility, the group would still include persons that might not necessarily identify with being “elderly” and persons with reduced mobility due to temporary reasons. Among the other options found were functional age as well as “the third and fourth age”. The last option was found to be very relevant to define a group of users with reduced mobility that in a social context could identify with being “elderly”.

The target group “elderly passengers” was in the end defined as persons of the fourth age still able to transport themselves to a bus stop, as well as persons in the process of crossing over from the third age to the fourth age with some degree of reduced mobility.

4.1.2 Reduced mobility

To get deeper insight to what reduced mobility means for elderly persons, research on medical conditions related to biological ageing as well as on the living situation of elderly persons was conducted. Elderly persons were found to be required to be mobile to get through many parts of everyday life, but eventually their health would prevent them. Many elderly persons were found to live alone and when becoming immobile they also risk becoming isolated and lonely. Long term involuntary loneliness could then also have serious implications on health when they miss out on both physical activity and social interaction. In a broad context, public bus services were found to be able to contribute to the physical health of elderly persons, since traveling by bus requires some physical activity and thereby helps users to keep their body in shape. Bus services were also found to be an important tool to prevent elderly persons from becoming involuntary isolated. For an elderly person, being able to use bus services may be the difference between living a mobile- and immobile life.
5 DEVELOPMENT OF DESIGN DIRECTIONS

In this chapter, the process of developing design directions is described. From findings made of measures needed to improve the situation, design directions to inform vehicle design could be created.

5.1 Researching accidents, stress and equal terms

In order to find reasons behind accidents, stress and unequal terms the three areas were researched through literature studies. Research was also made to investigate in what ways the vehicle design could be changed and what standards regulate the interior design and construction.

5.1.1 Accidents

In order to find out what cause accidents and how they could be prevented, common kinds of accidents were researched. The research confirmed that older passengers were at an increased risk of experiencing accidents when traveling by public bus services. A type of accident that was found important to prevent was fall accidents. On board the vehicle, common reasons for falling were sudden accelerations or decelerations. At the doors, common reasons for falling when boarding or alighting were doors closing unexpectedly or wet and slippery conditions. Most fall accidents happened when passengers were in a standing position, although cases were passengers had fallen from a seat occasionally occurred. Findings suggested that risks can be reduced to a large extent if elderly passengers are seated while the bus is in motion. To reduce the degree of injuries sustained in fall accidents, findings also suggested that interior details should be designed in ways that could not cause excessive injuries in case a passenger collides with the detail during a fall. As concluded from the research on elderly persons, temporary illness and injuries can also have serious consequences and therefore even slight injuries caused by minor accidents are important to prevent.

5.1.2 Stress

To find out what circumstances make elderly passengers feel stressed, stress and time pressure related to public bus services was also researched through literature studies. Overall, reasons of stress could be found on several levels of the transportation system. On a system level, time pressure cause stress by pressuring passengers to board and alight faster than comfortable. On a vehicle environment level, feeling unable to use or do something cause stress in situations when elderly passengers expect themselves to be able to do something but fail due to their physical condition. On an individual level, worrying or fear of having accidents also cause stress. Some aspects of stress could be partly possible to prevent or reduce by redesigning the vehicle environment, for example by making it possible for elderly persons to manage things they expect themselves to be able to do without help. However, to solve the underlying problem completely, extensive changes were found to be required on a system level. Suggestions found were for example to restructure the time table and change driver behaviour.

5.1.3 Equal terms

Traveling on equal terms means that elderly passengers not only should have the same access to-, but also be able to have the same use for public transportation as other passengers, as well as to receive equal treatment. In both research and policy context, accessibility was found to be given a large focus in the context of equal terms for persons with disabilities in public transportation. The main strategy to make bus services possible to use for passengers with
reduced mobility was found to be to adapt vehicles through traditional accessible design. To reach an equal level of usability however, adapting vehicles for persons with reduced mobility while letting the bus services remain designed for other passengers was not found to be enough. On a system level, equal terms could only be achieved if routes and time tables are designed to match where elderly persons want to go to the same extent as they match where other passengers want to go. And on a vehicle level, equal terms can only be reached if the environment accommodates the wants and needs of elderly persons to the same extent as it accommodates the wants and needs of other passengers. Furthermore, traditional accessible design solutions were also found to make it difficult to support equal treatment, as for example wheelchair users have to enter through the “back door” with most current ramp solutions. To fully support equal terms and treatment, both vehicle design and bus services were found to need to shift from an accessible design- to a Universal design approach.

5.1.4 Vehicle design

In order to determine what kind of changes could be made regarding the city bus interior design, as well as what common designs and features to accommodate passengers with reduced mobility can be found today, research on city buses was made.

Provisions for accommodating passengers with reduced mobility, wheelchairs and prams, was found to be well regulated by both international and national standards, but no specific provisions for accommodating passengers with walkers were found. Overall, the regulations were found only to contribute to making a small part of the vehicle accessible for passengers with reduced mobility. For benchmarking of features required to accommodate passengers with reduced mobility in current- and concept buses, see Appendix E.
5.2 The users’ perspective

The next step was to develop an understanding of accidents, stress and equal terms from the user’s perspective. To get an overview of the situation, user studies were carried out. The aim of the user studies was to identify underlying reasons of what could cause stress and make elderly passengers engage in behaviours that could increase risks, such as standing up during the journey. The aim was also to investigate why and how elderly persons want to use city bus services and how well the bus environment accommodates their needs.

5.2.1 User studies and analysis

The user studies consisted of observations and unstructured interviews and were carried out in Stockholm on the 15-16th of February. Interviews were conducted spontaneously along SL services 1, 4, 54 and Närtrafiken Lidingö, chosen because of their close proximity to areas with larger populations of elderly persons. In total five interviews with elderly persons and one interview with an SL service worker were carried out, ranging from 10-30 minutes long. Notes were taken during and after the interviews. The data from the user studies was analysed through post-it clustering, see Figure 16.

![Figure 16. Post-it clustering.](image)

First, individual observations and statements were written on post-its and thereafter sorted by topics and clustered in categories. Insights supported by quotes and observations were then formed from each category. To explore connections between insights, these were also analysed in a second set of clustering.

5.2.2 Themes

By analysing data from the user studies, three main themes that a majority of the users’ behaviours, wants and needs could be related to were found: Independence, Social well-being and Co-existing flows. For insights behind the themes, see Appendix F.
Independence

“There will come a day when I will need help, but until that day, I want to be as independent as I can be” – Mathilda 80+, SL service 54

Findings suggest that elderly persons want to be as independent as they can be for as long as they possibly can. In a city bus context, being independent means being able to get through the journey without help or having to bother others. Feeling independent is also strongly related to pride, dignity and self-esteem. Even in situations when elderly passengers are offered help by other passengers, they may choose to refuse the offer in favour of handling the situation by themselves. In some cases however, situations occur when elderly passengers are forced to rely on help from others. For example when the bus stops far from the curb.

“If the distance to the curb is too far I need help to exit” – Signe 85+, SL service 4

But being offered help from other passengers is not to be something that can be guaranteed, as other passengers are often otherwise occupied or unable to notice that help is needed.

In the bus environment, help is sometimes also offered through special treatments, such as designated stop buttons. Elderly passengers were found to avoid special treatments rather than appreciating them. In some cases, elderly passengers sitting in priority seats were even observed to put extra effort to be able to reach an ordinary red stop button.

“I’m not old enough to press the blue stop button” – Albert 80+, SL service 54

Some special treatments were also observed to be disparaging. For example walker- and wheelchair users being systematically restricted to enter through the “back door”. Another aspect of being independent is living an independent lifestyle. Many elderly passengers were observed to use shopping trolleys or walkers to be able to transport groceries and other things. However, the bus environment was not found very well adapted for accommodating independent lifestyles. The priority seats did not allow sufficient space for passengers to bring shopping trolleys and one woman also described how the height difference between bus and curb limits how much food she can buy at a time.

“I can’t buy too much. Then I can’t lift the walker on to the bus” – Signe 85+, SL service 4

Living an independent lifestyle also requires being active. Findings confirmed that seniors today are more active than persons of the same age were in the past. However, they were also found to often be presumed to live less active lives than they actually are.

“People get stuck in old thinking patterns, now-a-days an 80-90-year-old can be very active” – Albert 80+, SL service 54

To uphold independent and active lifestyles, persons were found to invent their own techniques and strategies to solve problems. For example a woman described that she had discovered that exiting backwards with the walker made it easier for her to keep her balance.

“I have found the best technique to exit with a walker, you exit backwards. Once I even got a comment from a driver, she said - Here’s someone who has found out how to do it! to me” – Mathilda 80+, SL service 54
Social well-being

“I know many people who would love to be able to get out on weekends, to go the graveyard for example, but they can’t because there is no bus on weekends.” – Gunvor 80+, SL Närtrafiken Lidingö

Public bus services can play an important part in preventing elderly persons from becoming involuntary isolated in their homes. For persons living a life with few social encounters, making the most out of every opportunity becomes increasingly important.

A pair of elderly women who meet at the bus stop start chatting happily. On the bus they have to stop talking because they cannot find a way to sit together since one of them has a walker – Observation made at Fridhemsplan

However, the bus environment was found to divide socializing people, especially in cases where the group consisted of a mix of passengers from different groups, for example when one someone had a walker or had to sit on a priority seat.

For elderly persons with very few social contacts, everyday meetings with service staff can fulfil a large part of their social needs. Having personal contact with the driver was found to be very meaningful and appreciated, especially at SL Närtrafiken where drivers are few and therefore often know regular passengers well.

“The drivers are very nice and recognize everyone” – Gunvor 80+, SL Närtrafiken Lidingö

Contact between driver and passengers was also found to increase safety, since the driver would know where passengers were going to get off and could thereby make sure that they had exited properly.

One particular physical interior detail was also found to be able to increase the feeling of safety. Many elderly passengers were observed to rest their hand on a handhold at a comfortable height in front of or beside them while seated during the journey. Having a “comfort handhold” provides extra stability and was said to feel restful and safe.

“I like having my hand on the handhold in front of me, it feels restful and safe (...) Maybe it’s something that comes with age” – Albert 80+, SL service 54

Co-existing flows

Passenger flow is not a single flow, but a mix of different co-existing flows. The tempo could roughly be categorized as fast or slow, with elderly passengers typically belonging to the slow category. For example elderly passengers may stop completely while checking the ticket while passengers of fast flow groups will walk by and check the ticket without stopping.

Two elderly passengers stop completely after entering to scan their tickets – Observation made on SL service 1

In cases where passengers of slow flow groups have to adapt to a fast flow, behaviours emerge that could increase the risk of accidents. For example elderly passengers may choose to stand up and go to the door before the bus has stopped.

“I like to get up in advance, so that I am at the doors when they open” – Maj 80+, Östermalm

An elderly woman squeeze herself past a foreign woman sitting on the outer priority seat to get to the doors before the stop, as it turns out both her and the other woman are exiting the vehicle at the next stop – Observation made on SL service 1

The driver’s attitude and actions was also found to have an impact on whether elderly passengers sit or stand. In many cases, drivers’ were observed not to wait for elderly passengers
to get seated, while at SL Närtrafiken drivers’ use their authority to enforce a rule requiring all passengers to sit during the whole ride.

“You can’t stand up while the bus is driving, it’s a rule. When someone stands on the bus, the driver tells them that it’s not allowed” – Gunvor 80+, SL Närtrafiken Lidingö

In areas where several groups compete over the same space, collisions between different groups were found to cause risky situations. Passengers with prams, wheelchairs, shopping trolleys, suitcases and walkers all compete over the same area, but only prams and wheelchairs really have priority. For walker users this leads to a lot of inconvenience, as they are solely restricted to the area but lack the right to claim it. They may therefore end up moving around a lot in order to make way for prams.

“It’s complicated to have to move around all the time” – Birgitta 75+, Gärdet

Since there are two possible areas at different doors, walker users were also found to end up in a dangerous situation when boarding. One woman describes how she hurries from door to door to find a space.

“I first aim for the middle door and if there is no space, I quickly hurry to the rear door” – Signe 85+, SL service 4

Collisions between groups sometimes also tend to occur at priority seats, as non-prioritized passengers occasionally occupy available priority seats in order to have personal space or space for bags and other belongings.

In situations when the fast flow is kept separate, for example when groups of children board the bus through the middle doors, the overall flow was found to run more smoothly. Slow flow groups could also use the opportunity to board simultaneously through the front door without being affected by the fast flow.

A large group of school children enter through the middle doors, a teacher stands inside the door hurrying them along and making sure everyone enters. The front section of the bus is relatively unaffected by the large amount of children entering – Observation made on SL service 1

Another parameter that can be used to optimize flow was found to be the intuitiveness of interfaces in the bus. If passengers for example are unable to open the doors, the flow is interrupted.

“The doors should be improved, it’s not comfortable to stand so close to make them open” – Albert 80+, SL service 54
5.2.3 Findings related to accidents and stress

From the themes, underlying causes of behaviours leading to increased risks were identified, as well as positive behaviours that could contribute to reducing risks. Based on the findings, conclusions were made regarding measures that could be taken to prevent accidents and reduce stress.

Causes of behaviours that increase risks

Through the theme Co-existing flows, several causes of behaviours related to increased risks were found. An important factor behind why elderly passengers voluntarily choose to stand or walk around during the journey was found to be that they were forced to adapt to a faster passenger flow than comfortable. When experiencing time pressure caused by the faster flow, they adopted more risky behaviour and started to compromise with safety. An important factor behind why elderly passengers involuntarily end up standing during the journey was found to be the driver’s behaviour. If the driver starts the bus before elderly passengers are properly seated, elderly passengers have no option but to stand up or walk during the journey.

Another underlying cause of a behaviour increasing risks was found to be groups not properly integrated in the overall passenger flow. Walker users were only able to travel in a way where they face large risks both when boarding, due to having two door options, and on board the vehicle, when unable to claim space to sit in a safe way.

Behaviours that could reduce risks

Behaviours that could reduce risks were found through all three themes. Separating fast- and slow flow, as presented in Co-existing flows, could be promoted to make the overall flow run more smoothly as well as to avoid forcing slow flow groups to adapt to a fast flow. Personal contact with the driver, as presented through the Social well-being theme, was also found useful, as it could increase the driver’s awareness of elderly passengers. It could also make it possible for elderly passengers to inform the driver of medical conditions, as well as to contribute to feeling of safety, by reassuring passengers of that the driver will take caution. Yet another behaviour found useful were personal techniques presented through the Independence theme. When allowing and encouraging passengers to use their own safer methods, risks could also be reduced.

