Smart Home Project

*IP 2014 - Group 3 “Mango”*

Francesca Bertè  
Ioana Branzei  
Martijn ter Meulen  
Justine Moens  
Eveliina Saloranta  
Christian Willer
# Table of Contents

1 Introduction ................................................................................................................. 3

2 Methodology ................................................................................................................. 4

3 Situation and personas ................................................................................................. 5
   3.1 Original home situation .......................................................................................... 5
   3.2 Health situation and personas .............................................................................. 6
      3.2.1 Persona Tom Muller ..................................................................................... 7
      3.2.2 Persona Sarah Rossi ..................................................................................... 8
      3.2.3 Persona Mary Jacobs ................................................................................... 9

4 Concepts ...................................................................................................................... 11
   4.1 Technological concepts ......................................................................................... 11
      4.1.1 The ‘intelligent system’ ................................................................................. 11
      4.1.2 Medicine dispenser ..................................................................................... 12
      4.1.3 Environmental monitoring and controls system ........................................... 12
      4.1.4 Leaving detection ....................................................................................... 13
      4.1.5 Automated windows and window blinds ..................................................... 13
   4.2 The communication and home control system ....................................................... 13
   4.3 Concepts for home adjustment .............................................................................. 14
      4.3.1 Elevators and stairs ..................................................................................... 14
      4.3.2 Wheelchair space ....................................................................................... 15
      4.3.3 Bathroom ..................................................................................................... 17
      4.3.4 Bedroom ..................................................................................................... 18
      4.3.5 Balcony ........................................................................................................ 18
   4.4 Health concepts ...................................................................................................... 18
   4.5 Safety and security concepts ............................................................................... 19
      4.5.1 Smoke and heat sensors .............................................................................. 19
      4.5.2 Security system ............................................................................................ 19
   4.6 Social concepts ...................................................................................................... 20

5 Comparisons and best options ..................................................................................... 22
   5.1 Comparison of technological concepts ................................................................. 22
      5.1.1 Fall detection .................................................................................................. 22
      5.1.2 Medicine dispenser ..................................................................................... 22
   5.2 Comparison for the communication and home control system ............................ 23
   5.3 Comparison of home adjustment modifications ..................................................... 25
      5.3.1 Shower chair .................................................................................................. 25
      5.3.2 Adjustable toilet .......................................................................................... 26
      5.3.3 Adjustable bed ............................................................................................ 27

6 Final result/total implementation ................................................................................ 29
   6.1 Ground floor ........................................................................................................... 29
   6.2 Apartments (first to fifth floor) ............................................................................. 30
      6.2.1 Implementations by room ............................................................................. 31
   6.3 Attic ....................................................................................................................... 33
   6.4 Basement ............................................................................................................... 33

7 Summary ..................................................................................................................... 35

8 Discussion ................................................................................................................... 36

9 Appendix ..................................................................................................................... 37
1 Introduction
This report examines the renovation, by cooperation, of a house with 10 flats for older people. The inhabitants have been living in their apartment over more than 40 years and want to stay there as long as possible. What kinds of solutions are available for the different residents and their limitations? How can the apartment be adjusted, be prepared for possible adjustments, so everybody feels at home? Those questions were a guideline during the design process.

Besides the fact they want to stay as long as possible in their own flats, the residents had some other wishes. They want to get assistive technology for daily life, feel safe and have an emergency connection to a doctor in case of falling or other dangerous health situations. Furthermore they insist that the 2 flats on the ground floor become a doctor’s office, nurse and service station.

The technology used in this report is based on presentations, a visit to the smart home lab, research on the internet and common knowledge. First of all the paper describes the possible health situation of the residents. Second there are the different concepts regarding technology, communication, health, safety, house adjustments and social areas. These concepts are followed by a comparison on the possible alternatives for the main home modifications. At last there is a description and summary of the whole renovation.
2 Methodology

First there was a brainstorming session. The environment was used in a creative way during the brainstorm sessions. There were different cupboards and each cupboard represented one of the concept areas such as health. On those cupboards the post-its could be put on, so everybody had a good overview.

After this brainstorm moment it was time to organize the thoughts on the post-its and make personas to get an idea of the persons for whom the concepts were made. Therefore a large paper was divided into 4 categories according to the MoSCoW method; must, should, could and won’t (won’t is originally would).

The ‘must’ category contained everything that was essential to the design process. The ‘should’ category was used for high-prioritized features and in the ‘could’ the desirable feature were classified. In the last category ‘won’t’ contained everything we dreamed of, but wasn’t realisable.

After the prioritisation, it was time to start with the realisation of the concept. After the concepts were complete, different alternatives/options for the most important concepts were compared according to gathered information obtained by desk research. At the hand of these comparisons, the total implementation/final result could be made.

