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performed in WP2 and the description of the tests  
carried out and their results obtained v2.0**

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## Document History

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**Abstract:** This document contains a practical Accessibility Guideline for the RFID reader development. According to the recommendations of the corresponding consensus report of the 2<sup>nd</sup> review meeting in Zaragoza in July 2008, the report now includes a filled-out developer checklist for the assessment of the implemented accessibility features. Furthermore, the new version of the document contains a detailed explanation of the specific support for WP2 that was performed during the accessibility workshops.

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# 1. INTRODUCTION

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The EASY LINE+ project concept involves developing and designing products for as many people as possible, including the elimination and avoidance of difficulties that can arise during the use of technical products. This requires a wide knowledge and sensitivity with regard to the special needs of people with limited motor, sensory or mild-cognitive skills.

The following Accessibility Guideline describes the basic requirements for technical implementation in practice. It offers background information about human senses and the relevant accessibility standards and takes the household environment into account, presenting aspects of household technology and the associated criteria.

WP5 provides WP2 with the Accessibility Guideline to further the development of the RFID Reader interface. The guideline is based on the practical knowledge of the accessibility experts of C-LAB, on the user requirement specifications and on international accessibility standards.

WP5 also supports this work package with a specific developer checklist that acts as a measuring instrument for the verification of the implemented accessibility features of the RFID reader interface that meet the user requirements.

This guideline and the corresponding checklist ensure the consideration of accessibility requirements during the whole cycle of the RFID reader development.

Against this background C-LAB performed two Accessibility Workshops in the run-up to the accessibility tests of the RFID reader prototypes. The practical workshops took place in October 2008 in Paderborn and 42 elderly people (carers included) took part in the workshops to discuss the potential benefit of customized RFID solutions that comply with the specific needs of the affected people.

The important results of the discussions have a significant influence on the development of tailor-made built-in and stand-alone RFID readers that meet the needs of the target group.

## 2. ACCESSIBILITY GUIDELINE

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### 2.1 Scope

This guideline is intended for use by those responsible to plan, design, develop and evaluate household technology. It provides recommendations to improve the accessibility of household equipment. Devices following this guideline will have wider accessibility for use in home environments. This guideline covers issues associated with designing equipment for people with a wide range of sensory, physical and mild-cognitive abilities, including the elderly people.

## 2.2 General principles to achieve accessibility

DIN TR 124 comprises the principles for designing accessible products. These indicate direction and offer orientation with regard to finding possible solutions.

|   |
|---|
| Principles  |
| <p>1. Equitable Use</p> <p>1a. Provide the same means of use for all users: identical whenever possible; equivalent when not.</p> <p>1b. Avoid segregating or stigmatising any users.</p> <p>1c. Provisions for privacy, security, and safety should be equally available to all users.</p> <p>1d. Make the design appealing to all users.</p>  |
| <p>2. Flexibility in Use</p> <p>2a. Provide choice in methods of use.</p> <p>2b. Accommodate right- or left-handed access and use.</p> <p>2c. Facilitate the user's accuracy and precision.</p> <p>2d. Provide adaptability to the user's pace.</p>   |
| <p>3. Simple and Intuitive Use</p> <p>3a. Eliminate unnecessary complexity.</p> <p>3b. Be consistent with user expectations and intuition.</p> <p>3c. Accommodate a wide range of literacy and language skills.</p> <p>3d. Arrange information consistent with its importance.</p> <p>3e. Provide effective prompting and feedback during and after task completion.</p>  |
| <p>4. Perceptible Information</p> <p>4a. Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.</p> <p>4b. Provide adequate contrast between essential information and its surroundings.</p> <p>4c. Maximize "legibility" of essential information.</p> <p>4d. Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).</p> <p>4e. Provide compatibility with a variety of techniques or devices used by people with sensory limitations.</p> |
| <p>5. Tolerance for Error</p> <p>5a. Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded.</p> <p>5b. Provide warnings of hazards and errors.</p> <p>5c. Provide fail safe features.</p> <p>5d. Discourage unconscious action in tasks that require vigilance.</p>  |

**6. Low Physical Effort**

- 6a. Allow user to maintain a neutral body position.
- 6b. Use reasonable operating forces.
- 6c. Minimise repetitive actions.
- 6d. Minimise sustained physical effort.