Conclusions

- Elderly passengers must be allowed to travel and move at their own pace.
- Allowing passengers to travel at their own pace could be achieved by separating fast- and slow flows.
- All groups need to be integrated in the overall flow and provided with space adapted for them that they have the right to claim.
- Passengers with reduced mobility should be able and encouraged to use personal techniques to make difficult situations easier and safer.
- Personal contact with the driver can increase safety.
- The attitude and actions of the driver largely affects the behaviour of the passengers and can be used to promote safe behaviours.
- Only groups that compete on fair terms can share a common space.
- Walker users face increased risks both when boarding and on board the vehicle.
5.2.4 Findings related to equal terms

From the themes, basic wants and needs of elderly passengers could also be identified, as well as insight to how well the bus environment can accommodate them. Based on the findings, conclusions were made regarding measures that could be taken to support equal terms.

The wants and needs of elderly passengers

A lot of clues as to why and how elderly persons want to use city bus services were found through the Independence- and Social well-being theme. Elderly passengers travel by city buses to support their independent- and active lifestyles, as well as to keep healthy through both social interaction and physical activity. Elderly passengers want to use bus services to travel to the local store and be able to bring shopping trolleys and walkers with them to transport food. To feel independent, elderly passengers also need to be able to manage to travel by themselves without being forced to accept help from others or special treatments. Elderly persons also want to use bus services to meet with people and socialize, many thereby want or need to have personal contact with the driver. The most important needs of elderly passengers are described by the theme Co-existing flows. To be able to travel safely and stress-free, elderly passengers need to be allowed to travel at their own pace and be provided with space adapted for them that they can claim.

Accommodating elderly passengers based on their wants and needs

When identifying wants and needs of elderly persons, notion was also taken of how the bus environment meets them. To support independent lifestyles, the bus environment would need to allow elderly passengers to bring shopping trolleys and walkers. However, in most areas, including the priority area, there was not enough space to keep a shopping trolley. To support the user feeling independent, the bus environment would need to allow elderly passengers to travel without dependencies on others or unwanted special treatments. This was observed to be impossible in some cases, due to the height difference or gap between vehicle and curb. To support elderly passengers need to socialize, the bus environment would need to allow passengers of different groups to be able to sit together. This was also found to be very hard to achieve, for example due to that priority seats were grouped together and that walker users were restricted to sit in the pram- and wheelchair area. Contact with the driver was found to be largely available, but due to time pressure and a large overall passenger flow when boarding, personal contact came across as unlikely. Elderly passengers were also to a very large extent forced to adapt to the fast passenger flow.

Conclusions

- The bus environment needs to be designed to support the independence of elderly passengers and avoid creating dependencies to the furthest extent possible.
- Elderly persons should not be forced to accept unwanted special treatments
- Special treatments need to be offered in a way that does not feel disparaging to the user.
- The priority area needs be designed to accommodate persons with independent lifestyles and thereby allow passengers to for example bring shopping trolleys.
- Passengers of different groups need to be able to sit together and socialize during the journey.
- Opportunities to make personal contact with the driver needs to be provided for elderly passengers.
- All passengers must be allowed to travel and move at their own pace.
- All passenger groups need to be provided with space adapted for them that they have the right to claim.
In this chapter concept development is described. Apart from the guidelines concept, design concepts to be used as applied examples were also developed. A second set of user studies was conducted to inform the concept development.

### 6.1 Guidelines concept

The guidelines were made by compiling the main findings of the project in to a brief and visual format. When creating the guidelines the main focus was to find an efficient way to mediate the main findings of the project in a way relevant to Scania. At Scania, brief formats such as PowerPoints were found to be favoured in order to save time. The guidelines were therefore designed in a brief format, similar to a brochure of maximum 20 pages, to allow more text but still allow readers quick and easy access to the material. The guidelines were also designed to be useful in different time frames, both by quick summaries for readers in a hurry and more substance for readers wanting to spend some more time. To keep the guidelines brief and uncomplicated, readers were referred to the project report for references and more details.

#### 6.1.1 Contents

To mediate knowledge and understanding of the elderly passenger experience, background information describing the purpose of the project, the focus areas, the situation of elderly passengers and priority on city buses was included in the guidelines. To encourage empathy for elderly passengers, the guidelines were developed with focus on the passengers’ experience and perspective. Visual material was also included to further help readers identify with elderly passengers and understand the difficult situations they may face.

The main content of the guidelines were the design directions developed to inform vehicle design based on wants and needs of elderly passengers. To make the design directions clear and easy to understand, context and quotes were also attached. To demonstrate how the design directions were to be used, applied examples were also included.

#### 6.1.2 Design and layout

To make the document readable both on screen and in print an A4 landscape design was selected. To make the guidelines appealing and consistent a graphic theme was made. Icons representing the focus areas and design directions were also made to make them easy to remember.

**Visualization**

To be able to effectively communicate problems found within the focus areas, two situations typical of each area were selected and visualized. Within the Accidents focus area, fall accidents when alighting and sudden decelerations were chosen, see Figure 17.
Figure 17. Visualization of fall accidents.

For the Stress focus area, worrying about sustaining injuries and time pressure when boarding and alighting were visualized, see Figure 18.

Figure 18. Visualization of stress.

For the focus area Equal terms, scenarios representing wanting to feel independent and being unable to socialize were visualized, see Figure 19.

Figure 19. Visualization of unequal terms.
6.2 Development of applied examples

The concept development was conducted through the steps concept generation, selection and two iterations of concept development and evaluation. Due to the limited time frame, no detailed technical solutions were developed.

6.2.1 Concept generation and selection

To start the concept development, a shorter brainstorming session focused on finding solutions to problems identified through the focus areas and themes was carried out. The session resulted in a number of rough concepts found to solve problems on different levels, as well as to require changes of different magnitudes to be implemented.

**Small – Medium – Large**

To be able to compare and get an overview of the concepts, the format “Small – Medium – Large” was introduced. “Small” concepts, were solutions only requiring small local changes, which would otherwise not affect the rest of the bus environment. “Medium” concepts, were solutions requiring changes that would also affect other parts of the bus, but were still possible to implement solely by bus manufacturers themselves. “Large” concepts, were solutions requiring more extensive changes only possible to implement by cooperation between bus manufacturers and other actors.

Among the solutions of the “Small” category were for example neck rests on priority seats, rear-view mirrors for exiting walker users, mixed seating layouts and entry/exit supports, see Figure 20.

![Figure 20. Examples of “Small” category solutions.](image)

Neck rests were suggested as an easy way to protect elderly persons with reduced muscle strength during sudden accelerations or decelerations. A rear-view mirror was suggested to make it possible for all walker users to exit backwards. Mixed seating was suggested to make
it easier to sit next to friends belonging to other passenger group and the entry/exit support was suggested to reduce the risk of accidents when boarding and alighting as well as to make elderly passengers able to board and alight by themselves to a greater extent.

Among the “Medium” category solutions were concepts such as a designated walker seat and a ramp at the front door, see Figure 21.

![Figure 21. Examples of “Medium” category solutions.](image1)

The walker seat was suggested to solve the difficult situation for walker users, providing them with a space adapted for their needs. The ramp solution was suggested as a way to be able to welcome all users through the “front door”.

In the “Large” category, two concepts were presented, see Figure 22. The first was One vehicle – two buses aiming to divide the bus into a slow- and a fast section. The concept would thereby create a better overall flow and allow all passengers to travel at their own pace and at their own terms. The second concept aimed to solve the problem of height differences between curb and vehicle by an elevated platform or sunken driveway and thereby reduce the risk of accidents when boarding and alighting.

![Figure 22. The “Large” category solutions.](image2)

**Concept selection**

When selecting concepts for further development, one concept from each category was chosen. Concepts were chosen based on estimated ability to prevent accidents, reduce stress and support equal terms, as well as feasibility and innovative potential. From the “Small” category, the concept Entry/exit support was selected because of its ability to both prevent accidents and support equal terms. From the “Medium” category, the Walker seat concept was selected because of the need to improve the difficult situation for walker users on the bus. And from the “Large” category, the One vehicle – two buses concept was selected because of its ability to largely improve the overall situation.
6.2.2 Entry/exit support

The *Entry/exit support* concept was inspired by observations of elderly users twisting around to be able to hold on to the handrail while stepping down from the vehicle to the ground. The basic idea was to provide users with a horizontal support extending out from the vehicle, allowing them to hold on stably also when taking the final step down to ground level. For boarding users, the original idea was to provide an angled support allowing them to pull themselves up when stepping in to the vehicle. The entry- and exit features could either be combined into one single solution, or kept as separate pieces. Overall, the concept would reduce the risk of fall accidents when boarding and alighting, as well as to support the independence of elderly passengers, as they would be able to enter and exit by themselves to a greater extent.

**User studies**

To inform the development of the *Entry/exit support*, user studies were conducted by watching Youtube videos of elderly persons climbing stairs with the purpose to discover both personal techniques and helpful handrail features.

**Requirements**

To develop the concept further, general requirements regarding usability, function and placement, technical solutions and safety were set for the entry- and exit features, see Appendix G.

**Concept development – First iteration**

To create concepts for the exit support features a solution matrix was used, see Table 2.

<table>
<thead>
<tr>
<th>Sub function Solutions</th>
<th>Mount</th>
<th>Deployment mechanism</th>
<th>Propulsion</th>
<th>Shape</th>
<th>Activation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wall</td>
<td>Telescopic</td>
<td>Electric motor</td>
<td>Bent</td>
<td>Button</td>
</tr>
<tr>
<td>Outswing</td>
<td>Door</td>
<td>Rotation</td>
<td>Mechanical</td>
<td>Other</td>
<td>Sensor</td>
</tr>
<tr>
<td>Foldable</td>
<td>Door mechanism</td>
<td>None</td>
<td>Door mechanism</td>
<td></td>
<td>Automatic</td>
</tr>
</tbody>
</table>

By combining different sub-functions and technical solutions three concepts were made, Figure 23.
The first concept, *Extendable entry/exit*, was a combined entry/exit support with an electric motor deploying a telescopic extendable handhold simultaneously with the door opening. During the journey, the handle would be retracted into the lower bar of the angled handle. The entry support part of the concept was the angled upper rail and the parallel lower section of rail underneath. The upper section would allow the user to support the lower arm on the rail while gripping further up. The lower section could be used to support a second hand if needed, making it possible to use the handrail in several different ways. Two fasteners were also placed, making it possible to grip both the rail and the fastener for a secure grip.

The second concept, *Outswing exit + entry*, was an exit support handhold mounted directly to an outswing bus door joint. When the door open, the handle would swing with the door to the outmost position and when the door close, the handle would swing back into the storage position. In the outmost position, the handle would function as a support similar to a cane for persons stepping down to the ground. To provide both the entry- and exit support features, the concept would also be combined with a separate entry support, see Figure 23.

The third concept, *Foldable entry/exit*, was a combined entry/exit solution consisting of a manual folding handhold attached to a stationary entry handrail inside the vehicle, Figure 23. The concept was inspired by foldable handles often used in the wheelchair area and would function in a similar way with a locking mechanism keeping it still in the unfolded position. When needed, the handle could then be folded out and used. And during the journey, the handle would be folded back and stored inside the vehicle. The handle would also feature a mechanical solution, automatically folding the handle back after use. The entry support part of the concept would be similar to the design used for the *Extendable entry/exit concept.*
Concept evaluation and selection

To evaluate the concepts against the requirements, a weighted evaluation matrix was used, see Table 3.

Table 3. Evaluation matrix

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Weight (1-5)</th>
<th>Reference</th>
<th>Extendable</th>
<th>Outswing</th>
<th>Foldable</th>
<th>Part sum</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Usability</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easy to reach from inside</td>
<td>5</td>
<td>25</td>
<td>5</td>
<td>25</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>Easy to see</td>
<td>4</td>
<td>20</td>
<td>4</td>
<td>16</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>Intuitive</td>
<td>4</td>
<td>20</td>
<td>4</td>
<td>16</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>Familiar</td>
<td>3</td>
<td>15</td>
<td>4</td>
<td>12</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td><strong>Function and placement</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Firm and stable support</td>
<td>5</td>
<td>25</td>
<td>3</td>
<td>15</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>Extends at least 10 cm</td>
<td>5</td>
<td>25</td>
<td>5</td>
<td>25</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>Space efficient in storage position</td>
<td>3</td>
<td>15</td>
<td>5</td>
<td>15</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Space efficient movement</td>
<td>4</td>
<td>20</td>
<td>5</td>
<td>20</td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td>Automatic deployment</td>
<td>5</td>
<td>25</td>
<td>5</td>
<td>25</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>Automatic retraction</td>
<td>5</td>
<td>25</td>
<td>5</td>
<td>25</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>Deploy/retract with door movement</td>
<td>4</td>
<td>20</td>
<td>5</td>
<td>20</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td><strong>Technical solution</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life time</td>
<td>4</td>
<td>20</td>
<td>3</td>
<td>12</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>Low complexity</td>
<td>4</td>
<td>20</td>
<td>2</td>
<td>8</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>Driven by door movement</td>
<td>5</td>
<td>25</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td><strong>Safety</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low injury risk</td>
<td>5</td>
<td>25</td>
<td>4</td>
<td>20</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>Low collision risk</td>
<td>5</td>
<td>25</td>
<td>3</td>
<td>15</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>Low risk for things to get caught</td>
<td>4</td>
<td>20</td>
<td>3</td>
<td>12</td>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td><strong>Sum</strong></td>
<td>370</td>
<td>286</td>
<td>335</td>
<td>230</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The *Extendable entry/exit* concept performed well on both usability- and functional requirements. However, higher complexity due to the need for a separate electric motor to power the automatic deployment and retraction resulted in low scores for the technical solution, scores on safety were relatively low.

The *Outswing exit+entry* performed the best out of the three concepts. The usability- and functional scores were overall very high. Since the concept builds on the door joint causing extra clearance to be needed, scores for space efficiency were however lowered. The technical solution received a full score and by utilizing the door mechanism, complexity could be kept low.

The *Foldable entry/exit* concept received the lowest score of the three. The solution received low scores in the usability category, as well as low scores in function, due to the lack of automation and space required to store and unfold the handhold. In terms of safety, the concept would induce some risk of injury and collisions, as the deployment movement would be unsynchronized with the doors.

The concept selected for further development was the *Outswing exit+entry* concept.
Concept development – Second iteration

To further improve the concept, inspiration was taken from handicap handrail designs for stairs, see Figure 24. From the handrail design, dimensions and measurements could be defined, such as an appropriate height above ground level and a vertical distance between the parallel rails.