Figure 1: An impression of the brainstorming process
3 Situation and personas

3.1 Original home situation

The original home has 5 floors. On every floor there are 2 apartments. Every apartment consists of a living room, bedroom, children’s room, kitchen and bathroom. The 2 apartments on the ground floor have no children’s room. Besides the apartments, there is also a cellar and an attic area. All those different floors are connected with stairs. The main entrance has no threshold; behind the door there is a stair with 8 steps to the ground floor. The back entrance has stairs that lead to the cellar area. Behind the house there is a courtyard with a shed. At this moment the shed is used as a laundry area.

To have an insight in the division of each flat, there is an explanation of the different rooms in the flat and the installed equipment. The first thing you notice, seeing the plan, is the very big, useless hallway. Besides that there are 2 large bedrooms. The bathroom is a small space, with a bath, sink and toilet. Furthermore there is a nice kitchen, living room and balcony. In the middle of the staircase there is enough space to put in an elevator.

The overall conclusion is that it is a nice apartment, but the division of the different rooms can be optimized.

Figure 2: Original situation of the ground floor.
3.2 **Health situation and personas**

The residents of the apartment are perfectly healthy. They have no significant health problems or limitations. It does not mean that there is no possibility they end up in a wheelchair or will get dementia. These thoughts have to be taken into consideration during the renovation process. For example, when people end up in a wheelchair, they still need to be able to cook a dinner. Therefore, we need a movable kitchen, enough space in each room to turn the wheelchair and a lot more home modifications. Based on this case, there have been made 3 personas that represent the (future) residents of the building and the disabilities they could have.

First there is Tom Muller, a perfectly healthy man. In his case the flat needs to look as normal as possible. He doesn’t need bars besides the toilet, closed windows, a seat in the bathroom.

Second there is Sarah Rossi, an old lady with symptoms of the first stage of dementia. She has difficulties with her memory, planning and organizing activities and self-care ability (ADL). Besides those problems, she is still aware of herself and her environment. Having dementia is not the only issue; she is also dealing with some aging symptoms, such as reduced eyesight and loss of hearing.

At last there is Mary Jacobs an 81-year-old lady. Mary is paralyzed form the waste down, so she is ‘chained’ to her wheelchair. In addition to the paralysis, she has a decreased hearing and eyesight.
3.2.1 Persona Tom Muller

Profile
- Born on 12 October 1951
- Working as a librarian since 1972
- Married in 1973 with Clara
- In 1985 his one and only child was born, his name is Harry

Daily activities
Tom is most of the time at work in library on weekdays. When he comes home, he loves to build and play with his model trains and reading books. He really loves books, that is why he worked in a library all of his life. On Saturday he goes to play tennis with his wife Clara and shopping for groceries. On Sunday he likes to relax and read some more books, especially on the balcony of his apartment, if the weather is good.

Hobbies
The biggest hobby of Tom is reading books. He could do it all day, every day. Besides that he loves to build model trains and let them ride around. He also likes to play tennis for a couple hours a week. He mostly plays tennis with his wife Clara, but sometimes also with his son Harry or with a friend or colleague.

Characteristics
Tom could be described as a calm and social person. He likes to take his time for things. Sometimes this makes him a bit lazy. Tom doesn’t goes out much; he loves to stay at home. He is especially fond of his balcony and can spend many hours there when it is sunny. Tom is also a bit conservative and not fond of technology. He likes things ‘the way they were’.
3.2.2 Persona Sarah Rossi

Name: Sarah Rossi  
Age: 76  
Occupation: Retired, formerly a cleaning lady  
Marital status: Single  
Children: None  
Disabilities: Slight loss of eyesight, loss of hearing, beginning dementia

Profile
- Born on 18 May 1937
- Working as a cleaning lady since 1953
- Retired in 2002
- She has 3 cats and loves them very much
- She has a slight loss of eyesight and needs glasses
- She has a loss of hearing and needs a hearing aid
- She is in a very early stage of dementia, but it will increase over time

Daily activities
Sarah likes to stay at home. Since she retired as a cleaning lady, she almost never goes out anymore, only to shop for groceries. When she wakes up the first thing she does is making breakfast and cleaning the house. After that she spends time with her cats, giving them the ‘attention they deserve’. After that she fills up her remaining time with her hobbies that mainly consist of watching television and making sweaters, scarves and other pieces of clothes.

Hobbies
The biggest hobby or passion of Sarah is her cats. She has got three of them and she loves them more than anything else in the world. She loves to play and cuddle with them and would be devastated if something happened to them. For this reason the cats are never allowed to go outside. Besides her cats, she loves to sew or knit. Making all different kind of clothes. The last hobby she has is watching television; she can spend multiple hours a day watching different types of programs. She mostly likes cooking programs, animal programs (especially when there are catlike animals in it of course) or talk shows. She can also enjoy a good documentary or movie from time to time.

