Deliverable D4.1

Interface Strategy v3

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1 Executive Summary

The deliverable D4.1 - Interface strategy v3 is the third version of the first deliverable of Work Package 4 - User Interaction, and it is associated with Task 4.1 - Interface language. The deliverable is closely linked to D2.1 - Report on requirements and D2.3 - Report on Design of HW, Interfaces, and Software, taking the collected requirements and putting them into a common interface strategy for the different user interaction devices that are created in the scope of WP4. Chapter 8 and 9 are new amendments to version 3 of this deliverable.

The document is based on the design considerations presented in the first version of this deliverable, which are shaped by observations we made during the second group workshop. The deliverable will first introduce the topic in a few short paragraphs, including some references to the most important literature and how the deliverable is related to the other tasks and deliverables of the project. Afterwards, we introduce the rationale of the interface strategy, including the timeline and scope within the project, the collected requirements and their impact on the interface strategy, the current iteration of the hardware architecture, and best practice as gathered in the proposal phase and in the creation of this document.

In the next part we introduce the preliminary interface strategy that will drive the development of the user interfaces in the first phase of the project, including the introduction of some personas that will drive the strategy for the different types of interfaces that are subsequently introduced. In the next section we list the technical implications of this strategy on the different interfaces that are developed in the first phase of POSEIDON.

Chapter 5 and 6 of this deliverable is dedicated to the description of the activities that were organized during the second group workshop. We used the opportunity of this workshop to investigate certain aspects of interest in the design of our strategy. In order to deliver a stable system and to mitigate the device abandonment phenomenon, we have presented a series of demos meant to demonstrate the concept of this project and to gather feedback from both secondary and primary users. This feedback will be used as guidance information in the development process. We present our approach as resulted from this workshop in two subsections dealing with the interactive table, and the Virtual Reality system.

Chapter 7 presents plan for Pilot 1, which runs summer 2015.

In Chapters 8 and 9 the achieved development of the interfaces are briefly presented with additional explanation provided when needed to complement the description from other deliverables which are very close in theme like D4.5 - HCI user and developer manuals. Because pilot 1 is not finalized yet, we mention only a part of the feedback gathered by the pilot 1 users and will explain how the outcome of the pilot 1 influences the interface strategy in the next version of the deliverable.
2 Introduction

User interface design (UID) is the design of websites, computers and software application with the focus on the user’s experience and interaction. Hereby a user-centered design has as goal to ensure an interaction is as simple and efficient as possible, while the users are accomplishing their goals.

To ensure the good quality of user interfaces, principles and guidelines have been formulated [1] which are applicable for all kinds of user interfaces, whether they are websites, applications or devices. These guidelines are especially concerned with accessibility.

"Worldwide, there are more than 750 million people with disabilities. As we move towards a highly connected world, it is critical that the Web be usable by anyone, regardless of individual capabilities and disabilities," said Tim Berners-Lee, Director of the W3C and inventor of the World Wide Web. [2]

The goal of the W3C is to make content accessible to a wider range of people with disabilities. They address blindness, low vision, deafness, hearing loss, learning disabilities, cognitive limitations, limited movement, speech disabilities, photosensitivity, and a combination of the above. The target group on which POSEIDON is focusing, people with Down’s syndrome, might present several of these impairments in different combinations and development. Thus, a user interface design for POSEIDON should strongly take the WCAG guidelines into account.

Due to the different nature and combination of the impairments people with Down’s syndrome are suffering from, customizable interfaces are needed. Adaptive interfaces change modality, layout and elements according to the user’s preferences either manually or automatically, triggered by a changed context [3]. This allows the interface to be conformant to specific user needs. Mostly it is required to change presentation and navigation according to requirements. This research area has been in development for several years. An important topic is the modeling of the user either autonomously or via user input [4], allowing to control the interface according to specific context. Modeling in this context describes creating a profile of the individual capabilities that have to be taken into account when designing the user interface. Considering our tackled scenarios a combination of both methods is viable using a combination of prior knowledge as ground truth and autonomous adaptation based on the current context. Some evaluations have been done on the challenges posed by current computer interfaces to people with DS [5], [6] with some interesting outcomes on identifying what may be more useful in terms of communication and safety. However, there is still much to do, especially with the adaptation of interfaces to contexts, preferences and needs. Another aspect of adaptive interfaces is recently becoming more apparent in a paradigm called responsive web design [7]. This proclaims crafting sites to provide an optimal user experience.