![Image: UN Enable](image)

**Figure 24. Examples of handicap handrails and fastener shapes by UN Enable [m].**

To improve the exit support part of the concept, different configurations of outswing door mechanisms and handhold shapes were tested and analysed by CAD-modelling, see Appendix H. When analysing the movement of the door arm and handhold, a conclusion made was also that in all three cases the exit- and entry supports would not possible to place on the same side of the door due to interferences.
6.2.3 Walker seat

The basic idea of the Walker seat concept was to create a space adapted for walkers, where walker users have priority. Through the concept, walker users would be able to travel without confusion over what door to choose and without having to compromise with safety in order to make space for others.

User studies

To inform the development of the Walker seat, user studies in the form of observations, semi-structured interviews using trigger material and shadowing were conducted with the aim to map the situation of walker users. Interviews were carried out on the 6th of April and in total four walker users, three women and one man, were interviewed. The following trigger material was used, see Figure 25. Additional comments were written down after the interviews.

![Figure 25. Walker interview trigger material.](image)

The trigger material consisted of illustrations of a seat and a number of interior details, an overview of the front section of a city bus, as well as magnetic seat and walker icons possible to place on the front section overview. Interviewees were asked to choose how and where they wished to enter the vehicle as well as where they wanted to sit by placing the magnetic icons. An open interview about personal experiences of traveling with a walker, as well as interior detail preferences then followed.

Requirements

Through the insights, the general requirements regarding usability and function and placement were set for the concept, see Appendix I.
**Concept development – First iteration**

To find possible placements and simulate manoeuvring in a city bus environment, a desktop scale model was built. The model was built using foam core and included the front section of the bus, from the front overhang to the wheel pair behind the first service doors, see Figure 26.

![Desktop model](image)

*Figure 26. Desktop model.*

The model was also made adaptable to different bus lengths and axle distances by allowing the rear wheel house covers to be moved forwards and backwards. To test placements and moving paths, a scale model representing a walker and post-it notes marking the location and direction of seats and the doorway were used. When testing placements, the front end of the wheelchair area was kept fixed in line with the front end of the door opening.

The scale model exercise resulted in two possible placements, either a sideway facing seat placed next to the service door, or a sideway facing seat mirrored across to the opposite side. To be able to keep the walker unfolded and directly in front of the seat, both placements would also result in a bent gangway, see Figure 27.

![Bent gangway layout](image)

*Figure 27. Bent gangway layout.*
With the possible placements set, other features were added to fulfil the requirements. Fixed handles were added to the seat to aid the user when standing up, remaining low enough not to interfere with the walker when placed close to the seat, see Figure 28.

![Figure 28. Visualization of walker seat concept.](image)

The handles also functioned as side supports, preventing the user from sliding off the seat. A yellow line was added to the floor to mark the reserved area, keeping it separate from the gangway. Clearly marking the area could both help the walker user to claim the required space, and at the same time encourage keeping the walker inside the area and clear of the gangway. When placed on the service door side, a wall was added to separate the walker seat from the doorway and paper bin, providing the walker user with a more protected personal space. A sign similar to those for wheelchair users was also added, to clarify the walker user’s right to the seat.
Concept evaluation

To evaluate the walker seat concept and the two alternative placements the concept was tested by a rough full scale mock-up made during a visit to the Varsam store at Kungsgatan 59 in Stockholm on April 28th. During the tests approaching the seat, sitting down and placing the walker in front of the seat, standing up and walking back towards the initial position both backwards and forwards was tested and evaluated, see Figure 29 and Figure 30. For detailed information about how the tests were conducted, see Appendix J.

![Scenario - Door side](image)

**Figure 29. First scenario.**

![Scenario - Opposite side](image)

**Figure 30. Second scenario.**

Based on the tests, the concept was confirmed to be possible to use in the intended way. Placing the walker seat on the same side as the service door was also found to be most convenient when exiting, however both solutions were found acceptable.
**Concept development – Second iteration**

To further develop the concept, estimations of the turning radius of walkers as well as the placement of the walker when seated made when performing tests using the mock-up were used, see Figure 31 and Figure 32.

*Figure 31. Walker turning radius test.*

*Figure 32. Placement of rear walker wheel when seated.*

By combining the estimated placement and turning radius with data of common walker dimensions mapped by Sandqvist (2011), the approximate space required for the walker seat floor area could be determined. Using the measurements of the largest walker models, length 820 mm and width 720 mm, an approximate floor plan was made and confirmed that placing a forward-facing seat on the opposite side of the walker seat would probably be possible, see Figure 33. Based on the mock-up tests, the centre of the rear wheel could be kept in line with the front end of the seat. Since the longest walker had a wheel diameter of 300 mm, the length of the space needed in front of the seat was estimated to the length of the walker minus the wheel radius 150 mm, resulting in an approximate length of 670 mm. Clearance was also added sideways to support turning both ways, resulting in an approximate width of 960 mm.

*Figure 33. Approximate floor plan.*
6.2.4 One vehicle – two buses

The basic idea behind the concept was born after the user studies made at SL Närtrafiken. The idea was to take a Närtrafiken bus and integrate it into a larger ordinary bus. The result became a vehicle divided in two sections, one fast and one slow. The slow section would be the front of the vehicle and function as a Närtrafiken bus, passengers would be required to be seated and the driver would have a lot of oversight. The fast section would begin after the first service doors and continue on to the rear end of the vehicle. Fast section passengers would board through the middle- and exit through the rear doors. Altogether, one vehicle would function as two separate but conjoined buses, see Figure 34.

Figure 34. The two sections of the One vehicle – two buses concept.

User studies

To inform the development of the One vehicle – two buses concept, user studies in the form of observations and semi-structured interviews using trigger material were conducted on 7th of April. The overall aim was to gain knowledge of what passenger types could share space on fair terms, as well as what passengers might need their own reserved space to be able to travel on equal terms. The social interplay between bus passengers was analysed by two parameters, how passengers of different types prioritize other passengers and what the strength and speed of different passenger types are. In total 7 persons, 5 men and 2 women between the ages 24-85, were interviewed. Two of which were walker users, one a walking stick user and one had a pram. For the interviews, the following trigger material was used, see Figure 35 and Figure 36.
Interviewees were asked to imagine scenarios in which they were a certain type of passenger occupying a seat and had the option to either stay or give up their seat at the arrival of another passenger. As the second step, interviewees were also asked to rank different passenger types from weak to strong and fast to slow. The purpose of the exercise was to get insight to the pecking-order of bus passengers, in order to then be able to uncover what groups can share a common area on fair terms.
Specification

From the previous insights and user studies, a rough specification for the front and rear section of the concept was made. For more information, see Appendix K.

Concept development – First iteration

To test and develop the concept, a number of scenarios with different layouts were simulated using Pathfinder, an agent based evacuation simulation software made to simulate and analyse evacuation scenarios from buildings and aircrafts, see Figure 37. For detailed information about the simulations see Appendix L.

Figure 37. Simulation with the initial layout.

Overall, the concept performed well in the simulations. Fast flow passengers walked longer distances simultaneously as slow flow passengers walked shorter distances, making both groups reach their seat at approximately the same time. Through the simulations, conclusions could also be made that in order to optimize the flow in the front section, the front section would also need to have two separate doors for boarding and alighting. New layouts with more doors were therefore introduced and tested, see Figure 38.

Figure 38. New layouts with four doors.

Another conclusion made regarding the walker seat was that in order to optimize the flow, the walker seat would have to be placed on the side opposite to the service door. If placed on the same side, the walker seat was discovered to obstruct the flow since passengers would have to walk around the walker area to get to- and from the door.
Concept development – Second iteration

To develop the concept further, an effort was made to create ways to encourage passengers to choose certain areas. To avoid occupying the wheelchair space if not necessary, passengers with prams could choose the rear pram area. A family area, letting parents sit together with all their children in the rear pram area could for example be used to make it extra attractive. To avoid having standing passengers blocking the middle section and the drivers visibility, an area for standing passengers could be placed close to the rear doors to encourage standing passengers to walk all the way back to the rear door. To differentiate the sections and encourage wanted behaviours, visual appearance, colour schemes and sound could also be used, as discovered from examples (Ljunggren et al. 1997) of how colour schemes can affect how public transportation environments are perceived.
In this chapter the final results of the project are presented.

7.1 User studies

Through the user studies the following main findings were made. For insights regarding walkers, wheelchairs, ramps and usability, as well as data and other findings, see Appendix F and Appendix M.

7.1.1 Themes

Three main themes were found that describe why and how elderly passengers want and need to travel by public bus services.

Independence

An independent lifestyle can be manifested by ordinary everyday things such as buying groceries for oneself. Feeling independent is strongly connected to pride, dignity and self-esteem. To feel independent, elderly passengers need to be able to manage to travel by themselves without being forced to accept help from others or special treatments. They also need to be able to bring mobility aids and other means for their independent lifestyle.

Social well-being

For elderly persons an important aspect of traveling by bus is having the opportunity to meet with people and socialize. Being able to sit together with friends and keep a conversation during the journey can be very valuable. For elderly persons with few social contacts socializing with the driver can be highly appreciated. Personal contact with the driver can also contribute to increase safety as passengers can inform the driver of their needs.

Co-existing flows

Passenger flow is not a single flow but a mix of several co-existing flows. The flows can roughly be divided in fast and slow. Most public bus services are adapted for fast flow and when slow flow groups are forced to adapt, stress and risk of accidents increase. To be able to travel stress-free and safely elderly passengers must be allowed to travel and move at their own pace on board the bus.

7.1.2 Priority

Based on how passengers prioritize each other and the speed and strength of different groups the pecking order of bus passengers was found to be the following, see Figure 39.
Passengers with wheelchairs were found to have the highest rank. They had no problem being prioritized by other passengers and were strong enough to claim their right. Passengers with prams were also ranked high. They were in most cases prioritized by others and had no problem claiming their right. Next in rank but with a gap in between were passengers with walkers. Passengers with walkers were in most cases prioritized by passengers of lower rank and in some cases also by passengers with prams, but since they have no explicit right to the space they are restricted to use, as well as weaker than passengers with prams who they compete with, walker users are largely unable to claim space. Next in rank were passengers with suitcases closely followed by passengers with shopping trolleys. Passengers with shopping trolleys were found to be generally disliked by others which probably contributed to their low rank.

### 7.1.3 Walker users

Having two door options when boarding was found to cause dangerous situations for walker users, as they are forced to hurry from one door to the other outside the vehicle if the area at the first door is already occupied.
7.2 Accidents, stress and equal terms

To reduce stress and prevent accidents for elderly passengers in the vehicle environment, the most important measures are to allow passengers to travel at their own pace, to provide passengers with space adapted for them that they have the right to claim, to make sure that passengers can safely bring belongings, to make sure that they can have contact with the driver and to allow passengers to use their own personal techniques to make difficult situations easier and safer. The exact same measures are also some of the measures needed to allow elderly persons to travel on equal terms.

All three themes describing how to support equal terms, based on the elderly passengers’ wants and needs, also to some extent contribute to reducing stress and preventing accidents, see Figure 40.

Out of the three themes, Co-existing flows make the strongest contribution to preventing accidents and stress, by allowing passengers to travel at their own pace and thereby helping them escape stressful time pressure causing increased risks. But Independence also contributes, by making elderly passengers able to manage things on their own and by making sure that they can bring walkers and shopping trolleys along safely. Social well-being also contributes, by creating opportunities for personal contact with the driver, thereby increasing the driver’s awareness and make passengers feel safer.

To support equal terms, city buses need to be adapted to provide both physical accessibility but also an equal degree of usability for elderly passengers. In the vehicle environment the most important measures to support equal terms is to make it possible for elderly persons to travel without help or having to accept special treatments, to make it possible to safely bring mobility aids and shopping trolleys, to make it possible for elderly passengers to socialize with each other and with the driver, to allow elderly passengers to travel at their own pace and to provide them with space adapted for them that they have the right to claim.

Figure 40. Connection between themes and focus areas.
7.3 Design directions

The following design directions were developed to promote designs that prevent accidents, reduce stress and support equal terms.

Designing for Independence

Respect independence

Design without creating dependencies and special treatments.

Elderly persons, like most people, strive to get by without asking for help and do not want to feel like they bother others. To respect and strengthen the dignity, pride and self-esteem of elderly persons, supporting their ability to take care of themselves is central. It is therefore important that the bus environment is designed in a way that does not create dependencies or situations where passengers are forced to accept special treatments against their will. Special treatments should to the furthest extent possible be optional and be performed with great respect for the integrity of the passenger.

Support active lifestyles

Design to accommodate mobility aids and means for independent and active lifestyles.

Elderly persons today live more independent and active lives than ever before. The view of elderly persons as inanimate passengers traveling without belongings from point A to point B therefore needs to be challenged. To be adapted for elderly passengers, the bus also needs to be able to accommodate means and mobility aids for independent lifestyles, such as shopping trolleys and walkers. It is also vital that every step of the journey, from going to the station to arriving at the destination, works smoothly for elderly passengers traveling with mobility aids and larger belongings.

Celebrate ingenuity

Take inspiration from life hacks of persons with reduced mobility, they are real experts.

Great lessons can be learned by observing and drawing inspiration from life hacks of persons with reduced mobility, the real experts of their own situation. To create highly usable environments, versatile designs that allow passengers to utilize their personal techniques is an important key. To further increase usability similar reoccurring features can also be standardized through different environments, making it possible to apply the same technique in multiple situations. Apart from making difficult situations safer and easier, encouraging passengers to use their own techniques also supports them feeling independent and capable.

Designing for Social well-being

Encourage socializing

Support and enable socializing between all different kinds of passengers.

Socializing is vital to health and well-being. At an old age, social interaction is just as important as at a younger age but staying in touch with friends and making new acquaintances can become harder along the natural course of life. Many elderly persons live alone and as social contacts become fewer, making the most out of every single meeting becomes increasingly important. Elderly passengers want to use the opportunity to socialize with friends they encounter on board the bus. Friendship is not something limited within their passenger group so to be able to support and enable socializing, seating arrangements must allow all different kinds of passengers to sit together.
Driver’s care

Facilitate meaningful meetings between elderly passenger and bus driver.

For elderly persons with few social contacts, interaction with service workers and staff in public environments can help fulfill a part of their daily need for social interaction. Being acknowledged and greeted by the bus driver can therefore be very meaningful and highly appreciated. To be able to provide opportunities for meaningful social interaction between driver and elderly passenger, the passenger needs to be able to come within a close distance. Contact with the driver can also contribute to increase safety by making passengers able to inform the driver of their needs. It can also contribute to increase the experienced feeling of safety, as passengers can be reassured that they will be cared for.

Designing for Co-existing flows

Fast or slow

Design the bus environment to allow passengers to move at their own pace.