Characteristics
Sarah can be described as a very introvert person. She almost never goes out and doesn’t talk much to other people. People always find her a bit sad and lonely, but also a bit nagging. She doesn’t talk much, unless she has
something to complain about. The last thing that really describes Sarah, is her love for animals, especially cats. She maybe doesn’t talk much to other people, but she can talk entire days to her cats.

3.2.3 Persona Mary Jacobs

Name: Mary Jacobs  
Age: 81  
Occupation: Retired, formerly an English teacher  
Marital status: Widow  
Children: 3  
Disabilities: Paralyzed from the waist down, decrease of hearing, decrease of eyesight

Profile
- Born on 8 June 1932 as Mary Millburn
- Working since 1954 as an English teacher
- Worked on three different schools over the course of 40 years
- Married with Frank Jacobs in 1955
- In 1959 her first child was born. It was a son. They named him John. John works nowadays as an accountant
- In 1963 her second child was born, a daughter. They named her Eliza. Eliza works as an Spanish teacher
- In 1968 her third and last child was born, again a daughter. They named her Anna. Anna works as a nurse
- In 1991 her first granddaughter was born. In the next seven years four more grandchildren would be born.
- In 1999 Mary had a terrible accident, which left her paralyzed from the waist down.
- In 2009 her husband, Frank, got very ill. He was diagnosed with cancer
- In 2011 Frank passed away
- Her children and grandchildren visit her very often. At least one time a week someone visits
- She can’t hear and see well anymore and therefore she needs glasses and a hearing aid

Daily activities
Mary starts her day in an easy pace. She makes breakfast and takes a shower. After that she likes to read a good book or watching television. If the weather is good she also goes to the park often. On Tuesdays and Thursdays she plays cards with some of her friends. Her children and grandchildren often visit in the weekends; she always looks forward to this.
Hobbies
Mary’s main hobbies are reading a good book or going to the park, preferably both at the same time. Besides that she loves playing cards with her friends. Her last hobby is collecting snow globes. She does this since she was 12 and has gathered a very large collection by now, but ‘there is always room for one more’.

Characteristics
Mary could be described as a kind, social and caring person. She always sees the best in people. This also makes her a bit naïve and easy to take advantage of. She loves to go out, especially to the park. She always looks pretty happy and is very talkative. Sometimes a bit to talkative, she sometimes tells entire stories to complete strangers.
4 Concepts

4.1 Technological concepts

4.1.1 The ‘intelligent system’

The so-called intelligent system is a system that controls and monitors vital functions/aspects of each apartment and its resident. The system will be self-made because there aren’t any existing systems that exactly meet the requirements. You could choose to modify/expand an existing system, but this will be almost just as hard and take almost just as much time as making your own system. Besides that, not every corporation or business would like it if you ‘stole’ their idea or expand/modify it without their consent.

The main purpose of the intelligent system is monitor the house and help the resident where needed. Many sensors that are placed in the house send data and signals to the system and the system responds to it. For example, if all residents have left the house or are asleep, the system automatically turns off the light, water and gas. This will greatly decrease the chance of calamities.

Health and safety

A vital aspect of the system is that, via cameras, constantly checks your breathing rate and heartbeat. This is done by a slight coloration of your skin when your heart beats. There is more than one type of software for this on the market and you would have to thoroughly research them to find the best option. Unfortunately there wasn’t time to do this.\(^1\)

The system will also have fall detection. One in three persons over 65 years will fall, on average, once a year. For people over 80 years this average rises to one in two people, 70% of all falls occur at home.\(^2\) Fall detection, therefore, is an absolute necessity.

The system will also have a functionality to detect epileptic seizures. The software for this isn’t widely available yet, but there are some applications that work pretty well. It can detect even very light seizures if a person is just

---


sitting at the table. All these applications are still in the research phase, but in the near future it will definitely be possible.\textsuperscript{3}

So if there is something wrong (for example the resident has fallen, has a heart attack etc.) the system automatically sends an alarm to the appropriate instance. This instance can be the doctor and nursing station downstairs, but can also be a hospital if necessary.

**Utilities controls**
The system can detect if someone is present in the house. If there is no one present, the system will automatically shut off the lights, gas and water. The system will do the same if all residents are sleeping. This sleeping detection is possible via heartbeat and respiratory monitoring functions of the system in combination with locating software that measures the resident’s location and activity.

This functionality is mainly for the residents with dementia. They sometimes forget to put the stove off. This functionality makes sure that it won’t be on when they leave or go to sleep. Of course this functionality is optional for all the residents who don’t have dementia, so they don’t necessarily have to use it, but they can if they like.