**7. Size and Space for Approach and Use**

- 7a. Provide a clear line of sight to important elements for any seated or standing user.
- 7b. Make reach to all components comfortable for any seated or standing user.
- 7c. Accommodate variations in hand and grip size.
- 7d. Provide adequate space for the use of assistive devices or personal assistance.

Principles for the design of accessible products, DIN TR 124 (origin in "The Principles of Universal Design", State University of North Carolina, Trace Center [8])

## **2.3 Recommendations related to user characteristics**

### **2.3.1 The blind and partially sighted**

According to the German Association of the Blind (1996) there are approximately 155,000 blind people and approximately 500,000 partially sighted people living in Germany and included in official statistics on the disabled. Limited sight is usually compensated by increased use of other senses – mostly feeling and hearing.

Accessible household equipment shall be designed such that the blind and partially sighted are able to compensate the absence of or reduced sight by another sense, e.g. by the sense of hearing (audio information) or touch (offering tactile information). For that reason additional aids such as pressure-sensitive adhesive film are often used by the affected people to facilitate the use of control panels.

### **2.3.2 Hearing**

For the design of household equipment hearing difficulties resulting from age and noise which might arise, for instance, from conditions in the workplace are to be taken into consideration. Consideration is to be given to the following hearing limitations in particular:

- Reduced volume perception to exclude problems with quiet sounds
- Reduced sensitivity to high frequencies to exclude problems with high frequencies

- Increased sensitivity to background noise should be assumed. With age it becomes increasingly difficult to blank out interference from background noise. This applies especially to users of hearing aids.

The official German statistics record 2.5 million hearing impaired people registered with the social services, among them approximately 80,000 deaf people, these being people who have become deaf before acquiring speech and who depend on sign language to communicate. (German Deaf Association 1999). The actual number of hearing impaired people in Germany is considerably higher. A study determined 13.3 million hearing impaired people, i.e. people who can no longer hear at least one of the studied frequencies at 40 dB. (German Association for the Hard of Hearing 2001)

The aim is to enable the hearing impaired to compensate for an absent or reduced sense of hearing with another sense, e.g. the sense of sight or touch.

### **2.3.3 Feeling**

Feeling comprehends a number of touch and movement impressions which are perceived by means of the skin.

For the design of accessible household equipment, reduced or increased sensitivity of the skin's sensory functions is to be taken into consideration for the following environmental influences:

- Pain
- Vibration
- Pressure
- Temperature
- Moisture

With regard to the above mentioned list vibration and pressure often play essential roles in conveying information.

### **2.3.4 Motor skills**

For the design of accessible household equipment consideration is to be given to the following limitations in motor skills:

- Reduced physical strength - Physical strength falls with increasing age. Thus 60 year old people still have on average 70 % and 80 year old people only 50 % of the maximum strength they had at the age of 30. In general women

have only approximately 60 % of the strength of men. There are, however, big individual differences.

- Malfunction of the gross and fine motor skills - Malfunctions of the gross and fine motor skills can be expressed, e.g., in: reduced speed of reaction; inability to carry out targeted precise movements; loss of finger skills or impaired balance.
- Restrictions in the functioning of hand and arm - Illness, loss of strength due to age and other limitations due to the situation they find themselves in can lead to the following restrictions in the workings of hand and arm: reduction in the turning ability of the forearm and hand; reduced ability of the hand to grip; preferred use of one particular hand; loss of the use of a hand / single-handedness as a consequence of an injury, illness, disability or a simultaneous action which prevents the use of the other hand, e.g. using a walking stick.
- Restrictions in the functioning of the spine and reduced mobility in the joints - Lack of movement, loss of strength due to age or illness can cause the following limitations in physical function: stiffness of movement; stiffness in the joints; diminished ability to bend over forwards; back pains, e.g. owing to prolonged bending forwards.

### **2.3.5 Thinking**

When designing accessible household equipment, the following reduced mental abilities are to be taken into consideration:

- Reduced attentiveness
- Diminished memory capacity
- Increased forgetfulness
- Increased time requirement for assimilating and processing information
- Impaired retention and decoding of new information
- Reduced speed of reaction (approx. 3 times slower for a 60 year old than for a 20 year old)
- Greater difficulty in fulfilling more complex procedures
- Increased tendency to become irritated
- Reduced coordination

In general the user shall not have to memorise or mentally calculate anything when working with the equipment.