Passenger flows could roughly be categorized as fast or slow, with elderly passengers typically belonging to the slow category. On public bus services they are often forced to adapt to a fast passenger flow, which can cause stress and increases the risk of accidents. To make the bus environment safer for elderly passengers they need to be able to travel at their own pace. The bus needs to be designed to allow different flows to co-exist without colliding and to optimize the overall flow, both fast- and slow flows need to be able to keep their natural tempo. To keep a good flow, it is also important that all features that passengers come into contact with work together smoothly to avoid unnecessary interruptions.

Provide territories

Provide all passenger groups with space adapted for them that they have the right to claim.

All persons who can get to the bus stop have the right to take the bus. On the bus however, not all passenger groups have a right to somewhere to stay. Passengers with wheelchairs and prams have clear explicit rights, while walker users who are solely restricted to the same areas do not have priority. To support equal terms, all passenger groups need to be provided with space adapted for them, that they have the right to claim. These ‘territories’ also need to be designed to help guide the passenger flows to avoid collisions, as well as to contribute to making passengers compete over space on fair terms. New explicit rules may in some cases also be needed to be able to guarantee priority for groups in need of it.
7.4 Guidelines

The project resulted in a 20 page guidelines document, see Figure 41 for the cover. For the full guidelines document, see Appendix N.

![Guidelines cover](image)

**Figure 41. Guidelines cover.**

**Contents**

The guidelines include a letter from the author explaining the background and purpose of the project, as well as information and visualizations of issues within the focus areas, information about the elderly passenger background, priority on city buses, design directions and applied examples. To enable mediating the main findings within a very short time frame readers in a hurry are directed straight to the design directions, see Figure 42 and Figure 43.

![Contents and recommendation](image)

**Figure 42. Contents and recommendation for readers in a hurry.**
**Figure 43. Overview of design directions.**

**Design**

In order to make the guidelines attractive for professional vehicle designers but at the same time also encourage empathy for the elderly users the guidelines were designed to integrate a contemporary clean and strong look inspired by Scania graphics design with a soft, highly empathic and slightly romanticized expression, see Figure 44.

**Figure 44. Clean and strong (left) and soft and romanticized (right).**
7.4.1 Applied examples

The development of applied examples resulted in three final concepts, presented last in the guidelines document.

Entry/exit support

The final Entry/exit support concept consisted of two separate solutions to aid boarding and alighting passengers. For boarding passengers a rigid handrail mounted inside the door opening or on the front door was provided. The solution consisted of an upper angled rail and a lower parallel rail, allowing the user to support their lower arm on the upper rail and simultaneously grab on with their other hand to the lower parallel rail, see Figure 45. The connection between the upper and lower rail would also allow the user to grab around a corner for a slip-free grip.

Figure 45. The final entry handrail (left) and exit handhold (right).

For alighting passengers a handhold integrated to the door arm mechanism was provided to make it possible for the user to hold on to without twisting around during the process of taking the step down to ground level, see Figure 45. To differentiate the handhold from the rest of the door arm, the handhold would be marked by a bright yellow colour.
Walker seat

The final Walker seat concept aim to improve the situation for walker users by providing a designated area adapted for them in the form of a seat with reserved floor space, see Figure 46. The walker seat is placed directly in front of the wheelchair area and located close to the door used for boarding and alighting to minimize the walking distance on board the bus. The surroundings of the seat are kept free of handrails and other obstacles that could intervene with the walker when placed in front of the seat. To aid the walker user standing up as well as to prevent the user sliding off the seat, the seat has been equipped with handholds on the sides. The concept also makes it possible for walker users to sit together with others on the bus.

Figure 46. The final Walker seat concept.

To guarantee priority for walker users, signs similar to those provided for wheelchair users are included. The floor space is also clearly marked to make it easier for walker users to claim the needed space. To make it easy for walker users to exit both forwards and backwards, as well as to minimize the need for turning the walker, the seat is placed sideways. The sideways placement also results in a bent gangway. To avoid forcing alighting passengers to take a detour around the walker seat floor area, the placement opposite to the service door was chosen resulting in a gangway bent towards the door side.
One vehicle – two buses

The final One vehicle – two buses concept aims to improve the overall situation of elderly- as well as other passengers by allowing all passengers to travel at their own pace and by providing more groups with space adapted for them that they have the right to claim. The concept divides the bus in two sections, one slow, optimized for passengers who want or need to travel in a slow tempo, and one fast, optimized for a fast and frequent flow without interruptions, see Figure 47.

**Figure 47. The final One vehicle – two buses concept.**

In the slow section passengers board through the front door and have close contact with the driver. For the safety and convenience of walker users, only the front middle door is used for boarding with walkers and a designated walker seat is provided. The seats in the slow section are adapted to allow passengers to sit with shopping trolleys and no standing would be allowed in the area to guarantee free passage for passengers with reduced mobility and to prevent standing passengers from obstructing the driver’s view of those in need of oversight.

In the fast section passengers board through the rear middle door and alight through the rear door, creating a flow automatically encouraging passengers to go all the way to the rear end of the vehicle. Passengers also scan their tickets themselves when boarding. To avoid passengers standing in the wheelchair-, pram- and gangway areas, an area adapted for standing passengers is be provided by the rear door. The area also allows space for suitcases and larger bags. To encourage passengers with prams to choose the rear pram area when boarding, the rear pram area is made extra family friendly by allowing space for passengers to sit together with all their children next to the pram.

The wheelchair- and walker ramp is placed at the front middle door to allow simultaneous ramp usage and fast flow boarding. By making the middle doors a main entrance, social inclusion is also improved, as segregation of wheelchair- and walker users become less apparent.
To improve the experience of elderly passengers a holistic approach was chosen focusing not only on the vehicle environment, but also the context of city buses and their use. The holistic approach led to that the deeper cause of problems could be found instead of just their effects inside the vehicle environment. For example stress and accidents were through literature studies found to often be caused by time pressure and time pressure could through the project in turn be connected to unequal terms and passengers being forced to adapt to a faster tempo than comfortable.

Through the user studies, three main themes that most of the elderly users’ behaviours and want and needs were related to were found by analysing observations and interviews. Since the number of interviews was small due to limited time and resources, individual participants were given a large focus and most situations that led to the outcome were only encountered once or a few times. On the other hand, some situations observed, for example of walker users running between doors when boarding, should not occur in any case and encountering the situation once is enough to know that it has to be prevented. That the interviews were conducted within a small geographical area and that most participants belonged to similar ethnic groups could make the findings very limited. However, it is largely possible that the findings also apply to a broader spectrum of elderly passengers throughout Sweden given their deep connection to core issues such as being able to manage everyday situations without help and valuing socializing with others. The flow aspects are also mainly related to the physical limitations of users and may therefore also be universal. To be able to ensure the results statistically for a larger area and population, a lot more interviews would however have to be made.

The qualitative data gained from interviews was collected by writing notes during and after interviews and was analysed through clustering. The results may therefore be affected by how the answers of the participants and their expressions were interpreted by the interviewer. During the analysis the personal values of the analyser may also have led to certain situations being given a larger focus than they would have by the participants. On the other hand participants already deeply rooted in a situation may accept treatments that should be unacceptable due to the force of habit. The active interpreting role of the interviewer and analyser could therefore contribute to lifting issues that need to be addressed but could otherwise not be addressed by the users themselves.

During the project the social interplay and how passengers prioritize each other was investigated and resulted in a pecking order. Given the small number of participants, the results can only be assumed to be relevant for limited cultural context. However the results still highlight interesting aspects such as that an 85 year old walker user would sometimes choose to give up their seat for a 40 year old passenger with a pram.

The results of the project suggest that a lot can be done to improve the city bus experience through vehicle design. Even if vehicle design in itself is not enough to create fully equal terms, it can still contribute to more equal terms by making buses adapted to meet the wants and needs of elderly passengers. To resolve the underlying problem on a system level, collaboration between all actors throughout the public transportation is however still needed.

Guidelines to inform vehicle design were created, complete with applied examples. The brief format of the guidelines seems to be well adapted for Scania. The applied examples also became a very good complement to the guidelines, clearly illustrating how the design directions can be used to inform product development. Although the concepts were only developed to a
conceptual stage, they still serve their purpose well. All three concepts could also have potential as actual vehicle designs if brought to a higher resolution with complete technical solutions.

The final Entry/exit support concept supports equal terms by allowing users to board and exit by themselves to a greater extent. By creating a design inspired by how elderly persons use handrails, the concept is very likely to support users in the intended way. However, a provision for the concept to work is that a technical solution is added to guarantee that the doors stay still when the support is in use. The concept could also be even more useful on buses with more steps at the doors, such as coaches, where more effort is required for elderly passengers when boarding and alighting.

The final Walker seat concept improves the situation for walker users by providing them with a designated seat that allows them an area where they have priority and limits walker users to one door option when boarding to reduce risks. By considering the passenger flow when developing the concept, the walker seat is also likely to be possible to integrate well in the city bus environment. The attitudes of interviewees asked about the idea of a walker seat already during the user studies also strongly pointed towards that a walker seat would be highly appreciated, which further supports the concept.

The final One vehicle – two buses concept improves the overall situation on the bus not just for elderly- but also for other passengers. By allowing passengers more equal terms by making it possible for them to travel at their own pace, risks and stress can most likely be efficiently reduced. Apart from the advantages related to flow, the concept also contributes to supporting equal treatment and social inclusion, for example by offering more than one “front door” for boarding passengers, making segregation of passengers such as wheelchair users less apparent.

8.1 Further development

To improve the elderly passenger city bus experience by preventing accidents, reducing stress and allowing elderly passengers to travel on equal terms, the guidelines developed through this project are recommended to be used to inform vehicle design.

To develop the guidelines further, more research could be made to confirm the results and to expand the cultural and geographic scope. Similar guidelines could also be developed for other passenger groups, such as passengers with wheelchairs and passengers with prams.

The design concepts developed through the project could also be developed further. To evaluate the concepts, the next step would be to build life-size mock-ups to test the designs and get feedback from real users.
To improve the elderly passenger city bus experience, prevent accidents and reduce stress in the city bus vehicle environment, the bus needs to be adapted to allow elderly passengers to travel on equal terms and thereby meet the wants and needs of the elderly passengers.

The overall wants and needs of the group of elderly passengers represented by the participants can be described through three themes, Independence, Social well-being and Co-existing flows.

To reduce stress and prevent accidents for elderly passengers in the vehicle environment, key measures are to allow passengers to travel at their own pace, to provide passengers with space adapted for them that they have the right to claim, to make sure that passengers can safely bring belongings, to make sure that they can have contact with the driver and to allow passengers to use their own personal techniques to make difficult situations easier and safer.

To support equal terms for elderly passengers in the vehicle environment, key measures are to make it possible for elderly persons to travel without help or having to accept special treatments, to make it possible to safely bring mobility aids and shopping trolleys, to make it possible for elderly passengers to socialize with each other and with the driver, to allow elderly passengers to travel at their own pace and to provide them with space adapted for them that they have the right to claim.

To make it safer for elderly passengers to board and alight, one solution could be the Entry/exit support concept. To improve the situation for walker users, one solution could be the Walker seat concept. To design the vehicle environment to allow passengers to travel at their own pace, one solution could be the One vehicle – two buses concept.

A brief guidelines document including background information, design directions and applied examples was a suitable way to mediate the main findings of the project to Scania.
REFERENCES


ECE-R 107/06 (2014) *Regulation No. 107 Uniform provisions concerning the approval of category M2 or M3 vehicles with regard to their general construction.* United Nations


https://www.msb.se/RibData/Filer/pdf/27623.pdf


## APPENDIX A – TIME SCHEDULE

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Scania started building city buses more than 100 years ago and has since then developed into one of the largest bus manufacturers in the world. Over the years, many innovative models have been made, such as the simple space-saving “Bulldog” and the ethanol city buses, Figure 1. (Scania 2011)

Figure 1. Scania-Vabis “Bulldog” 1932 (above). Scania ethanol city bus 1986 (below).

Scania provides both complete city buses and chassis for urban fleets. The current city bus line-up, Scania Citywide, offers fully customizable city buses in a variety of different sizes, configurations and fuel options, available in both low-floor and low-entry versions. Layouts and interior details are also customizable to meet every customer’s needs, Figure 2. (Scania 2017)
The Citywide line-up is designed to support business efficiency by providing reliable vehicles built for capacity and comfort. As for all Scania buses and coaches, sustainability is also central, leading the way by providing energy efficiency, alternative fuels and smart transport solutions. Apart from offering buses and chassis, Scania has also expanded their services offering with services such as Scania Fleet Care, Fleet Management and driver training. (Scania 2017)

References


Making public transportation possible to use for persons with reduced mobility has been a long term standing process in Sweden. In 1979 the law of handicap adaptation of public transportation was passed, stating that public transportation providers are required to make sure that services are adapted for passengers with functional impairments, as well as that specific needs of persons with functional impairments should be taken into account when public transportation services are planned and executed (Lag 1979:558).

The current policy for accessibility of public transportation was adopted in 2009. Among other things the specification of the functional goal for accessibility states that the transportation system is to be designed so that it is useful for persons with disabilities (Prop. 2008/09:93). A strategy for implementing the policy was also put in place, focusing on increasing accessibility of certain connection points, collaboration between actors in the transportation sector and increasing the number of persons with disabilities that experience that they have possibility to travel by public transportation (Regeringskansliet 2011). In 2012, when the new law of public transportation became effective, the regional transportation authorities, RKMs, became responsible for establishing and implementing transportation programs accounting for time limited goals and specific measures to continue to develop the regional transportation system. In detail, the programs were also to account for how connection points and services were to be made fully accessible to everyone (Lag 2010:1065).

According to a review of the accessibility of the transportation system for persons with functional impairments by Trafikutskottet (2013), there were still a lot of barriers making public transportation difficult to use. Yearly reviews of the goals of transportation policy carried out by Trafa (2017a) suggest that since the current goals were adopted in 2009, only a marginal improvement of accessibility has occurred. In the 2016 review, Trafa (2016) assesses the development to head in a positive direction given that stations are being adapted at a rate corresponding to the national plan and that the number of accessibility adapted vehicles has increased over the past years.

In an ongoing review of the transportation programs established by the regional transportation authorities, 14 of the currently reviewed 15 programs (out of 21 in total) presented deficiencies in accounting for connection points and services that should be fully accessible for everyone. 10 of the 15 reviewed programs also presented deficiencies when accounting for time limited goals and measures to implement accessibility adaptation (Trafa 2017b). The results suggest that the RKMs are currently still largely unable to comply with the legislation. According to Transportstyrelsen (2016) one problem is the absence of a clear definition of what a “fully accessible connection point” is, causing confusion in both acting- and governing authorities.
References


APPENDIX D – ACCIDENTS AND INJURIES

Reports


The report by Malmström (2015) issued by Transportstyrelsen, provides an overview of bus related accidents in the Stockholm region based on data from Strada health care sources. According to the report, 350 persons were registered in Strada when seeking medical treatment for injuries sustained in bus related accidents during the three-year period 2011 to 2013. However, according to Malmström (2015) there is a large overall risk of hidden statistics due to unrecorded occurrences, for example since data collection in Strada is dependent on that persons seek medical treatment at an emergency room where registration can take place. Incidents may also go unrecorded if the driver fails to notice the incident and does not report it back to the company.