### 4.1.2 Medicine dispenser

The apartment will be equipped with a medicine reminder and medicine dispenser. At a time the resident prefers (or in some cases the doctor dictates), the resident will get an alarm that it is time to take his or her medicine. The resident will receive the alarm trough the ‘communication and home control’ system that will be thoroughly described in paragraph 4.2. The resident will get the right medicine in the right dose via the dispenser. This dispenser is located in the bedroom wall. Because of this location, the people who supply the dispenser can do this from outside the apartment through the wall, so they can do it anytime without the resident having to be home, make an appointment or having to get in the apartment when the resident is sleeping.

### 4.1.3 Environmental monitoring and controls system

The environmental monitoring and controls system measures the temperature in the room and adapts this temperature if it gets very cold or very warm. The option to let the system adapt to this is of course optional for the resident and they can switch it on or off. Furthermore there will be carbon dioxide sensors placed in every room. These sensors are not very

expensive +/- €54 and probably even cheaper if you order them in large quantities.\footnote{iPrototype. (n.d.). CO2 Sensor. Retrieved on 12 March 2014, from https://iprototype.nl/products/components/sensors/co2-sensor} These sensors measure the carbon dioxide level in the room and will give a signal to the system when this level becomes too high. If that is the case, the resident will get a message through the communication system that it is wise to open up a window. Furthermore you will also have the option to let the system send an alarm downstairs to do the service desk so someone can check up on the resident or open a window for him. This latter option will probably mostly be used for people with dementia who will maybe forget to open a window.

4.1.4 Leaving detection
There will be detection sensors at the exit of the building. When someone enters or leaves the building the people at the service desk will get a message. If it is someone with dementia who wander and should not go outside on his self, the service people can bring him back to his apartment. The most logical option for this would be a simple motion sensor these are cheap (+/- €25), small and effective.\footnote{Smarthome. (n.d.). INSTEON Wireless Motion Sensor. Retrieved on 11 March 2014, from http://www.smarthome.com/2842-222/INSTEON-Wireless-Motion-Sensor/p.aspx} Of course you could also use these sensors for security.

4.1.5 Automated windows and window blinds
These options are mostly meant for people who are still perfectly healthy or are in wheelchairs. The residents will have the option to open the windows or window blinds by a remote controller and/or the communication and home control system that will be described later on. This option will be available for all residents except the ones with dementia, so that they won’t get scared.

4.2 The communication and home control system
The communication and home control system has multiple functionalities. The first functionality is the intercom system. This system allows the residents to call the doctor, the nursery and the service people downstairs, but also friends and family. The system will work visually or only with an audio communication. There is one fixed version of the communication and home control system and one portable version in every apartment. The fixed variant will be located in the living room in the wall. The reason there is a fixed variant is that you can connect it to the power grid and doesn’t have to rely on batteries that can run out. The portable variant can be used by in every room. This makes it a flexible system that can be used where and when the user likes it. That’s also important in case something is wrong, because it can also be used to ask for help and will have an alarm function. When this function is used, the service station downstairs will be alarmed.
The portable version does run on a battery, so they do have to charge it from time to time. The charging station will be attached to the wall near the kitchen. The reason for this attachment is that the resident can never lose the charger and can’t fall over the wire of the charger.

The system in the wall will look like a screen with touchscreen functionalities but also some physical buttons. The resident can choose to use both, but also just one of the two. If the latter is the case, the other option (touchscreen or physical buttons) will be switched off so they don’t accidentally press something or select something. The portable version will be like a tablet only than also with a few physical buttons. The interface will be very simplistic with a high contrast and a combination of letters, and recognizable icons. There will also be the possibility to change the size of the letters, so that also people with lesser eyesight will have no problem with reading the text.

If the resident has dementia there is also the possibility to change the letters in clear and simple symbols. Images are always easier to recognize than words. Besides that, you will have the possibility to remove a few options, so that the interface will become even more simplistic and usable. Of course this is all optional so almost every person can use it, disabilities or no disabilities. The possibility to change some aspects of the interface to your liking is very important. For people with dementia you want a really simplistic interface with large and recognizable icons. But a person who has no disabilities will probably think it is a bit childish. So therefore you must be able to change the interface regarding the person and his or her physical condition.

Like described before, the medicine alarm will be received through this system and it will have the possibility to control the windows and window blinds. But it isn’t called the communication and home control system for no reason. You will also have the possibility to control the lights in every room, the movable kitchen and the temperature. This sounds like a lot of options, and that is true. But that’s even more reason to create a simple and very usable interface. Besides that there is also the possibility to switch some options on or off. When they’re off, they’ll disappear from the interface, which will give the user fewer options, less distraction and therefore a more simplistic and usable interface.

Another feature will be a door camera for making people visible who are standing in front of the door. This is partly for safety and security, but mostly just for the safe feeling of the resident and to let him or her know who is visiting.