## **2.4 Recommendations related to the device**

### **2.4.1 Acoustic signals**

Acoustic information (e.g. reminder, information and confirmation tones, warning signals) are transmitted by tone, frequency and pulse. They shall also be clearly and easily audible to users with reduced hearing without being burdensome to those with normal hearing. They shall also be presented graphically (Two Channel Principle). The following recommendations are to be taken into consideration:

- Acoustic information shall be presented in appropriate frequencies that can be perceived by users with limited hearing capacities.
- With regard to the background noise the volume of warning and other signals shall be individually adjustable to the respective hearing ability or capable of being switched off with regard to people who are disturbed by the signal (exception: warning signals!).
- Visual feedback is recommended.
- Signals shall be distinguishable from the operating noise.
- Wherever possible multiple tone sequences, time-related shall be used.
- Sufficient signal repetition for reminder and warning signals shall be used.
- Acoustic signals shall easy to be cancelled or switched off.
- Signals shall be clear, intuitive and distinguishable in the conventional manner. For example, positive signals can be indicated by a rising tone sequence and negative signals by a descending tone sequence.

### **2.4.2 Control panel arrangement**

Control panels shall be arranged on devices such that they can be set and checked with the minimum of physical effort and are as clearly visible as possible.

A control panel shall:

- be operated comfortably when sitting or standing upright.
- preclude risk to the user when activating the control element. For example, the user must not have to stretch across hot surfaces to reach the control elements.

Remote controls and individually positionable control panels permit especially flexible arrangement of the controls.

### **2.4.3 Displays**

Displays shall be designed such that they can also easily be perceived by users with limited vision.

The following recommendations apply to displays:

- Contrast shall be sufficiently strong. For luminous displays the luminance shall be individually adjustable.
- Flashing displays shall be used exclusively in order to achieve increased attentiveness.
- Absence of flickering.
- Appropriate colours shall be used.

#### **2.4.4 Installing/Mounting**

In terms of body position it shall be possible to use devices with the minimum of physical effort. This is guaranteed if the control elements, knobs, operating areas and the function areas are readily visible and manageable.

Appropriate installation means the device is positioned within the individual area of reach, e.g. height-adjustable work places.

Recommendations for working when standing:

- Reaching downwards, the vertical area of reach where mobility is restricted ends at approximately 40 cm above floor level.
- Reaching upwards, the vertical area of reach where mobility is restricted ends at approximately 140 cm above floor level.
- The optimum countertop level for light work is 10 to 15 cm below elbow height, and for heavy work requiring the use of force 15 to 40 cm below elbow height. Devices shall be installed in such a way that the most important work can be carried out at this height.

Recommendations for working when sitting:

- Reaching downwards, the vertical area of reach where mobility is restricted ends at approximately 40 cm above floor level.
- Reaching upwards, for wheelchair users ends at approximately 120 cm and for senior citizens approximately at eye level. For the average female senior citizen this is approximately 120 cm above floor level.

Recommendations for portable devices:

- Devices shall stand firmly on the work surface and not slip.
- Portable devices shall be designed such that they and their accessories can be put away in a space-saving manner.
- Portable devices shall be designed such that they and their accessories can be easily installed and removed.

## 2.4.5 Use of control elements

Control elements shall be selected such that they can also be used easily by users with hand and arm mobility limitations.

## 2.4.6 Sequence and structure of the control panel

The operating sequence and structure of the control panel shall be as simple and easy to understand as possible with regard to users with limited mental capacities.

The following recommendations apply to the sequence and the structure of the control panel:

- Control elements shall be arranged in a logical sequence.
- Control elements shall be arranged clearly, sorted and grouped.
- The identification of control element settings and functions shall be supported by their arrangement.
- Control elements shall be arranged so as to be easily accessible. This applies in particular to important and frequently used control elements like e.g. the Start and Stop function.
- Control elements shall be arranged equally suitably for right and left-handed users.
- Too many control elements shall be avoided.
- The number of setting steps shall be minimised.
- For a fixed sequence the device shall guide the user through the operation. It shall be clear to the user at all times what the aim of the settings is, which steps have already been carried out and which steps are still to be carried out.
- For wrong or unwanted settings it shall be possible to correct one or several setting steps without cancelling the setting and having to start again from the beginning.

## 2.4.7 Graphical symbols and numbers

Graphical symbols and numbers shall represent facts briefly, clearly and in a way that is easily understood. Special care is to be taken in their design with regard to users with limited mental capacity and reduced vision.