The report by Berntman, Holmberg and Wretstrand (2012) covers a study including bus related accidents in Helsingborg, Kristianstad, Lund and Malmö during the years 2006-2009. Apart from data from Strada police- and healthcare sources, the study was also based on replies to a voluntary survey sent out to patients involved in a bus related accidents, including accidents occurring on the way to the bus stop, at four hospitals in the region. In total, 1681 injured in bus related accidents were found by combining the data, including 267 cases unique to the survey but unrepresented in the official statistics. The majority of the accidents occurred in urban areas on local or regional buses and according to the combined data, nearly two thirds are injured in single accidents.

Risks

Both reports found elderly passengers to be the more likely to sustain injuries than younger age groups. Women were also found to be more likely to get injured than men. According to Malmström (2015) almost half of the injured passengers were older than 65 years and 30% were older than 75 years. Of the total number of injured passengers 77% were women and 23% were men. According to the survey respondents of Berntman, Holmberg and Wretstrand (2012) 59% of the injured were older than 65 and 44% were older than 75 years old. Of the 239 persons injured, 82% were women and 18% were men. Malmström (2015) also pointed out that while almost half of the injured passengers were 65+ years, only 4% of the SL passengers during 2013 actually belonged to the age group (SL 2013), which suggests that there is a significantly increased risk for elderly passengers to get injured. The fact that 56% of the SL passengers 2013 were female (SL 2013) while more than two thirds of the injuries were sustained by women was also pointed out as noteworthy. This suggests that women are not overrepresented in accident statistics because the number of women traveling by public transportation surpluses the number of men, but rather because of other reasons.
Injury types

Slight injuries were the most common, but in the group that does sustain more serious injuries elderly passengers are overrepresented. Overall about 20% of all injured persons are hospitalized after the accident, 18% (63 out of 350) (Malmström 2015) and about one out of five of the survey respondents of Berntman, Holmberg and Wretstrand (2012). According to Malmström (2015), 65% of the injured passengers were slightly injured, 19% moderately injured and 7% seriously injured. Among the survey respondents of Berntman, Holmberg and Wretstrand (2012), most passengers also sustained slight injuries. However, the very oldest passengers were claimed to more often be the ones to sustain moderate or serious injuries. Malmström (2015) states that a clear majority of the serious injuries were fractures of the lower extremities, such as hip, femur, knee and foot fractures and that hip- and femur fractures were exclusively found in passengers over 70 years old. Malmström (2015) also suggests that elderly passengers are at greater risk of sustaining serious injuries when falling, due to being frailer than younger persons. Of the moderate and serious injuries, fractures of the upper and lower extremities were most commonly occurring, but also sprains of the cervical spine and neck as well as concussions of a varying degree.

Injury mechanisms

The majority of injures are sustained when the passenger is on the vehicle and due to sudden decelerations or accelerations. According to Malmström (2015), 49% of the injured passengers were standing and sustained injures when falling. 22% were sitting and injured when crashing into interior details or falling from the seat. Sudden forceful decelerations were described as the most common cause for falling and sustaining an injury. Sudden forceful accelerations were also described as a cause and often in the context of the passenger getting seated but not having sufficient time to do so. According to the survey responses of Berntman, Holmberg and Wretstrand (2012), the majority of accidents also occurred while the passengers was on the bus, for example due to the bus leaving the stop before the passenger had sat down or found a safe way to stand. Almost half of those injured while on board the bus was older than 75 years and many of the injured elderly passengers had walkers to maneuver on board. Most fall accidents in the bus were said to be caused by sudden decelerations and were sustained by passengers standing or getting up from the seat. However, cases where a seated passenger was injured due to a sudden deceleration also occurred. Seated passengers sustained injuries both by crashing into interior details as well as falling off the seat.

Sustaining an injury when exiting the vehicle is more likely than when boarding. According to the survey responses of Berntman, Holmberg and Wretstrand (2012), sustaining an injury while exiting the bus was twice as likely as when boarding. The oldest passengers experienced a lot of difficulties while exiting, especially if the bus had stopped far from the curb. The height difference was described as a contributing factor to accidents, along with snow and slippery conditions. In the report by Malmström (2015), 7% of the injured passengers also described that they had been injured by doors closing, either due to getting stuck or falling over as a result of getting pushed. Other reasons for falling over were also described as slipping on snow, ice or water.

When considering other parts of the transportation chain Berntman, Holmberg and Wretstrand (2012) also highlight that the transport to and from the bus stop is a critical part of the chain and increases the total risk of injury of the whole trip substantially.
References


Priority seats

Citea – different colour on priority seats.

Optare – Single priority seats.

Scania – Extra wide seats.

Mercedes – Priority seats placed together.

Mercedes – More leg space

Scania – L-shaped handrail
Wheelchair area

Citea – By the service door.

Optare – At the front door.

Mercedes – Opposite to the service door.
Ramp

Mercedes – Ramp at the service door.

Optare – Ramp at the front door.

Other

Mercedes – Casted seat on wheel cover.
Concept buses

Iveco – Concept bus.

Mercedes – Concept bus.

MAN – Concept bus.
Iveco – Concept bus wheelchair area.

Volvo – Future bus concept.
Appendix F - Insights

Insights regarding Independence, Social well-being, Co-existing flows, Walker, Wheelchairs, Ramp and Usability.

Independence

Elderly people want to be as independent as possible

“I usually answer ‘No thank you, I’ll be fine!’ when people offer help. There will come a day when I will need help, but until that day, I want to be as independent as I can be” – Mathilda 80+, SL service 54

Elderly persons want to be as independent as possible for as long as possible. The line between not needing help and needing help may not be very clear.

Conclusion: The bus environment needs to be designed to avoid making elderly persons dependent on others to the furthest extent possible.

Many passengers are kind and offer to help elderly passengers, but it cannot be taken for granted

“I think lots of people are nice and offer help and their seats” – Mathilda 80+, SL service 54

“I would like to see more younger people stand up for elderly people more often” – Maj 80+, Östermalm

“It is not a privilege (to be handicapped) anymore, as it was back in the days” – Benny 80+, SL service 921

People have a hard time noticing if they need to stand up when an elderly passenger can’t find a seat, a lot of people have all of their attention on their phones – Observations made on SL service 1 and 4

A man standing in the pram area looking down on his phone fails to notice a woman with a pram entering and end up being trapped in the inner corner of the area – Observation made on SL service 4

In many cases elderly people get help from other passengers, but there is no guarantee that help will always be offered. People are also often otherwise occupied and may have a hard time noticing if they need to give up their seat.

Conclusion: Elderly passengers need to be able to use public transportation without having to rely on the kindness and attentiveness of others.
Drivers frequently stop the bus leaving a gap between bus and curb

“If the distance to the curb is too far I need help to exit” – Signe 85+, SL service 4

“Sometimes you have to wait until the driver has continued forward a bit further” – Signe 85+, SL service 4

The bus often stops with the front door close to the curb, but the service doors further and further away leaving a triangular gap between the bus and the curb. – Observation, SL service 1 and 4

The driver often stops leaving a gap between the bus and curb. When the distance is too far, it becomes difficult for elderly persons to exit and they may need help. The gap tends to be the smallest at the front door and increase towards the rear end of the bus.

Conclusion: Since the gap tends to be smaller in the front end, elderly passengers should board and exit as far forward as possible to make it more likely that they can do it by themselves.

Not all elderly persons want or need special treatment

Some elderly persons move sideways in order to reach a red stop button even if they have a blue one within reach – Observation made on SL service 1 and 4

“I’m not old enough to press the blue stop button” – Albert 80+, SL service 54

On the SL Närtrafiken service, there is no practical difference between the different stop buttons. The driver waits for everyone to get off properly. – Observation, SL Närtrafiken Lidingö

Even if special treatments such as designated stop buttons are offered, they may be rejected by the intended users. Having to accept special treatment may also be perceived as disparaging. A system that works without special treatments supports the dignity and self-esteem of all users.

Conclusion: The bus environment needs to be designed without special treatments to the furthest extent possible. If special treatments are necessary, they need to be offered and performed in a way that does not feel disparaging to the user.
Some passenger groups, such as wheelchair- and walker users, are restricted to entering through the “back door”, which counteracts equal terms and equal treatment.

A young woman in a wheelchair has to ask the driver three times before he agrees to step out and help her with the ramp. – Observation, SL service 72

Passengers restricted to entering through the service doors and are not obliged to pay travel by the good grace of the bus service rather than their right to travel with it, since they in some sense become freeloaders – Observation, SL service 1, 4, 54 and 72

On most city buses it is not possible for passengers with wheelchairs and walkers to enter through the front door, otherwise used for boarding. Being restricted to enter through the “back door” does not support their right to travel on equal terms and receive equal treatment. Not being obliged to pay for the service could also make it harder for these passengers to claim their right to equal terms and treatment.

Conclusion: All passengers need to be welcome to board in a way that supports feeling social inclusion and equal treatment.

Elderly persons are often presumed to live less active lifestyles than they actually are

“People get stuck in old thinking patterns, now-a-days an 80-90-year-old can be very active”
– Albert 80+, SL service 54

Seniors today are far more active than seniors of the same age were before. People however often presume persons of high chronological age to live an inactive lifestyle.

Conclusion: Many elderly persons live active lives. When designing environments for elderly persons, active lifestyles should be taken into account by for example making space for shopping trolleys.
The prioritized area is not adapted for passengers bringing shopping trolleys

A lot of elderly passengers carry shopping trolleys or bags – Observation made on SL service 1, 4 and 54

A man with a shopping trolley manages to sit with the trolley squeezed in between him and the rail in front of him on a prioritized seat – Observation made on SL service 1

An elderly woman sitting on a prioritized seat parks her shopping trolley in the aisle – Observation, SL service 1

A shopping trolley belonging to an elderly lady gets caught on the back of a seat protruding into the aisle, she backs up and goes forward a number of times before managing to release it – Observation made on SL service 1

“Once there was a lady who had a shopping trolley with a package of eggs on the top that fell over (...)” – Gunvor 80+, Lidingö

“Once, my shopping trolley got caught on something in the subway and made me fall backwards. Please tell everyone you see to keep the trolley in front of them, it’s much safer!” – Frida 85+, Fältöversten

Being independent also means being able to buy groceries by oneself. Shopping trolleys make it easier to transport things and a lot of elderly passengers bring shopping trolleys with them on the bus. For passengers sitting on prioritized seats it can be hard to find somewhere to put the trolley, due to the limited space. Trolleys end up standing in the aisle or squeezed in, in front of passengers. If not placed in a secure way, they can also fall over. It can also be hard to manoeuvre with the shopping trolley in the bus, which can put passengers at risk of falling.

Conclusion: The prioritized area needs to allow passengers to bring shopping trolleys as well as to place them in a secure way.

The height difference between ground and bus limits how much groceries walker users can buy at a time

“I can’t buy too much. Then I can’t lift the walker on to the bus” – Signe 85+, SL service 4

“I usually take the bus daily, it’s my only opportunity to go out and shop” – Signe 85+, SL service 4

Since walker users have to lift their walker on board the bus, the amount of things they can buy before it becomes too heavy is very limited. Buying groceries could therefore require making multiple trips.

Conclusion: Having a height difference between ground and bus causing elderly users to have to lift their walker to board the bus lowers the usability of the walker significantly.
The best way to exit with a walker is backwards

“I have found the best technique to exit with a walker, you exit backwards. Once I even got a comment from a driver, she said - Here’s someone who has found out how to do it! to me” – Mathilda 80+, SL service 54

“I have recommended the technique to several people, but some can’t do it. They can’t turn their head far enough, you have to be able to look backwards” – Mathilda 80+, SL service 54

When exiting the vehicle with a walker backwards, balance can be maintained in a better way. The person first moves up to the door and steps out, holding on to the walker securely while stepping down. The walker can then be dragged out back wheels first and then front wheels in a controlled pace. When exiting forward with a walker, the person has to support themselves on the walker while it is positioned tilting forward, as the front- and back wheels are pushed out down on the ground. This leads to an uncontrolled movement, which subjects the person to a higher risk of losing their balance. Some walker users are however unable to do it.

Conclusion: People with reduced mobility invent their own solutions to make things easier. When designing it’s important to create features that allow people to use their own techniques. Personal techniques can sometimes also be taught to help others.
Social well-being

Access to usable public bus services can prevent elderly people from getting isolated

“I usually stay at home during the weekends when it’s slippery outside and there’s no bus (Närtafiken is not in service during weekends)” – Gunvor 80+, Lidingö

“I know many people who would love to be able to get out on weekends, to go the graveyard for example, but they can’t (Närtafiken is not in service during weekends)” – Gunvor 80+, Lidingö

“It’s important to get out to move and see things a bit” – Mathilda 80+, SL service 54

“I am very lonely (...) My children are under a lot of pressure from work, they don’t have time. (...) It’s boring to be alone (...) I go to senior gatherings sometimes, that’s nice” – Mathilda 80+, SL service 54

Both physical activity and social interaction is important for maintaining good health. Having access to and being able to use bus services can be the thing that prevents elderly persons from becoming isolated involuntary.

Conclusion: Providing elderly persons with access to usable public bus services can prevent them from becoming isolated.

The distance to- and accessibility of a bus stop determines who has the ability to take the bus

“It’s hard to get to the regular bus stop, they’ve moved it far away” – Gunvor 80+, Lidingö

“Where I live it’s ‘vinkområde’, the bus stops directly in front of the house number where you are at” – Gunvor 80+, Lidingö

The effort required to get to the bus stop determines if an elderly person can take the bus or not.

Conclusion: Even if the bus was to be made more accessible, the accessibility of the bus stop would still limit who could ultimately use it.
The design of the bus divides socializing people

A pair of elderly women who meet at the bus stop start chatting happily. On the bus they have to stop talking because they cannot find a way to sit together since one of them has a walker – Observation made at Fridhemsplan

A company of four people split in half because one the persons need to sit in the prioritized area and the rest of them do not want to take up the rest of the seats there – Observation made on SL service 54

Socializing groups of people have trouble finding seats together on the bus when some of them have to sit on prioritized seats or have walkers. An everyday encounter with a friend on a bus might fulfil a large part of an elderly person’s need for social interaction, it is therefore important to make the most of every meeting.

Conclusion: The bus needs to be designed to allow persons of different passenger groups to sit together.