4.3 Concepts for home adjustment

4.3.1 Elevators and stairs

At first it is important to install an elevator in the middle of the stairs in the house. This is necessary for older people or people with limitations to get to the upper flats or to get to the attic.
Furthermore there will be a stair lift added to the stairs at the main entrance. This is a good option because it saves room in comparison to a conventional ramp. There is also the possibility to use the normal stairs for people without disabilities. So it is a universal solution for the residents.

![Figure 4: A stair lift for wheelchair users.](image)

4.3.2 Wheelchair space

It is required that in each apartment there should be enough space for a wheelchair to turn around without hitting the walls or doors.

The turning space needs to be circular (Figure 5a) or T-shaped (Figure 5b). The diameter of the space needs to be at least 1500mm. The arms and base of the T-shaped must have a width of 900mm or more. The T-shall must be clear of any obstruction. In the arms, there has to be a free space of 300mm in each direction and in the base, a free space of 600mm. (Figure 5b)⁶

---

Figure 5: Wheelchair turning space.

If a person wants to approach an element, the floor needs to be clear. This space needs to be positioned in a square that measures 760mm by 1250mm at least. In these measurements, knee and toe clearances are included. The floor of this space may not be steeper than 1:40. Besides that, other stipulations of the floor surface have to be taken into account. Furthermore, one fully unobstructed side shall adjoin or overlap with an accessible route or adjoin another clear floor. (See Figure 6).\footnote{Department of public works. (2001). \textit{Standard electrical, mechanical and architectural guideline for the design of accessible buildings (facilities for disabled people)}. Retrieved on 11 March 2014, from http://www.publicworks.gov.za/PDFs/consultants_docs/DISABLED.PDF}
The furniture in the whole flat will be designed without legs as far as it is possible. This makes it easier to clean and to give wheelchair users the possibility to drive under the tables. It will improve the usability and the process of cleaning the flat.

4.3.3 Bathroom

The bathroom of every apartment will have a floor with extra grip. This will make it easier for people in wheelchairs to make use of the toilet and shower seat. Also, for all people in general, it will reduce the chances for slipping and falling.

Furthermore the floor will be totally flat without any obstacles. The shower will consist of wide, lightweight glass doors that can open in two directions. Of course the shower can be equipped with a shower seat, but these are easy to implement, so they will not be there on a standard basis. If the person is already in a wheelchair before the home modification starts, there is a more aesthetic version of a shower seat possible. But this will be further described in the next chapter.
The last thing is the toilet. The toilet will be adjustable in height, so it is usable for everyone, also people in wheelchairs.

4.3.4 Bedroom
In the bedroom there is an adjustable bed. The bed will be able to move up and down, so it is easier for people in wheelchairs to get in and out of the bed. Of course the bed will have a nice design so that it won’t look like a hospital bed. Furthermore it needs to have some kind of bars that will prevent people from falling out. Of course the resident must be able to put the bars down and make them almost invisible. This is necessary for the residents who don’t need them or don’t want to use them.

4.3.5 Balcony
The balcony is equipped with a sliding protective glass. The glass door is easy to open, so the residents can feel the breeze when they sit on the balcony and will actually have the feeling that they are outside. For the people with dementia, however, it can be locked. This will only be done if it’s necessary for their safety.

One problem regarding the balcony is that it is not big enough for wheelchairs. So people in wheelchairs will unfortunately not be able to use it. However, they can spend their time in the garden at the back of the building or the small garden that is built on the attic. It isn’t perfect, but it is something.

4.4 Health concepts
In the ground floor there is a doctor’s room and a nursery. The doctor is there eight hours a day for residents who need for example recipes for medicines or a checkout for a physical complaint. There will be a nurse all day, every day.

There is a possibility for homecare-service and the resident can use it if it is needed. Then a caregiver comes in a few times a day and helps with food, cleaning, washing and everything else the resident needs help for. It is important, especially for people with some specific disabilities like dementia, that there is someone 24 hours, 7 days a week.
On the ground floor there is also a service desk. There will be at least one person 24 hours a day, 7 days a week and they help with problems and monitor the building. For example if the resident is missing his or her key, the service person comes to open it. They also monitor who goes in and out. If someone with dementia goes out he is still allowed to walk freely, but the service people will see the person coming out and will keep an extra eye on him, so he won’t get lost. Of course they also look at who goes in, what will reduce the chance of burglary. Another thing the service desk does is monitoring the system and if it functions correctly. This doesn’t mean they look through the camera’s all the time, the privacy of the residents is respected and there will be no visible video feed of the cameras available unless there’s an emergency. The last thing the service desk does is alarming authorities if necessary or reacting at calamities like evacuating the building in case of a big fire or extinguishing a small fire if the resident can’t do this by himself anymore.