Graphical symbols and numbers shall be designed according to the following recommendations:

- They shall be sufficiently large with a high contrast.

- Graphical symbols shall be self-explanatory. For new functions/features plain text shall be used. For standard functions a graphical symbol can be understood more quickly than the corresponding plain text.
- It shall also be possible to perceive graphical symbols and numbers by touch wherever possible with regard to the blind users.

## 2.4.8 Colour

(+ very suitable; - not suitable)

| Background | Symbol colour (print colours CMYK) |       |        |      |      |       |        |     |
|------------|------------------------------------|-------|--------|------|------|-------|--------|-----|
|            | black                              | white | purple | blue | cyan | green | yellow | red |
| black      |                                    | +     | +      | -    | +    | +     | +      | -   |
| white      | +                                  |       | +      | +    | -    | -     | -      | +   |
| purple     | +                                  | +     |        | -    | -    | -     | -      | -   |
| blue       | -                                  | +     | -      |      | +    | -     | +      | -   |
| cyan       | +                                  | -     | -      | +    |      | -     | -      | +   |
| green      | +                                  | -     | -      | +    | -    |       | -      | -   |
| yellow     | +                                  | -     | +      | +    | -    | -     |        | -   |
| red        | -                                  | +     | -      | -    | -    | -     | +      |     |

Suitable and unsuitable colour combinations for symbols and background, DIN TR 124 [4]

For the selection of colours for accessible devices there must be consideration for limited vision, especially defective colour vision and also for limited mental abilities. The above listed table (suitable and unsuitable colour combinations for symbols and background) shall improve the design of accessible devices.

Furthermore colour shall not be used as the exclusive conveyor of information (Two channel principle).

## 2.4.9 Dazzling effect

The following applies to operating and work surfaces:

- Devices shall be designed such that dazzling is minimised.

- For shiny surfaces easy and good legibility of the printing / displays shall be guaranteed.

### **2.4.10 Erroneous operation**

Erroneous operation can occur during use of the control panel, but also during use of other parts of a device. They can lead not only to unexpected or poor work results but even to damage to the device itself or to the environment.

The device shall therefore be equipped such that:

- all foreseeable erroneous operations are widely excluded.
- wrong or illogical settings are not possible.
- errors are explained to the user. This means that the user is made aware of a wrong or illogical setting clearly and can perceive this with two senses (Two channel principle).
- the user is requested to make a correction and is guided through the corrective steps that need to be carried out.
- ideally automatic correction is introduced and reported to the users clearly and such that they can perceive this with two senses (Two channel principle)

### **2.4.11 Device feedback**

Device feedback shall give the users the opportunity to get information about the result of their action in order to have a corrective effect where applicable. According to the communication channel referred to a distinction is made between visual, acoustic and tactile appliance feedback.

Some examples:

- Visual feedback: indicator lights, check lamps
- Acoustic feedback: signals, voice output
- Tactile feedback: stop positions, vibration

The following shall also be considered with regard to users with limited abilities:

- Feedback shall be clearly perceptible.
- Feedback shall be easily understood.
- Feedback during setting shall take place immediately when an action has ended in order to guarantee clear association between action and feedback.
- For operational faults the device shall indicate the cause of the fault if users can rectify the fault themselves.

- There shall be a programme progress indicator present which clearly indicates whether the appliance has been switched on, whether it has been started and whether it is ready.

### **2.4.12 Hand reach**

Hand reach indicates the arm's area of movement within a space.

Device parts that are operated during setting procedures and other work shall be arranged within hand reach such that it is possible to avoid movements of the trunk and detrimental body position.

### **2.4.13 Handedness**

Handedness not only expresses with which hand a device can be operated, but also whether one hand suffices or two hands are necessary.

The following recommendations are to be considered:

- It shall be possible to operate devices with one hand.
- It shall be possible to carry out all work on a device by both, a right-handed and left-handed person in the same way and with the same results.

### **2.4.14 Body position**

Body positions refer to different angles of inclination in the joints, in particular the back and knees. Here the strain on the body is greater, the greater the angle of inclination.

Devices shall cause as little strain as possible, i.e. it should be possible to operate them without bending and stretching. For accessible design particular consideration is to be given to users with reduced motor skills.

### **2.4.15 Ease of cleaning**

Devices shall be easy to clean and able to be cleaned with little effort.

The following recommendations are to be considered:

- All visible parts (including also spaces between control elements) shall be easily accessible.
- The materials used shall be clean again after a brief wipe with a damp cloth and a little detergent and not scratch during appropriate cleaning.