Socializing with the driver can have a strong positive effect on elderly passengers

“I like to have a personal contact with the driver” – Albert 80+, SL service 54

“The drivers are very nice and recognize everyone” – Gunvor 80+, SL Närtrafiken Lidingö

“Once there was a lady who had a shopping trolley with a package of eggs on the top that fell over. The driver insisted on that the lady should come down to the next service so she could buy her new eggs to replace them. She did, and the driver got her new eggs.” – Gunvor 80+, SL Närtrafiken Lidingö

Having personal contact with the driver can be very highly appreciated by elderly passengers. Drivers that passengers meet regularly become acquaintances that can feel very meaningful, especially for persons with otherwise few social contacts. On SL Närtrafiken Lidingö, there are only a few drivers sharing all the services. Since they recognize passengers and know where many of them live, they can also remind passengers to get off at the right stop. Since the drivers keep a close eye on all elderly passengers, safety is also likely to be increased.

Conclusion: The bus needs to be designed to allow elderly persons to get close enough to the driver to be able to have a conversation at some point during the journey.
A handle to hold while sitting can provide a feeling of comfort and safety

“I like having my hand on the handle in front of me, it feels restful and safe (...) Maybe it’s something that comes with age” – Albert 80+, SL service 54

“I like to hold on to something during the journey, especially when it shakes and wobbles” – Carl 80+, Karlaplan

For some elderly persons, holding on to or resting one hand on something while seated during the journey seems to offer an extra sense of safety and comfort.

Conclusion: Having something to hold on to during the journey may provide a feeling of comfort and safety.
Co-existing flows

Elderly passengers adapt their behaviour to a fast passenger flow

“I prefer to sit at the very front or behind the doors in the middle of the bus, it’s convenient when I am getting off and I have good oversight” – Albert 80+, SL service 54

“I like to get up in advance, so that I am at the doors when they open” – Maj 80+, Östermalm

Elderly people who don’t stand up to prepare for exiting prepare while still seated. Some turn their feet into the aisle and grab the handholds tight – Observation made on SL service 1, 4, 54

An elderly woman squeeze herself past a foreign woman sitting on the outer seat to get to the doors before the stop, as it turns out both her and the other woman are exiting the vehicle at the next stop – Observation made on SL service 1

Elderly people adapt to a fast passenger flow by either preparing to exit passively, by for example choosing a seat close to a door, or actively, by getting up and moving towards the door before the stop. When elderly persons get up and go to the door before the bus has stopped properly, they are at a higher risk of falling.

Conclusion: Having to adapt to a faster flow than comfortable increases risk of accidents.

Different passenger groups have a different flows

“I don’t get stressed when other people are in a rush” – Maj 80+, Östermalm

Two elderly passengers stop completely after entering to scan their tickets – Observation made on SL service 1

A shopping trolley belonging to an elderly lady gets caught on the back of a seat protruding into the aisle, she slowly backs up and goes forward a number of times before managing to release it – Observation made on SL service 1

An elderly woman with a shopping trolley becomes standing in the doorway waiting for other passengers to continue down the aisle before continuing to move inside to find a seat – Observation made on SL service 1

“It’s complicated to have to move around all the time (with the walker)” – Birgitta 75+, Gärdet

Passenger flow is not one single flow, but multiple flows existing side by side. The tempos could roughly be categorized as “fast” or “slow”. Elderly persons appear to more often have a slow flow, compared to other passenger groups. In some situations the flows collide and passengers end up waiting for each other or having to move out of the way.

Conclusion: The passenger flow consists of multiple co-existing flows. Problems occur when different flows collide.
Pram, persons with larger bags, elderly persons with walkers and wheelchairs all compete about the same space

Two elderly persons with suitcases sitting in the pram area are forced to move when a woman with a pram enters the bus. The elderly persons end up standing by the door. Observation made on SL service 4

“I put my walker in the pram area and sit on the seat just behind it” – Mathilda 80+, SL service 54

“It’s complicated to have to move around all the time (with the walker)” – Birgitta 75+, Gärdet

An elderly women with a shopping trolley can’t find an available seat with enough space for it, she ends up standing – Observation made on SL service 4

A large group of persons with different needs all compete over the pram area. Since prams and wheelchairs have priority, elderly persons with shopping trolleys and walkers are often forced to move.

Conclusion: Some passenger groups, such as walker users, do not have priority in any area and therefore have to move around a lot.

Non prioritized passengers spread evenly over all seats, including prioritized seats

People tend to spread out evenly over all the seats, sitting one passenger at every pair of seats before starting to fill out the second seat – Observation, SL service 1, 4, 54 and 72

There is no larger visual difference between ordinary seats and seats for persons with reduced mobility – Observation made on SL service 1, 4 and 54

Passengers tend to follow a pattern spreading evenly when choosing seats; single passengers occupy one pair of seats each and when all pairs are occupied by one passenger, the second seat in each pair starts to be filled. If the prioritized seats are free, non-prioritized passengers may also choose to spread evenly over prioritized seats.

Conclusion: The flow of non-prioritized passengers needs to be directed in order to guide them away from prioritized seats. A greater visual difference could also be helpful to differentiate prioritized- from non-prioritized seats.
Letting passengers enter through the middle doors is very time efficient

A large group of school children enter through the middle doors, a teacher stands inside the door hurrying them along and making sure everyone enters. The front section of the bus is relatively unaffected by the large amount of children entering – Observation made on SL service 1

Few people entering through the middle doors chose to go forward – Observation made watching SL service worker at Fridhemsplan

By letting people enter through the middle doors, the front section does not get crowded. The flow is optimized, as people get in faster by boarding through two doors. Passengers also seem more likely to move further back instead of staying in the front or middle of the bus.

Conclusion: Boarding through the middle service door is a good way to avoid the front section to become crowded and move passengers as far rearwards as possible.

How the driver acts largely affects the passengers

Drivers do not always wait for elderly passengers to sit down before they drive off – Observation made on SL service 1 and 4

“You can’t stand up while the bus is driving, it’s a rule. When someone stands on the bus, the driver tells them that it’s not allowed” – Gunvor 80+, Lidingö

How the driver acts impacts the behaviour of the passengers. If the driver starts the bus before an elderly person is properly seated it sends the message that it is not important for the person to sit during the journey. If the bus instead has a no-standing rule enforced by the driver, passengers are very likely to respect the rule and sit.

Conclusion: The drivers need to use their influence to promote wanted behaviour, as well as to be aware of what the wanted behaviour is.

The interfaces between passenger and bus are not always intuitive or clear

“The doors should be improved, it’s not comfortable to stand so close to make them open” – Albert 80+, SL service 54

An elderly woman presses the red stop button three times in a row ‘pling-pling-pling’ – Observation made on SL service 4

“Once I thought I had pressed stop, but the bus didn’t stop. Then I was a bit irritated. But it was probably my fault, I probably hadn’t pressed it” – Mathilda 80+, SL service 54

To avoid confusion and mistakes, interfaces between passenger and bus, such as the door sensors and stop buttons, need to be intuitive. They also need to be consistent, so that when doing something in a certain way you always get the same result. Confusion and mistakes tend to become time consuming and make the user feel incompetent.

Conclusion: Intuitive and consistent interfaces are important to optimize the flow.
Walkers

Having two possible areas to put walkers at different service doors result in walker users having to run between the doors outside the bus to ‘chase down’ a seat

“I first aim for the middle door and if there is no space, I quickly hurry back” – Signe 85+, SL service

It is hard to see from outside if the pram- and wheelchair area is occupied or not due to tinted door windows. – Observation, SL service 4

Pram- and wheelchair areas are the only places where walkers can be placed in the bus. In articulated buses there are usually two such areas, one at the middle- and one at the rear service door. Walker users end up in a position where they have to aim for one of the doors, quickly assess if they can fit the walker or not and if it’s already full, hurry to the other door and see if there is still an available space there. Assessing if there is available space or not may also be difficult since other passengers are simultaneously exiting and that the doors may have tinted windows.

Conclusion: The procedure makes boarding the vehicle stressful and increases the risk of accidents, since walker users are forced to move faster than comfortable and risk having the doors closing on them when they arrive late at the second door. Having passengers switching doors during boarding may also make it harder for the driver to keep an eye on passengers and managing to close the doors at the proper time without anyone getting injured.

Sharing the area with prams and small children cause inconveniences for walker users

“It’s complicated to have to move around all the time” – Birgitta 75+, Gärdet

“If there are too many people you can’t go” – Marianne, Östermalm

“And then there’s this idea of mixing elderly persons with small children... (negative)” – Birgitta 75+, Gärdet

When walkers and prams share the same area, walker users have to move around a lot to make space for prams coming and going. Walker users may also have to wait for the next bus it there are too many prams occupying both the pram- and wheelchair area. Mixing small children with walker users is not always appreciated by walker users either.

Conclusion: It is not suitable for walker users and prams to be restricted to share the same space, due to the inconvenience it causes for walker users.
Being able to stay close to the door reduces the hustle of traveling with a walker

“I want to stay as close to the door as possible” – Birgitta 75+, Gärdet

Due to the difficulties in manoeuvring and positioning the walker on the bus, walker users want to stay as close to the door as possible. By staying close to the door they are also in a better position to exit.

Conclusion: By making it possible for walker users to place the walker and sit close to the door, the effort of traveling with a walker can be reduced.

The best way of exiting with a walker is backwards

“I have found the best technique to exit with a walker, you exit backwards. Once I even got a comment from a driver, she said - Here’s someone who has found out how to do it! to me” – Mathilda 80+, SL service 54

When exiting the vehicle with a walker backwards, balance can be maintained in a better way. The person first moves up to the door and steps out, holding on to the walker securely while stepping down. The walker can then be dragged out back wheels first and then front wheels in a controlled pace. When exiting forward with a walker, the person has to support themselves on the walker while it is positioned tilting forward, as the front- and back wheels are pushed out down on the ground. This leads to an uncontrolled movement, which subjects the person to a higher risk of losing their balance.

Conclusion: The safer technique of exiting backwards should be encouraged.

How the walker is placed in the bus determines if the walker user exit forwards or backwards

“I exit forwards or backwards depending on how the walker is placed in the bus” – Marianne 80+, Östermalm

Walker users may choose or be forced to exit in a certain direction depending on how the walker is placed in the bus. The direction that requires the least space, time and rotation of the walker is preferred.

Conclusion: Walkers should be possible to place in such a way that it is easy to exit both forwards and backwards from the initial position.
Walker users exiting backwards need to know the distance to the edge of the step, the distance to the curb and the height of the step.

“I usually exit backwards and I want to see where I step. I need to know the distance to the edge, the height and how far away the curb is. If it’s too far, I will need help.” – Signe 85+, SL service 4

“I have recommended the technique to several people, but some can’t do it. They can’t turn their head far enough, you have to be able to look backwards.” – Mathilda 80+, SL service 54

Conclusion: The important things to know for walker users exiting backwards is where the edge is, how high the step is and how far away the curb is.

Sitting close to the walker is more safe and convenient

If walker users sit next to the walker they don’t have to take out and carry their bag – Observation, Gärdet

“I usually sit on the seat right behind the pram area so I can reach the handle if it starts rolling.” – Marianne 80+, Östermalm

“I rather want to sit close to the walker.” – Marianne 80+, Östermalm

When walker users sit next to the walker they both have good overview of their belongings and can prevent the walker from rolling away during the journey. It also makes it possible for the user to use the walker for support during the journey.

Conclusion: Walker users should be able to sit next to the walker during the journey.

A walker is not stable enough to support walker users getting up from a seat on the bus

Handrails or handholds are still needed to help the user get up safely, even if the user has a walker. – Observation, SL service 4

“It’s enough to hold on to the walker to stand up when the surroundings are still, but not when they’re moving. I want to have handles to hold on to first and then I can grab on to the walker.” – Marianne 80+, Östermalm

“The handles cannot be too far forward, then they will be in the way when you are getting up” – Marianne 80+, Östermalm

Walkers can be used as support when getting up if the surroundings are completely still, but not while in motion, as on the bus.

Conclusion: Handrails or handholds need to be provided to support walker users when getting up.

xxvii
Sideway facing seats work well for elderly persons with walkers, but side support may be needed

“The seats facing sideways work well for walkers” – Gunvor 80+, Lidingö

An elderly woman sitting on the sideways facing seat closest to the door holds a tight grip around the vertical rail next to her and supports the rest of her arm along the rail during the entire trip for good stability – Observation made on SL service 1

Sitting sideways requires more strength than sitting forwards or backwards, but if there is a handrail to hold on or some other form of side support, stability can easily be increased.

Conclusion: Walker users can sit sideways in the bus, but may need some extra support.
**Wheelchairs**

Wheelchair backrests are not possible to use correctly for wheelchair models with closed loop handles

*A woman in a wheelchair model with a loop shaped handle enters the bus and places her wheelchair against the backrest. Only the tip of the closed loop handle touches the backrest, which makes her sit far from the backrest leaving her back and neck unprotected, occupying more than half the combined pram- and wheelchair space. – Observation, SL service 1*

The wheelchair backrest is not adapted for wheelchair models with closed loop handles, since the backrest design prevents the passenger from getting close to it when placing the wheelchair correctly. Passengers ends up unable to use the backrest to protect their back and neck. Since they are unable to get close to the backrest, the placement of the wheelchair also becomes very space inefficient.

Conclusion: According to the current regulations (ECE) the backrest is to form a continuous surface, leaving no possibility of redesigning the backrest in a way that could resolve the issue. Either regulations or wheelchair designs have to be changed.

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Wheelchair backrests are often used as side supports instead of backrests

*Wheelchair users often place the wheelchair with the side towards the backrest instead of the back, in order to make space for prams or other passengers. Observation, SL service 1 and 72*

In total, 3 out of 4 observed wheelchair users chose to sit sideways instead of rearwards. Placing the wheelchair in a correct rearward facing position is more space consuming than placing it sideways. If there are prams in the wheelchair area, placing the wheelchair in a rearward direction would also make it impossible to exit the bus without the pram exiting first.