4.5 Safety and security concepts

4.5.1 Smoke and heat sensors
   Off course there will be smoke and heat sensors available in every apartment. These sensors will not only alarm the resident when there is smoke, but also the service desk downstairs, so that the people at the service desk can take immediate action. Furthermore they can see if the smoke and heat sensors go off in more than one location. If this is the case, they have the possibility to alarm the entire building, start the evacuation process and call in the fire department.

4.5.2 Security system
   The security system will be for the entire building, but it will also be split up for individual apartments. The alarm system shall include perimeter protection and indoor surveillance. Monitored doors and windows shall be equipped with magnetic contacts. Movement detectors used in indoor surveillance shall be sensitive enough for presence detection of a single person, so that they can also be used for lighting controls and air-conditioning controls. The lighting controls can be switched off if desired. Especially for people with dementia this will sometimes be necessary.
Intruder alarms will be integrated on software level for every individual apartment. When the resident leaves, the alarm will switch on automatically. The registration of the person leaving will be done by the intelligent system that is described in the first paragraph of this chapter. When a person leaves, the system sends a signal to the alarm and it goes on. Granted access disarms the alarm automatically. In case of burglary the system gives an alarm, which is relayed through to the service desk downstairs and the can patch it through to the police.

4.6 Social concepts

In the ground floor, next to the nursery and the service area, there should be a social area like a group living room. People can meet there to chat and spend time together. It should look nice and friendly so people like to be there to spend their time in company.

Figure 9: There should be many flowers and comfortable seats and couches in the social area.

There is also an area for doing sports and wellness at the attic. So the residents can stay in good shape. This will contain simple sports equipment but also equipment for people in wheelchairs. There will also be a sauna and a changing room.
Figure 10: Impression of the sporting area.

Figure 11: Impression of the sporting equipment for people in wheelchairs.
5 Comparisons and best options

5.1 Comparison of technological concepts

5.1.1 Fall detection

For the fall detection there are two viable options. The first option is fall detection by cameras with interpreting software. The second option is fall detection by sensors in the floor. The fall detection by cameras is preferred for the realisation of this concept. The main reason for this is the effort for the installation and the already present technologies. For sensors in the floor, it is necessary to adjust the entire floor in the whole apartment. This is a lot of work and pretty expensive. There is already one fish-eye camera present in every room for heart rate and respiratory monitoring. To implement the fall detection, only the required software needs to be added. For this reasons, fall detection via camera is the best option for realisation of this concept. The specific software that will be used is something that will need further research. There is more than one type of fall detection software.\(^8\)

5.1.2 Medicine dispenser

An option to manage the medication for the residents could be a hatch where the nurses put the medicine inside and the person inside the flat can take it. It will be locked that no one else than the nurses and the user get access to it. With this solution is guaranteed that every resident of the house gets the right medicine at the right time in the right dosage. A disadvantage is that it is not controlled if the client really takes the medicine but that is a problem of every medication dispenser system.

Another solution is the Philips MD.2.\(^9\) It is a system that can be filled for a month by a service member with the required pills or liquid medicine. When it is time to take the medicine a voice is telling a message appears at the

---

\(^8\) Klack, L., Möllering, C., Ziefle, M., & Schmitz-Rode, T. (n.d.). Future Care Floor: A sensitive floor for movement monitoring and fall detection in home environments. Human Technology Centre, RWTH Aachen University, Aachen Germany

Miaou, S., Sung, P., & Huang, C. (2006). A Customized Human Fall Detection System Omni-Camera Images and Personal Information. Downloaded on 13 March 2014, from http://scholar.google.fi/scholar_url?hl=nl&q=ftp://ilx00.prip.tuwien.ac.at/pub/outgoing/zamba/fallpapers/Miaou06.pdf&sa=X&scisig=AAGBfm1enHn-12rEgSs7q1XgnmifjWgAAg&oi=scholarr&ei=6VghU96rJKF9ywOjhoKYDA&ved=0CCkQgAMoADAA


display and a light is blinking. If the user doesn't take the box with the pills the MD.2 calls the caregiver. It calls also the caregiver when there is the need to refill it.

The decision arrived at the hatch because its more personal than the dispenser and the nurse can check if the resident has taken the medicine earlier than the pill dispenser can. Furthermore the MD.2 is more expensive than installing a hatch because you need to pay a monitoring fee monthly and this costs a lot of money in comparison to a single investment for a hatch. Also it could be that people with dementia get frighten of it when it starts to talk and the lights starts to flash.

![Image of Philips Medicine Dispenser]

Figure 12: Philips Medicine Dispenser.