- All parts that are to be cleaned shall be rounded and must not have sharp or rough edges. Corners shall be avoided or rounded.

### **2.4.16 Safety**

Devices shall be designed such that they can be used safely.

- It shall be possible to set all functions reliably.
- It shall be possible to operate all device parts reliably.

### **2.4.17 Language**

Language serves to convey information. The information for a device shall therefore be passed on in a language the user knows and understands easily.

For devices the following recommendations are to be considered for inscriptions and voice inputs and outputs:

- Words shall be taken from the language of the country concerned.
- Different functions of a device shall be identified with terms that are clearly distinguishable from one another.
- Technical specialist terms shall be avoided.
- If abbreviations are used it must be ensured that the circle of users knows them.

### **2.4.18 Voice input and output**

Voice control and voice recognition systems are already regarded as the technology of the future for using computers and increasingly required in products in the field of information and communication technology.

Voice input supports the activation of control elements and voice output conveys information to the user that is necessary for the operation.

Voice inputs and outputs are very useful for people with impaired vision (blind and visually impaired people).

As, however, not all users value the advantages of voice input and output, the following recommendations are to be considered:

- It shall be possible to switch voice input and output off.

- Voice input and output shall not replace control elements and displays, but only complement them. This satisfies the demand for at least two senses.
- For high functionality with voice input and voice recognition systems the instructions that are to be entered shall be as short as possible, sound acoustically different and correspond to the user's general vocabulary. Possible dialects shall also be considered.

### **2.4.19 Start/Stop function**

The start/stop control element shall be easily identifiable. It shall be separated from the remaining control elements.

It shall be possible to stop a programme at any time. When the stop control element is activated the device shall stop a running programme immediately and recognisably.

It shall be clearly apparent whether it is necessary to press a start button.

### **2.4.20 Tactile information**

Tactile information on devices are the shapes and contours of devices and their parts, the composition of surfaces, reliefs, e.g. prominent inscriptions and similar. They shall be perceivable by people with limited vision (blind and visually impaired people) and it shall also be possible to perceive them easily and clearly when there is reduced finger sensitivity.

### **2.4.21 Door system**

It shall be possible for people with little hand strength and limited functional capabilities in the hand and arm to open and close doors safely and easily. The following requirements are to be considered in the view of accessible design:

- It shall be possible to open doors with a single grasp.
- The expenditure of force for opening and closing the door must not be too much.
- The door hinge on doors shall be convertible in order to permit adjusting the direction of opening to the respective set-up situation.

## 2.4.22 Visual information

For visual information a distinction is made between visually perceptible labelling (graphical symbols, letters, font, etc.) and displays (e.g. check lamps, line scales, digital displays). It shall be possible for users with limited vision to perceive visual information easily and clearly.

The following general recommendations are to be considered in the view of accessible design:

- Visual information shall be sufficiently large.
- The contrast shall be sufficiently strong.
- Reflections shall be avoided wherever possible.
- Materials shall be selected for displays that are resistant to signs of ageing and abrasion.

## 2.5 Procedure for assessing applicability

Annex I provides a developer checklist that should be used to determine whether the applicable requirements and recommendations in the guideline have been met.

The checklist can be used either during the development or for evaluation of a completed equipment or service.

The checklist contains all requirements and recommendations from the guideline. It should be noted that the procedure described is provided as guidance and is not an exhaustive process to be used as a substitute for the guideline itself.

The use of the checklist provides a basis for determining which of the requirements and recommendations are applicable.

**Note:** For this reason C-LAB recommends to complete the checklist after each development stage to ensure the consideration of accessibility aspects during the entire cycle of the prototype development.

## 2.6 Summary

The observance of the guideline ensures that developers consider the wide range of required accessibility aspects during the entire development cycle.

The achieved level of accessibility for the related type of impairment depends on whether the specific requirements of the concerned users will be applicable or not.

In this way the usage of the developer checklist presents a suitable manner to verify the achieved level of accessibility in each development stage.

By following the steps mentioned above, this procedure will lead to accessible prototypes of RFID readers that comply with the needs of the elderly people with physical, sensory and mild-cognitive impairments.