Conclusion: The design of the wheelchair area needs to be adapted allowing users to sit sideways, using the backrest as a side support. For example making sure that the wheelchair handhold does not cover the backrest when folded, making it uncomfortable when using it as a side support.
Ramp

The ramp needs to become more socially available

“I would like to use the ramp if it is offered, but I don’t want to trouble others” – Marianne 80+, Östermalm

Zero cases of the ramp being used to aid a walker user boarding or alighting was made throughout the entirety of the project – Observation, SL Service 1, 4, 54 and 72

A young woman in a wheelchair has to ask the driver three times before he agrees to step out and help her with the ramp. – Observation, SL service 72

The driver helping a young woman with a wheelchair to unfold the ramp releases it from a height of approximately half a meter, resulting in a loud ‘bang’ causing most passengers on the bus to cry out in pain and cover their ears. He then repeats the same process when folding the ramp back, but fortunately the ramp compartment inside the bus was padded, muffling the noise. However passengers expecting another loud ‘bang’ were equally startled the second time. – Observation, SL service 72

To be able to use the ramp, passengers often explicitly have to ask the driver to unfold it. In some cases this may make the ramp inaccessible for persons who would like to use it, but do not obviously look like they need to use it and do not want to bother others. From the driver’s perspective offering the ramp means becoming delayed, having to leave the driver’s area unattended and having to lift the ramp with a dirty handle from floor height. For other passengers, someone using the ramp means boarding and exiting being delayed. Currently, the ramp is only used when obviously one hundred percent necessary.

Conclusion: Having to explicitly ask for the ramp knowing the inconvenience it causes to the driver and other passengers becomes a large social obstacle of using the ramp. The final decision on whether the ramp is to be used or not also needs to fall on the passenger instead of the driver. Lifting from floor height cannot be recommended from an ergonomic standpoint.

Using the ramp is very time inefficient

A man in an electric wheelchair wants to exit, it takes 10 seconds before the driver (who still is very observant) notices. It then takes another 20 seconds for the driver to go out and unfold the ramp. The man exits in 2 seconds. It then takes about another 30 seconds before the driver is back and ready to drive. Observation, SL service 1

The time it actually takes a wheelchair user to exit is only a fraction of the time the procedure of noticing that the ramp should be used, climb out, unfold the ramp, fold the ramp back and return to the driver’s area for the driver. Even if the driver is observant it can still take time to notice that someone wants to exit. Using the ramp also interferes with other passenger flows, since no-one can board while the driver is away or use the door to exit while the ramp is in use.

Conclusion: The ramp is not efficiently integrated in the flow.
Usability

Elderly persons may not be able to use seats with too little leg space

“I avoid seats with too little leg space” – Albert 80+, SL service 54

“I like to sit in the ‘sofa’ at the rear end of the bus the most, so that I can stretch out my leg. I’ve had an operation” – Maj 80+, Östermalm

Elderly persons may need to stretch out their legs to sit comfortably. The need for adequate leg space may also apply to elderly persons not in need of using a prioritized seat.

Conclusion: A large number of seats in the bus should have adequate leg space. If only prioritized seats have enough leg space they become very attractive for non-prioritized passengers who also need more leg space, making it harder to discourage non-prioritized passengers from using them.

The pram area is not possible to place effectively if prams can’t be placed in a transverse direction

An elderly woman has to sit on her walker in the bus during the journey since the pram next to her cannot be placed in the transverse direction due to the narrow gangway and seats on the opposite side – Observation, SL service 4

When there are seats on the opposite side of the pram area making the gangway next to the area narrow, there is not enough space to place prams in a transverse direction with the handle towards the aisle. This causes the area to be occupied in a space inefficient way.

Conclusion: The pram area needs to be made as deep as possible and allow prams to be placed in a transverse direction without completely blocking the aisle.

Handles and rails become inaccessible to people holding on to crutches or walking sticks

An elderly woman with walking sticks gets up from her seat and starts moving towards the door while the bus is waiting for a red light in the intersection before the bus stop. She has trouble grabbing the rails properly with the hand she is carrying the walking sticks in. – Observation made on SL service 4 16/2 2017

“I don’t usually hold on to anything while the bus is driving” – Benny 80+ traveling with a crutch and a plastic bag, SL service 921

Handles and rails become inaccessible when people have their hands occupied. Since they are unable to grab the rails and hold on properly they are at an increased risk of falling.

Conclusion: Handrails need to be possible to use for support without gripping them with the hands.
Handles should be possible to use both for left and right handed persons

“I’m right handed, so I’d like a handle on the right side. “ – Birgitta 75+, Gärdet

Handles need to be adapted for both left- and right hand use.

Conclusion: Handles need to be adapted for both right- and left handed users.

---

Elderly people standing up during the journey can stand more stably if they have support for a larger area of the body

An elderly man is chatting vividly with the driver, leaning against the door to the driver’s area with both forearms supported by the flat top surface – Observation made on SL service 54

An elderly women leans her back towards the wall of the articulated section to stand stably – Observation made on SL service 1

In occasions when elderly passengers have to stand up during the journey. They are able to stand more stably, if they have support for a larger part of their body than just their hands.

Conclusion: Elderly passengers need to be provided with features allowing them to stand more safely, supporting a larger part of their body.

---

Stop buttons limit the useable area of handles and rails

An elderly man fully extends his arm to reach above the uppermost stop button of the rail in front of him and heaves himself up – Observation made on SL service 1

The usable area of handles and rails is reduced when stop buttons are fitted to the rail. Stop buttons also disrupt the path, making it difficult to move a hand along the rail in a continuous motion. Sometimes the number of stop buttons on the same rail is excessive.

Conclusion: Stop buttons should not be placed in such a way that they reduce the usability of the rail.

---

Passengers frequently get straps and clothes caught on the foldable armrests

A younger women walking past the prioritized seats get the wire of her headphones stuck on the armrest and has to back up to release them – Observation made on SL service 1

An elderly woman gets the strap of her handbag caught on the armrest as she attempts to sit down on the inner prioritized seat. – Observation, SL Service 1

Straps and other things tend to get caught on the foldable armrests as passengers pass by or sit down on the prioritized seats.

Conclusion: The foldable armrests need to be designed to prevent things from getting stuck.

---
The foldable armrests require prioritized passengers to make a lot of extra manoeuvres

Some elderly passengers have to fold the armrest back to get enough space to sit down – Observations made on SL service 1 and 4

An elderly women struggles to fold the armrest down while sitting – Observation made on SL service 4

The foldable armrests constantly need to be unfolded and folded as passengers sit and get up from the prioritized seats.

Conclusion: The armrests need to be designed to be possible to manoeuvre smoothly, without causing passengers to have to put a lot of effort into using them.
### Table 1. Entry handle functional requirements

<table>
<thead>
<tr>
<th>Usability</th>
<th>Easy to reach from outside vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Easy to see</td>
</tr>
<tr>
<td></td>
<td>Intuitive to use</td>
</tr>
<tr>
<td>Function and placement</td>
<td>Firm and stable support</td>
</tr>
<tr>
<td></td>
<td>Possible to support lower arm on top of rail</td>
</tr>
<tr>
<td></td>
<td>Provide two parallel rails</td>
</tr>
<tr>
<td></td>
<td>Possible to grip fastenings for a steady grip</td>
</tr>
<tr>
<td>Safety</td>
<td>Low risk for things to get caught</td>
</tr>
</tbody>
</table>

### Table 2. Exit handle functional requirements

<table>
<thead>
<tr>
<th>Usability</th>
<th>Easy to reach from inside</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Easy to see</td>
</tr>
<tr>
<td></td>
<td>Intuitive to use</td>
</tr>
<tr>
<td></td>
<td>Predictable</td>
</tr>
<tr>
<td>Function and placement</td>
<td>Firm and stable support</td>
</tr>
<tr>
<td></td>
<td>Extend at least 100 mm</td>
</tr>
<tr>
<td></td>
<td>Space efficient in storage position</td>
</tr>
<tr>
<td></td>
<td>Space efficient movement</td>
</tr>
<tr>
<td></td>
<td>Automatic deployment</td>
</tr>
<tr>
<td></td>
<td>Automatic retraction</td>
</tr>
<tr>
<td></td>
<td>Deploy/retract with door motion</td>
</tr>
<tr>
<td>Technical solution</td>
<td>Long life</td>
</tr>
<tr>
<td></td>
<td>Low complexity</td>
</tr>
<tr>
<td></td>
<td>Driven by door movement</td>
</tr>
<tr>
<td>Safety</td>
<td>Low injury risk</td>
</tr>
<tr>
<td></td>
<td>Low collision risk</td>
</tr>
<tr>
<td></td>
<td>Low risk for things to get caught</td>
</tr>
</tbody>
</table>
Entry/exit support cad variations

The first version was a square shaped handhold extended from a three armed door joint, see Figure 1.

Figure 1. First version in storage position (left). First version in outmost position (right).

For the second version, a top-and-bottom door arm was used as the base, see Figure 2.

Figure 2. Second version in outmost position (left). Second version while opening (right).

A third version was also made, combining the door arm and handhold, see Figure 3.

Figure 3. Third version in storage position (left). Third version in outmost position (right).
## APPENDIX I – REQUIREMENTS WALKER SEAT

<table>
<thead>
<tr>
<th>Table 1. Walker seat requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Usability</strong></td>
</tr>
<tr>
<td></td>
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<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td><strong>Function and placement</strong></td>
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</tbody>
</table>
The main objective of the mock-up was to test the scenario of approaching the seat, sitting down and placing the walker in front of the seat, standing up and walking back towards the initial position. Two separate rough pathways were constructed by using a stool with the approximate dimensions of a bus seat, a bag to mark the available space on the side of the seat and a pathway similar to the shape of the gangway and door area, see Figure 1.

Figure 1. Scenario 1 - door side (left) and scenario 2 – opposite side (right).

In the first scenario, the walker seat was placed on the door side. When approaching the seat and sitting down, steering along the pathway, placement of the walker as well as how close the walker could be placed to the seat was tested. When standing up and walking back, the turning radius and space needed to manoeuvre was estimated. Exiting both forwards and backwards was also tested separately. The procedure was then repeated for the second scenario with the walker seat placed on the side opposite to the door.

Two different common walker models were used to test each scenario, Legacy 600 and Rollator Soprano, see Figure 2. Both walkers were within the heavier segment and thereby intended for users in need of more support.

Figure 2. Legacy 600 (left). Rollator Soprano (right).
### Table 1. Specification of One vehicle – two buses

<table>
<thead>
<tr>
<th>Bus model</th>
<th>Length 12+ m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Front section</td>
<td>Designated for slow flow</td>
</tr>
<tr>
<td></td>
<td>Manual ticket check at the driver’s area</td>
</tr>
<tr>
<td></td>
<td>No standing zone</td>
</tr>
<tr>
<td></td>
<td>Priority seats mixed with other types</td>
</tr>
<tr>
<td></td>
<td>Walker seat</td>
</tr>
<tr>
<td>Rear section</td>
<td>Designated for fast flow</td>
</tr>
<tr>
<td></td>
<td>Express boarding and automatic ticket check at middle door</td>
</tr>
<tr>
<td></td>
<td>Areas adapted for standing passengers close to rear door</td>
</tr>
</tbody>
</table>
The following simulations were made using the software Pathfinder. To access the software a trial-version was downloaded from the Pathfinder website (Thunderhead 2015).

To create the layouts, the bus was defined as a building with a floor height of 0.25 m. An approximate floor plan of an 18 m articulated city bus was then made and imported to the software. Rooms representing the gangway, seats, pram- and wheelchair areas as well as a walker seat were added, see Figure 1. Doors and steps were also added to create the vehicle doors and elevated seating areas. To simulate passengers in the bus environment, agents were added and assigned specific tasks requiring them to go to a specific seat, wait and exit at a specific time. Four passenger profiles with different walking speed and characteristics were created to represent the groups: elderly passengers, passengers with walkers, fast flow passengers and passengers with prams. To be able to control what door passengers enter and exit the vehicle through, rooms outside the bus layout were also added.

In the first simulation the initial layout of the concept was used. The layout featured three double doors, with the front door belonging to the slow section and the middle and rear doors belonging to the fast section. Passengers in the slow section were assigned the elderly passenger profile, while passengers in the rear section were assigned the fast flow profile. In the scenario, passengers first board the vehicle, proceed their assigned seat, wait until the next stop and then exit the vehicle.

![Figure 1. Simulation 1 with the initial layout.](image)

From the first scenario it quickly became clear that the flow of the first section was not optimal when only one door was available, since it took too long for the slow flow passengers to exit.

In the second simulation, another door was added to the layout in the middle of the front section, Figure 2. The scenario was extended with a second stop where some of the passengers exit. Passengers with pram- and walker profiles were also added.
The door added to the front section was observed to improve the flow, however the walker seat was found to leave a too narrow passage between the front- and rear section when placed between the two middle doors.

In the third simulation the middle door was moved backwards, next to the service door used as the entrance for the rear section, Figure 3. The scenario remained the same as in the previous simulation.
Having the walker seat placed on the door side was found to slightly obstruct the flow, as passengers were observed having to take a detour around the seat when exiting the front section. In the fourth simulation the walker seat was mirrored across to the opposite side to allow better access to the door for passengers exiting the front section, Figure 4. The scenario remained the same.

Figure 4. Simulation 4 with the final layout.

References

APPENDIX M – FINDINGS FROM USER STUDIES
### A new passenger arrives - Who gets the seat?

<table>
<thead>
<tr>
<th>Occupies the seat</th>
<th>85 years old</th>
<th>30 years old</th>
<th>65 years old</th>
<th>35 years old</th>
<th>55 years old</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wants the seat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>90 years old</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 years old</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>68 years old</td>
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<tr>
<td>40 years old</td>
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</tbody>
</table>

**Scenario**

All seats are taken when a new passenger arrives and wants to sit in the wheelchair- & pram area with foldable seats, you currently occupy a seat in the area and can either choose to stay or to offer the new passenger your seat.

Who gets the seat?
Techniques for using handrails

Three useful techniques and features were identified, see Figure 1.

Figure 1. Woman using both hands to climb stairs (above). Woman using lower arm for support, as well as the poles underneath the rail for better grip (below).

References


xliv
GUIDELINES
Designing city buses with the elderly user in mind
“In 2060, every fourth person in Sweden is predicted to be 65 years or older.” - SCB

Sweden is a country with an ageing population and as the number of older passengers increase in the future, so will the demands on public transportation. Today elderly persons often experience difficulties when using public bus services. Aside from issues caused by reduced mobility related to ageing reasons, stressful situations, an increased risk of accidents and unequal terms also become barriers making it hard for elderly persons to travel. This project aims to improve the city bus experience for elderly passengers by establishing guidelines for how vehicles can be designed to prevent accidents, reduce stress and support equal terms. To be able to find and target underlying causes of stress, accidents and unequal terms, a holistic approach considering vehicles in the context of the entire transportation system has been adopted. While in many cases re-designing the vehicle can help partially improve the situation, the root cause of the major problems can still only be resolved by multiple public transportation actors working together.

The purpose of the guidelines is to mediate basic knowledge and understanding of the city bus experience of elderly passengers as well as design directions developed to inform bus design based on elderly passengers’ wants and needs. Applied examples of how the guidelines can be used for product development are also included. For references, more information and other findings, please see the full master thesis project report Designing city buses with the elderly user in mind. The project was made as the final part of the Industrial Design Engineering track of the Design and Product Realisation engineering program at the Royal Institute of Technology in Stockholm, on behalf of Scania Physical Vehicle Ergonomics.