### 5.2 Comparison for the communication and home control system

There isn’t any system available that meets the requirements for this concept. The system required must be highly adaptable for people with (multiple) or without disabilities. Most of the existing systems are, for example, not made (or specifically made) for older persons or people with dementia or don't have the required possibilities/options. Besides, many of them are too complicated and too complex and a good usability, which leans on simplicity, is crucial if you want the concept to be successful.
The first possibility is the Claris Companion system.10 This system is especially made for older people, but there are some disadvantages. It is a portable system that needs to be charged, but you could also install it in a wall, so that wouldn’t be a problem. Something that will be more of a problem is that this system can’t control the windows and window blinds and is not connected with a door camera. Furthermore it misses some other home control options that are necessary for realizing the concept.

The other option is PAUL, the experimental system form Germany. This system almost meets all the necessary requirements. There are only two major problems. The first is that it is not (yet) in a portable version and a portable version is an absolute necessity. The second is the absence of physical buttons. This also is an absolute necessity. Not everyone, especially older people, like touchscreens. So there must always be an analog input that they can use if they like. Furthermore, it looks it is a very closed system and therefore hard to expand. This isn’t a problem, but will cost more time and more money.11

The last and best solution would be to specially invent a new system of modify an existing system entirely to your liking. This system will need to look a lot like the Claris Companion, especially the portable version. It will consist of a large regular tablet device with its own cover and, of course, own communication and home control application. This cover will offer solid protection and have some analog buttons on it. You will be able to plug this cover in the tablet, so that the buttons will work. Via a later determined

---


wireless communication protocol (probably just WiFi) it can connect with the multiple home control functions, make video calls and use all the other options that are available in the system. The portable version will be permanently attached in the living room wall. For this, there is one main reason, the battery can never run out, because it will be permanently linked with a charger. The portable version will have a charging station, also attached to the wall. Because this charging station is attached to the wall the resident can never lose his or her charger or trip over the wire of the charger. The great option of this solution is that if a resident wants it, he or she can also use this device as a regular tablet. When they start to have dementia or just don’t want too many options, you remove the function to exit the communication and home control application and they can only use it for it’s main purpose.

5.3 Comparison of home adjustment modifications

5.3.1 Shower chair
People in a wheelchair will need a shower chair. This chair needs to be firm and confident and stay in place when the floor is wet. The best chair in this case is the Pressalit care Shower chair 310, because it looks better than other alternatives.\(^\text{12}\) It is attached to the wall and its height can move. The problem with this chair is that it needs to be attached to the wall. This can be done, especially when the person is already in a wheelchair before the home modification will be made. For after the home modifications it is still possible, but there is also a more flexible and cheaper alternative.

![Figure 14: The Pressalit care shower chair 310.](image)

This alternative is the Swift shower chair.\(^\text{13}\) This chair is lightweight, height is adjustable, armrests and backrest are removable and the rubber foot pegs do

---


not slip. So practically, this alternative is the best option. But if the resident would like a more good looking chair and is prepared to not use his shower for a few days to install the Pressalit care shower chair 310, this of course will be possible as well.

Figure 15: Swift shower chair.

5.3.2 Adjustable toilet
There are two options for toilets. On one hand there are high-tech toilets from Japan and on the other hand normal toilets that are height adjustable.

The Japanese toilets have lots of technical equipment like heated seats, water sprayers and air dryers. They can also play music and sounds to cover the toilet noises of a person.¹⁴

These toilets are way too complicated for older people. They don't need that amount of equipment in a toilet. An opportunity for the height adjustment is also missing, so it is not a good solution for wheelchair users. They can be scary for older people or people with dementia as well.

A better option will be a normal toilet with an adjustable seat. The person can elevate the seat to the right height and then he can sit down and only needs to lower the seat until his feet touch the ground.¹⁵

This seat has more advantages because it is cheaper and more usable for the client. The user has only two buttons to adjust the level of the seat and it can be attached to a normal toilet. So there is no need invest in a new one.

Another way to realize the adjustment is to lift the whole ceramic up. This is possible with a little handy crank but it takes a certain time until it is lifted. Older people will have a problem with that if they need to go to toilet

---


urgently. Also, it will need more energy from the user compared with an electrically lifted seat.  

![Figure 16: The Japanese toilet (left) is too complicated and maybe scary for people with dementia, the manually height adjustable toilet (right).](image)

### 5.3.3 Adjustable bed

For the residents who have trouble getting in and out of the bed, the bed needs to be easy to move and height adjustable. There are a few models that can do this. There are Saga-beds, which are movable, remote controlled and adjustable, but they look a little like a hospital bed. The Hepburn Height Adjustable Bed has same features as Saga bed, but it looks better. But it is big and looks heavy. The Ateliers du haut forez Bed Corail has the same features as the other beds but it looks nicer. It is the best alternative, because it looks very nice and simple and it has every necessary feature.