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## **3. ACCESSIBILITY WORKSHOPS**

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### **3.1 User recruitment**

C-LAB performed two workshops to gather specific information for the accessibility tests of the prototypes. The workshops took place on the 15th and 24th of October in 2008 in Paderborn. 42 elderly persons (personal carers included) took part in these workshops. The user selection procedure is detailed described in D5.2 in Chapter 3.1 "User recruitment".

### **3.2 Set up of an accessible demonstration environment**

The team of experts configured an accessible laboratory environment for the concerned users in advance to assure an unproblematic course of the practical tests. Most of the participants suffer from visual and physical impairments. A detailed description of the set up is presented in D5.2 in Chapter 3.2 "Set up of an accessible demonstration environment".

### **3.3 The workshops in detail**

Several test scenarios were presented during the workshops and the participants were able to interactively experience the different technologies in terms of accessible design. The complete course of the accomplished accessibility workshops can be found in D5.2 in Chapter 3.3 "The workshops in detail".

### **3.4 Specific work package support**

With regard to the practical accessibility workshops, C-LAB was intended to present the complete RFID environment including the washing machine, the refrigerator and the stand-alone reader. Due to the development course of the project partner IDENT the prototypes were unfortunately not obtainable for a practical demonstration.

Nevertheless the workshops led to vital results in terms of accessibility design that comply with the needs of the target group.

Most of the participants of the workshops were blind or visually impaired and were only able to manage their daily household tasks with relatives or carers. This explained the high interest of the people in the use of RFID technology that allows them to identify and register items in the household environment in order to increase their individual independence.

Radio frequency identification is a communication technology that is used for an easy localization, identification and registration of items like e.g. foods and garments in the household environment.

Although similar to barcode technology, RFID has an important advantage for visually impaired and blind users because the RFID tag reading procedures are easier to handle than dealing with barcode readers that need a higher precision in their usage.

RFID tags come in a variety of types (with different sizes or shapes) and can be attached to most items in the household. In some cases metal surfaces may cause problems e.g. if a tag is directly stuck on a tin. To solve this problem, tags with holes for bands or similar could be used as an applicable solution for elderly people with disabilities and in particular for blind and visually impaired users.

The facility of RFID readers to read contactless from tags, even through housings, allows the registration and identification of foods and items in an easy manner. The maximum read range depends on the tags and readers used in the environment.

Some of the participants had RFID readers and were already experienced in the use of this technology. Most of them worked regularly with the Milestone 311. The Milestone 311 is a small sized Daisy player that supports the usage of the Speakout module. Speakout is a talking label and identification device for the Milestone 311. It is a small module that provides the facility to read RFID tags. Figure 1 shows the multifunctional Milestone device that presents a variety of features.



**Figure 1. The portable Daisy player Milestone 311**

Detailed information about the Milestone 311 and the optional Speakout module can be found at the VZFB (Verein zur Förderung der Blindenbildung): <http://www.vzfb.de>. By using the Milestone the owners were well aware of the advantages and the problems that may occur.

The accessibility experts of C-LAB explained the different RFID scenarios in detail during the workshops. The values of labelled and read in tags were demonstrated by using adapted videos that were translated into German language. The videos represented this information in an audiovisual manner that complies with the needs of the participants. An example video is shown in Figure 2.



**Figure 2. Prototype functionality: List of foods including expired items**

The below listed prototype functionalities were demonstrated and intensively discussed in round-table and individual discussions to gather project relevant information for the next development stage. The following subjects were brought up:

- Appropriate tagging of garments
- Appropriate tagging of food and other items

- Registering of food that passes through the household
- Identification of colours respectively types of garments
- Unregistering of garbage that exits the household
- The usage of the built-in RFID readers
- The usage of the stand-alone RFID reader
- Warnings / notifications / reminders caused by the determination of used-by dates of food
- Warnings / notifications / reminders caused by the determination of expiration dates of food
- Warnings / notifications caused by mismatched types respectively colours of garments
- Determination of appropriate cooking / heating programmes initiated by the identification of food
- Determination of appropriate washing programmes initiated by the identification of garments
- Privacy related aspects

The above mentioned privacy aspects were discussed to inform the participants in advance that personal data will not be recorded by the installed RFID technology.

The discussions led to important results and in particular the experienced users were able to contribute practice-oriented information that exposed the advantages as well as the difficulties in the use of stand-alone readers. The results of the discussions can be found in Deliverable D5.4 in Chapter 2.2.1.