Matilda Svärd
Stockholm, May 28th 2017
CONTENTS

Accidents 4-5

Stress 6-7

Equal terms 8-9

Elderly passengers 10

Priority 11

Designing for Independence 12

Designing for Social well-being 13

Designing for Co-existing flows 14

Summary of design directions 15

Applied examples 16-19

Quick tip!
If you only have a few minutes to spend, start by reading page 12-15.
Elderly passengers face higher risks of accidents when traveling by public bus services. Many accidents can be prevented by one simple thing, staying seated during the journey. Elderly passengers are more likely to have accidents than passengers of other ages when traveling by public bus services. For older women, the risk is very high. Elderly passengers, especially those who use walkers, are at risk of accidents. When boarding or alighting the bus, elderly passengers may find it difficult to find a seat to sit during the journey. Elderly passengers with walkers are in many cases restricted to the rear and upper deck areas due to time pressure and lack of seats. Elderly passengers are also at risk to fall due to sudden accelerations or decelerations while the bus is in motion. In some cases, elderly passengers may fall due to slippery conditions on the bus. The main reason behind why elderly passengers are at higher risk of accidents is due to their mobility restrictions and time pressure. Elderly passengers are often forced to stand up and move towards the doors when the bus is moving to try to find a seat before the driver stops the bus.
Elderly man loosing balance when alighting.
Elderly passengers experience stress caused by **time pressure** when struggling to have time to board, alight or find a seat before the bus takes off. Stress can also be caused by **fear of accidents** or **feeling unable to meet expectations**.

**Background**

In the public transportation system reasons behind stress originate from several different levels. On a system level, tight time schedules can cause stress for both passengers and drivers struggling to keep up. On a vehicle level, situations when elderly persons feel unable to accomplish things they expect themselves able to do can also cause stress. And on an individual level, fear of accidents can cause stress when elderly passengers start to worry after hearing stories of other passengers getting hurt.

Vehicle design can in some ways contribute to reducing stress, for example by making it possible for elderly persons to manage things they expect themselves able to do to a greater extent, but to solve the underlying issues causing stress completely, extensive changes such as restructuring time schedules and changing drivers’ attitudes is however necessary.

**Example - Driver’s influence**

Something that can really make a difference when it comes to reducing stress is the behaviour and attitude of the driver. If the driver acts with considerate behaviour, passengers can be relieved of time pressure and have time to board, get seated and alight without stress. Expressing an understanding attitude can also help reassure elderly passengers that they will be cared for and thereby reduce their fear and worries.
Elderly passengers struggling to have time to board and alight.
Equal terms mean that all passengers not only have the same **access** to public transportation, but also experience the same degree of **usability** and are met with **equal treatment**.

**Background**

Public transportation today is mainly designed for the needs of the working community, supporting fast passenger flow and frequent movement. The main strategy to make public transportation possible to use for everyone is to adapt vehicles through traditional accessible design, but to allow elderly persons to travel on equal terms accessibility is not enough.

Equal terms require an equal degree of usability. On a system level, equal terms can only be achieved if routes and time tables are designed to match where elderly persons want to go to the same extent as they match where other passengers want to go. And on a vehicle level, equal terms can only be reached if the environment accommodates the wants and needs of elderly passengers to the same extent as it accommodates the wants and needs of other passengers. Equal terms also require equal treatment. To be able to support equal treatment both vehicle design and bus services need to shift from the traditional accessible design approach towards a universal design approach to be able to promote social inclusion instead of segregation and stigmatization.

**Example - Entering through the “back door”**

As a consequence of solutions in place to accommodate wheelchairs and walkers on city buses, wheelchair- and walker users are today only welcome to enter through the “back door”. Since they thereby also become unable to scan tickets, their only option is to travel for free on most SL buses. When unable to pay for the service, it may also become harder for them to claim their right to equal terms and treatment.
Elderly passengers wanting to sit together.
In our current age, society has shifted towards requiring a higher basic level of mobility to get through everyday life. Elderly persons are also expected to be mobile but due to ageing reasons their health may eventually prevent them. Many elderly persons live alone and when becoming immobile they quickly risk becoming isolated and lonely. Long term involuntary loneliness can then not only lead to decreased life quality but also have serious implications on health when they miss out on both physical activity and social interaction.

Traveling with public bus services can contribute to keeping elderly persons healthy both through requiring some physical activity and preventing elderly persons from becoming isolated. For an elderly person living alone, being able to use a bus service may be the difference between living a mobile- and immobile life.

When researching why and how elderly persons want to travel by public bus services, three major themes were found. Elderly persons travel to support their independent lifestyles, to socialize with friends and to travel safely they need to travel at their own pace.

**Public bus services can contribute to keeping elderly persons healthy by allowing them to stay mobile.**

**Independence**

An independent lifestyle can be manifested by ordinary everyday things such as buying groceries for oneself. Feeling independent is strongly connected to pride, dignity and self-esteem. To feel independent, elderly passengers need to be able to manage to travel by themselves without being forced to accept help from others or special treatments. They also need to be able to bring mobility aids and other means for their independent lifestyle.

**Social well-being**

For elderly persons an important aspect of traveling by bus is having the opportunity to meet with people and socialize. Being able to sit together with friends and keep a conversation during the journey can be very valuable. For elderly persons with few social contacts socializing with the driver can be highly appreciated. Personal contact with the driver can also contribute to increase safety as passengers can inform the driver of their needs.

**Co-existing flows**

Passenger flow is not a single flow but a mix of several co-existing flows. The flows can roughly be divided in fast and slow. Most public bus services are adapted for fast flow and when slow flow groups are forced to adapt, stress and risk of accidents increase. To be able to travel stress-free and safely elderly passengers must be allowed to travel and move at their own pace on board the bus.
Who gets the seat? - Findings from a field study

On board the bus, passengers interact with others through both written- and unwritten social rules. For passengers with wheelchairs and prams there are explicit rules expressed by signs to guarantee priority in certain areas. But for other passengers, unwritten social rules based on both how passengers perceive and choose to prioritize others, as well as ability to claim a space based on strength and speed determines who becomes prioritized.

By analysing both how passengers prioritize each other and the strength and speed of different passenger groups the pecking order of bus passengers could be uncovered. Passengers with wheelchairs have the highest rank. They have no problem being prioritized by other passengers and are strong enough to claim their right. Passengers with prams are also ranked high. They are in most cases prioritized by others and have no problem claiming their right. Next in rank but with a gap in between are passengers with walkers. Passengers with walkers are in most cases prioritized by passengers of lower rank and in some cases also by passengers with prams, but since they have no explicit right to the space they are restricted to use, as well as weaker than passengers with prams who they compete with, walker users are largely unable to claim space. Next in rank are passengers with suitcases closely followed by passengers with shopping trolleys. Passengers with shopping trolleys are generally disliked by other passengers which probably contributes to their low rank. The situation could create large problems for elderly passengers who need to sit but become unable to do so because of their shopping trolley.
“There will come a day when I will need help, but until that day, I want to be as independent as I can be” - Mathilda 80+

Elderly persons, like most people, strive to get by without asking for help and do not want to feel like they bother others. To respect and strengthen the dignity, pride and self-esteem of elderly persons, supporting their ability to take care of themselves is central. It is therefore important that the bus environment is designed in a way that does not create dependencies or situations where passengers are forced to accept special treatments against their will. Special treatments should to the furthest extent possible be optional and be performed with great respect for the integrity of the passenger.

“People get stuck in old thinking patterns, now a day’s an 80-90 year-old can be very active” - Albert 80+

Elderly persons today live more independent and active lives than ever before. The view of elderly persons as inanimate passengers traveling without belongings from point A to point B therefore needs to be challenged. To be adapted for elderly passengers, the bus also needs to be able to accommodate means and mobility aids for independent lifestyles, such as shopping trolleys and walkers. It is also vital that every step of the journey, from going to the station to arriving at the destination, works smoothly for elderly passengers traveling with mobility aids and larger belongings.

Persons with reduced mobility develop their own personal techniques to aid themselves in difficult situations - Observation

Great lessons can be learned by observing and drawing inspiration from life hacks of persons with reduced mobility, the real experts of their own situation. To create highly usable environments, versatile designs that allow passengers to utilize their personal techniques is an important key. To further increase usability similar reoccurring features can also be standardized through different environments, making it possible to apply the same technique in multiple situations. Apart from making difficult situations safer and easier, encouraging passengers to use their own techniques also supports them feeling independent and capable.
Two elderly women meet at the bus stop and start chatting merrily. Because one of them has a walker they cannot sit together on the bus and continue their chat - Observation

Socializing is vital to health and well-being. At an old age, social interaction is just as important as at a younger age but staying in touch with friends and making new acquaintances can become harder along the natural course of life. Many elderly persons live alone and as social contacts become fewer, making the most out of every single meeting becomes increasingly important. Elderly passengers want to use the opportunity to socialize with friends they encounter on board the bus. Friendship is not something limited within their passenger group so to be able to support and enable socializing, seating arrangements must allow all different kinds of passengers to sit together.

“The drivers are very nice and recognize everyone” - Gunvor 80+ (SL Närtrafiken Lidingö)

For elderly persons with few social contacts, interaction with service workers and staff in public environments can help fulfil a part of their daily need for social interaction. Being acknowledged and greeted by the bus driver can therefore be very meaningful and highly appreciated. To be able to provide opportunities for meaningful social interaction between driver and elderly passenger, the passenger needs to be able to come within a close distance. Contact with the driver can also contribute to increase safety by making passengers able to inform the driver of their needs. It can also contribute to increase the experienced feeling of safety, as passengers can be reassured that they will be cared for.
Passenger flow is not a single flow, but a mix of different co-existing flows - Observation

Passenger flows could roughly be categorized as fast or slow, with elderly passengers typically belonging to the slow category. On public bus services they are often forced to adapt to a fast passenger flow, which can cause stress and increases the risk of accidents. To make the bus environment safer for elderly passengers they need to be able to travel at their own pace. The bus needs to be designed to allow different flows to co-exist without colliding and to optimize the overall flow, both fast- and slow flows need to be able to keep their natural tempo. To keep a good flow, it is also important that all features that passengers come into contact with work together smoothly to avoid unnecessary interruptions.

Walkers are restricted to be placed in the pram- and wheelchair areas, areas that are not adapted for walker users and in which walker users don’t have priority - Observation

All persons who can get to the bus stop have the right to take the bus. On the bus however, not all passenger groups have a right to somewhere to stay. Passengers with wheelchairs and prams have clear explicit rights, while walker users who are solely restricted to the same areas do not have priority. To support equal terms, all passenger groups need to be provided with space adapted for them, that they have the right to claim. These ‘territories’ also need to be designed to help guide the passenger flows to avoid collisions, as well as to contribute to making passengers compete over space on fair terms. New explicit rules may in some cases also be needed to be able to guarantee priority for groups in need of it.
SUMMARY OF DESIGN DIRECTIONS

Respect independence
Design without creating dependencies and special treatments.

Enable socializing
Support and enable socializing between all different kinds of passengers.

Support active lifestyles
Design to accommodate mobility aids and means for independent and active lifestyles.

Driver’s care
Facilitate meaningful meetings between elderly passenger and bus driver.

Fast or slow
Design the bus environment to allow passengers to move at their own pace.

Provide territories
Provide all passenger groups with space adapted for them that they have the right to claim.

Celebrate ingenuity
Take inspiration from life hacks of persons with reduced mobility, they are real experts.
The concept consists of two separate solutions to aid boarding and alighting passengers in need of extra support. The entry handrail, inspired by how elderly persons use handrails, allow passengers to support their lower arm on the rail for extra strength and stability when boarding. The exit handhold, an extension of the door arm inspired by handicap handrails for stairs, makes it possible for passengers to hold on safely without twisting around while taking the step down to ground level by providing a support that extends out over the ground.

**Entry handrail**

**Entry/exit support**

**Respect independence**
- Easy to board and alight without assistance
- Subtle and voluntary special treatment

**Prevent accidents**
- Reduced risks by providing a stable support
- Increased risks if doors are not kept still

**Exit handhold**

**Support equal terms**
- Easy access for a greater diversity of people
- Supports wants and needs of elderly persons

**Celebrate ingenuity**
- Shape inspired by how handrails are used
Through the Walker seat concept, a designated area adapted for walker users is provided. The seat is placed sideways to minimize the need for turning the walker and located close to the door used for boarding and alighting to minimize the distance from door to seat. During the journey the walker user can keep the walker in front of the seat and easily hold on to it if needed. To guarantee priority for walker users, signs similar to those provided for prams and wheelchairs are provided, the reserved floor area is also marked with clear boarders making it easier to claim the space.

**APPLIED EXAMPLE**

**Walker seat**

- **Prevent accidents**
  - Reduced risks by competing on fair terms
  - Only one door for boarding with walkers

- **Reduce stress**
  - Less stress when boarding
  - Reduced need to move during the journey

**Support active lifestyles**
- Supports bringing mobility aids

**Celebrate ingenuity**
- Easy to alight both forwards and backwards

**Enable socializing**
- Walker users can sit together with friends

**Provide territories**
- Walker users have the right to claim a space

**Support equal terms**
- Passengers compete over space on fair terms
- Easier to travel safely with walkers
One vehicle - two buses is a concept that divides the vehicle into two sections, one slow and one fast, allowing passengers to travel at their own pace. The slow section works as a miniature version of SL Närtrafiken, passengers have close contact with the driver, no standing is allowed and the seats are adapted for bringing shopping trolleys and walkers. The fast section works as an express version of a regular bus, passengers enter through the rear middle door and scan their tickets themselves. To encourage passengers with prams to choose the rear door, the rear pram area is adapted to be extra family friendly.

**APPLIED EXAMPLE**

- **Fast or slow**
  - All passengers can travel at their own pace

- **Enable socializing**
  - Mixed priority and non-priority seating

**Slow flow**

- Driver’s care
  - Passengers who want to can meet the driver

**Fast flow**

- Support active lifestyles
  - Easy to bring mobility aids
  - Space for shopping trolleys

*Walker seat*
**Support equal terms**
- Areas adapted for passengers' wants and needs
- Passengers compete over space on fair terms

**Respect independence**
- Passengers can choose section by themselves

**Prevent accidents**
- Passengers can move at their own pace
- Driver has good overview of priority passengers

**Reduce stress**
- Priority passengers have contact with driver
- Passengers can move at their own pace

**Provide territories**
- Areas adapted for different groups are provided
- Passenger groups have space they can claim

*Realizing this concept requires cooperation between public transportation actors.*