---


Figure 17: The Ateliers du haut forez Corail bed and its options.
6 Final result/total implementation

6.1 Ground floor

The ground floor consists of multiple areas. There can be made a main division between the two sides. On one side there is the doctors area and nursing area. On the other side there is the service area, administrative office, concierge office and social area. There is a staircase leading to the main entrance. This staircase has a stair lift for people who are in a wheelchair. The surroundings of the building, which are not shown on the map, consist of a garden and a shed, originally done for the laundry. The laundry area, however, is replaced to the basement so this shed can now be used for other purposes as the residents see fit.

Figure 18: Map of the new ground floor
6.2 Apartments (first to fifth floor)
Concerning the adjustments of the apartment, the design focus on the technological solution but also about the organization and the quality of its spaces.
First of all the addition of a bathroom, which, exploiting the large hall, allows to have another bathroom for the guests and increases the usefulness of the flat. Secondly an open space for the living room and the kitchen was created; keeping in any case the two ambient distinct.
Finally a sliding door connects the main bathroom (which is bigger than before) with one of the sleeping rooms. This simplifies it to go to the toilet at night.

Figure 19: Map of the new apartments

All of the adjustments have been realized thinking about the different kind of users both a person with a wheelchair and a person in early age of dementia. In this way the flat will be predisposed to accommodate the different technology and when it will be necessary they will be placed easily and economically.
As you can see in figure 19, there is enough room in the entire apartment for people in wheelchairs. Besides that, the new layout of the apartment makes it possible to see the toilet from the couch. This is important for people with dementia so that they don’t forget to go to the toilet.

6.2.1 Implementations by room

The whole apartment
- Cameras that constantly checks your breathing rate and heartbeat
- Fall and seizure detection
- Carbon dioxide sensors
- Open the windows or window blinds by a remote controller
- Smoke and heat sensors
- Furniture without legs

Living room
- Screen for communication and home control system
- Chairs

Kitchen
- Charging station for the communication system
• Furniture in the whole flat will be designed without legs
• Chairs

**Bathroom**
• Movable shower holder
• Movable grips
• Adjustable toilet

**Bedroom**
• Adjustable and movable bed
• Adjustable wardrobe
• Medicine dispenser

**Hall**
• Extra toilet for visitors

**Balcony**
• Sliding protective glass
6.3 Attic

This is the attic. It was not used in the original plan but now there it is an area for sports and wellness. The residents can relax here or do some sports together. A sauna, simple sports equipment and big clear widows were added. Also on this entire floor there are cameras with fall and seizure detection software.

Figure 21: Map of the new attic

6.4 Basement

During the rebuilding process the division of the basement remained the same, only the purpose of it changed. At the left side, there is a storage room for each apartment and some cupboards. Besides that, there is also a laundry area equipped with:

- A washing machine
- A dryer
- An iron and iron board

The right side is reserved for the doctor and nurse. There is a large storage room with a lot of cupboards to organize all the supplies. Furthermore there is a separate laundry area for the nursing staff. At the back of the basement
you can find a room where the water heater is located. This room you can enter from the backyard and through the laundry area for the nursing staff.

There are also cameras in the basement for fall and seizure detection, so the inhabitants can feel safe at all times.

Figure 22: Map of the new basement
Summary
As you have read, the rebuilding design is adapted to all kind of possible limitations. Some of the adoptions aren’t installed such as bars besides the toilet, because not everybody would need them. However, they have been taken into consideration. So, for example, if someone ends up in a wheelchair, there is enough space provided to add those bars. In this way people will be able to live as long as possible in their own apartment. Some aspects of the interior design are left out on purpose. At this moment the inhabitants are perfectly healthy, so they do not want to be dictated what kind of paint they may or may not choose. It is their house and it needs to feel home. If someone would get dementia, they can ask for guidelines so they know what kind of small adjustments can be made. The overall conclusion is that all the adjustments that have been made are practical and efficient and will greatly improve the quality of life.
8 Discussion
This report has a very complex and diverse theme, so there are some things that could have been done better. The time was very limited so not every part is as detailed and specific as it should be. This is also the reason for the missing of sketches of own designs for some devices and equipment like a communication and home control system or the medicine dispenser.

Another aspect is the very high cost of this smart home. Much of the equipment and the adjustment of the floors are expensive. For example the communication and home control system, which is in every flat, will cost a lot.

It is not sure if all of the necessary software is already available and working as good as needed. The software for the communication system and home control needs to be developed because there is nothing on the market that will fit to the required functions of the system. Besides that there is also the need to combine the software for the 'intelligent system'.

Furthermore the adjustment of the whole house will take a lot of time. In this time the residents need to stay somewhere else. This could be a disruptive element for the people who live there because they cannot stay at home.

So if you really would want to realize this concept, still a lot of work needs to be done. However, this document could provide a good basis for further research, design and eventual implementation.
9 Appendix

9.1 Comparison demolition and rebuilding