Related to the visual impairments of most of the participants some of them had the following requests concerning additional prototype functionalities as well as specific design factors that may enhance the ease of use for the affected users:

- Tracking of food / garments / items for an easier localization
- Additional audio information should be recordable for registered foods / garments / items

- Registering of all items that are available in the household
- Search mechanisms to find registered food / garments / items

All of the mentioned requests are essential for blind and visually impaired users. Easy localization and identification of items are the prerequisites to perform their daily tasks without any assistance and will help to increase their independence.

### **3.5 General results**

Besides the project related results the workshops exposed general important information regarding the accessible design of household appliances. The results are presented in D5.2 in Chapter 3.5 "General results".

### **3.6 Summary**

Localization, identification and registration of food, garments and other items that pass through the household are essential preconditions to increase the independence of people who suffer from visual impairments.

For this reason the different usage scenarios of RFID readers were intensively discussed during the workshops to expose the potential benefit as well as to find potential obstacles in the use of RFID readers.

The round-table discussions yielded important results that will influence the development of built-in and stand-alone RFID readers for the concerned users. The results are outlined in D5.4 in Chapter 2.2.1.

## 4. CONCLUSION

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The principles to achieve accessibility and the recommendations of this guideline provide support for the development of solutions that will lead to increases in accessibility.

The achieved level of accessibility of the RFID readers is presented in the corresponding developer checklist that can be found in Annex I.

The checklist outlines all implemented accessibility attributes of the RFID readers that meet the needs of the target group considering their sensory, physical and mild-cognitive limited abilities.

Moreover the outcome of the accessibility workshops discloses the potential benefit as well as many expected problems of the elderly people in the use of the built-in and stand-alone RFID readers.

In particular the blind and visually impaired users request an accessible RFID solution with regard to the wide range of potential usage scenarios. Many household tasks are currently not manageable for them or only with the assistance of carers or relatives. An appropriate RFID solution will significantly increase the independence of this user category and will immensely help them to cope with their daily tasks.

Important results of the Accessibility Workshops that support the prototype development of the RFID readers can be found in Deliverable D5.4 in Chapter 2.2 "Results of the Accessibility Workshops".

The performed support of C-LAB led WP2 to factor the specific needs of the target group in the entire development of built-in and stand-alone RFID readers. Accessibility workshops, several meetings with affected users and discussion forums dealt with the different user characteristics as well as with their individual recommendations in the use of the RFID technology.

The user requirements were put into practice in the decision to replace the dishwasher and the cooker hob by an accessible microwave oven as well as an applicable stand-alone reader solution.

Moreover the consideration of user recommendations led to a design change of the stand-alone RFID reader. The originally planned tunnel shape that was able to read food or garbage bags was replaced by a functional enhanced and smaller device that is able to read different kind of items.

Accessibility aspects also influenced the appropriate positioning of the antennas in the refrigerator and the washing machine in terms of ease of use by affected people with physical and sensory impairments.

## ANNEX I: DEVELOPER CHECKLIST

### Results of development stage: Built-in and stand-alone RFID reader

**Note:** Most of the accessibility features for blind or visually impaired users are granted by the user interface and the e-servant system, but as a unique characteristic in view of accessibility, the stand-alone RFID reader of the project is able to read RFID tags at a distance of up to 0,5 meters. In this way, the blind and visually impaired users manage their read operation of RFID tags in an easy way.

This is a great advantage compared with the stand-alone RFID reader Milestone 311 [7] that is rated as an accessible device for blind and visually impaired users by only providing a maximum read distance of 5 centimetres.

| No | <b>Summary Checklist:</b> Built-in / stand-alone RFID reader<br><b>Appliance:</b> Stand-alone RFID reader<br>Checklist item | Not applicable | Relevant | Fully compliant | Not compliant | Comments   |
|----|---|----------------|----------|-----------------|---------------|--|
| 1  | Is acoustic information presented in appropriate frequencies?   | X              |          |                 |               | Acoustic signals should come from HMI or E-servant |
| 2  | Is the volume of acoustic signals adjustable?   | X              |          |                 |               |  |
| 3  | Is visual feedback for acoustic signals also provided?  | X              |          |                 |               |  |

|    |   |   |  |   |  |   |
|----|---|---|--|---|--|---|
| 4  | Are acoustic signals clear, intuitive and distinguishable in a conventional manner? | X |  |   |  |   |
| 5  | Are control panels easy to operate?   | x |  |   |  | Devices controlled by E-servant                                 |
| 6  | Is a control panel also available as a remote control?                              | x |  |   |  |   |
| 7  | Is the display contrast sufficiently strong?  |   |  | x |  |   |
| 8  | Are flashing displays used to increase the attentiveness of the user?               | x |  |   |  |   |
| 9  | Is display flickering avoided?  |   |  | x |  | Display consists only of LED's                                  |
| 10 | Are the display colours appropriate?  |   |  | x |  | R,Y,G   |
| 11 | Is the function area readily visible and manageable in standing position?           |   |  | x |  | Reader can be mounted on table or wall granting easy access     |
| 12 | Is the function area readily visible and manageable in sitting position?            |   |  | x |  | Depending on proper mounting                                    |
| 13 | Are control elements easy to use?   |   |  | x |  | Place objects in front of reader and E-Servant will do the rest |
| 14 | Are control elements arranged in a logical sequence?                                | x |  |   |  | Controlled by E-servant   |

|    |   |   |  |   |  |   |
|----|---|---|--|---|--|---|
| 15 | Are control elements clearly arranged?  | X |  |   |  |   |
| 16 | Are settings and functions of control elements easy to identify?                | X |  |   |  |   |
| 17 | Are control elements easy to use for left- and right-handed users?              | X |  |   |  |   |
| 18 | Are the number of control elements and setting steps minimized?                 |   |  | x |  | Reader awaits go trigger from E-servant, performs tasks, passes information along and goes to sleep again |
| 19 | Is it possible to correct an unwanted setting during the operation sequence?    | X |  |   |  |   |
| 20 | Are graphical symbols sufficiently large with high contrast?                    | X |  |   |  |   |
| 21 | Are graphical symbols self-explanatory?   | X |  |   |  |   |
| 22 | Are graphical symbols and numbers also available as tactile information?        | X |  |   |  |   |
| 23 | Are appropriate colours used for easy identification?                           | X |  |   |  |   |
| 24 | Is the colour information also conveyed according to the Two channel principle? | X |  |   |  |   |
| 25 | Are dazzling effects avoided?   | X |  |   |  |   |
| 26 | Are all foreseeable erroneous operations widely excluded?                       |   |  | x |  | Reader is tested for operations in live environment   |

|    |   |   |  |   |  |  |
|----|---|---|--|---|--|--|
| 27 | Are errors clearly explained to the user?   | x |  |   |  | Error messages go to E-servant                 |
| 28 | Is appropriate visual, acoustic and tactile feedback provided?                    | x |  |   |  | All this feedback comes from E-servant and HMI |
| 29 | Is an appropriate area of movement provided for people with limited motor skills? |   |  | x |  | Depending on correct mounting                  |
| 30 | Is it possible to operate with one hand?  |   |  | x |  |  |
| 31 | Is it possible to operate without bending and stretching?                         |   |  | X |  |  |
| 32 | Are all visible parts easily accessible?  |   |  | x |  | Depending on mounting                          |
| 33 | Are all parts of the shape easy to clean?   |   |  | X |  |  |
| 34 | Are all parts of the shape rounded?   |   |  | X |  |  |
| 35 | Are all parts and functions of the device reliable to use?                        |   |  | X |  |  |
| 36 | Is the language of the inscriptions easy to understand?                           | X |  |   |  |  |
| 37 | Is voice input and output provided?   | X |  |   |  |  |
| 38 | Are Start/Stop functions easy to identify?  |   |  | X |  | HMI  |
| 39 | Are Start/Stop functions easy to operate?   |   |  | x |  | HMI  |
| 40 | Is tactile information provided?  | X |  |   |  |  |

|    |   |   |  |   |  |  |
|----|---|---|--|---|--|--|
| 41 | Are door systems easy to use for people with limited motor skills?                      | X |  |   |  |  |
| 42 | Can the door system be opened with a single grasp?                                      | X |  |   |  |  |
| 43 | Is visual information sufficiently large?   | X |  |   |  |  |
| 44 | Are reflections avoided?  |   |  | X |  |  |
| 45 | Is the display resistant to aging?  |   |  | X |  |  |
| 46 | Are in case of regular user maintenance the relevant component parts easily accessible? | X |  |   |  |  |
| 47 | Does the maintenance work only require common household experience?                     | x |  |   |  | Maintenance can only be carried out by specialized personnel |
| 48 | Can the maintenance work be performed with one hand?                                    | X |  |   |  |  |

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