Due to the user-centered design, the preferences have been investigated by evaluating the results of the Task 2.1 Requirements gathering. These results are presented in the deliverable D2.1 Report on Requirements, revised after user workshops and pilots.
3 Rationale

3.1 Timeline of interface strategy development
The interface strategy strongly depends on the requirements gathered during the requirement analysis. The interviews of the primary user, the online questionnaires of the secondary and tertiary user and the first user workshop have all contributed to this process. From these requirements an interface strategy is extracted, imminently followed by an implementation in form of an integrated prototype. In Figure 1, (b) and (d), the requirements gathering phase and the first user workshop followed by f when the first interfaces and interactive technology are set up, are represented respectively. The created prototype (g) is evaluated in the second user workshop (h) and the outcome of the workshops is subsequently analyzed. The feedback is taken into account and the interface (l) is adjusted, when the interfaces are completely defined. This iterative process for the interfaces is finished in step r, when the improved interfaces are set up.

3.2 User requirements created within Work Package 2
The interface strategy is closely related to D2.1 - Report on requirements and to D2.3 - Report on Design of HW, Interfaces, and Software. The general design principles for interfaces have been presented in D2.3. Therefore, parts of the following section regarding the design principles are taken from there, while section 3.2.2 regarding the requirements analysis presents the requirements applicable for the interface strategy.

3.2.1 Design principles for user-centered design
Designing a fitting user interface is a complex challenge. The interface should be extremely simple and at the same time sufficient for the application in question. One should pay attention to the following ten general principles for designing user interfaces, which are based on the principles of universal design with focus on interfaces, as determined by Nielsen [8]:

Figure 1 Project and work package milestones and events
Principle 1: Learnability

The user interface should be easy to use from the first time a user interacts with it. There should be no need to learn a new functionality or new ways of interaction. The system should be based on recognition rather than the need to recall previous experiences.

Principle 2: Efficiency

The number of steps a user takes to complete a task should be as few as possible. The need for horizontal and vertical scrolling should be kept to a minimum. Helping tools (e.g. Wizards etc.) should be used to simplify complex interactions. Real world metaphors should be used where applicable. Less is more – leave stuff out, if it is not really needed.

Principle 3: Error recovery

The system should be designed so that it is hard or even impossible for a user to make mistakes. However, when a user mistake occurs, this should be clearly communicated with information on which actions to take to continue the use of the system. If there is a system error, this should also be communicated in a clear way, with simple and understandable information to the end-user. All error messages should be useful. The system should provide guidance on how the user should recover from the error.

Principle 4: Simplicity

Tasks frequently performed should be easy to do, and less common tasks should be possible to do. Unnecessary functionality should be avoided. The layout and design should be as simple as possible. The navigation should be narrow and shallow, providing only necessary functionality. For this, we need to understand profoundly the context of when and where our users will use the system.

Principle 5: Mapping

What the user expects to happen should happen. There should be a mapping between the conceptual model the user has of the system, and how the system actually works.

Principle 6: Visibility

The most important information should be most visible, and less important information should be less visible. When using a touch interface, no button should be smaller than the user's fingertips.

Principle 7: Feedback

The user should be in control of the interface and not the other way around. The system should provide quick responses. If the response will take some time, a progress bar or some other useful information should be provided. Speed and responsiveness are crucial for the user experience. In today’s computing environment one second is an “eternity” to wait for response from the system or application. If a system does not respond within a reasonable time frame, the users will assume there is an error and try again, or press other buttons that will nullify existing action causing confusion and a bad user experience.

Principle 8: Consistency

Identical items and identical functionality should always be displayed and behave the same way across the entire system/application.

Principle 9: Satisfaction
The users should enjoy using the system/software. The software should perform its expected tasks well and nothing more. If one would like to perform another task, one would most likely use another application or system.

**Principle 10: Predictability**

When a system follows the principle of predictability, the user would know what to expect from the system: The behaviour is consistent throughout the application/system/service. With a consistent user interface the user will not experience surprises. When a user presses a button or invokes a service, it should be evident for the user what to expect, and it should also be evident how the results will be presented. To ensure a predictable user experience, it is important to understand the targeted users' expectations and the conceptual models they have for the system they are using. If we design a system based on a different conceptual model than the one of the end-users’, the user interaction and how they use the system will never match the anticipations of the developers, and the system will score low on usability and expectations of the users. If the system is designed following the conceptual model of the end-users, we will get a high score on usability, because the behaviour of the system is what the end-users predict. The system and the user interaction follow the users’ expectations. Ideally there should not be any surprises for the end-user when using the system. If something unexpected happens, the methods for solving the unexpected should be predictable and well known by all users.

### 3.2.2 People with Down’s syndrome as computer users

Like already described in D2.3, the possible limitations and characteristics of people with Down’s syndrome have a major impact regarding the usage of technology, thus underlining the need for usability-focused and user centred design. The goal is not only to develop a technology that is easy to use, but one that will also be useful to the user and his/her possible limitations. Regarding the usage of computers by people with Down’s syndrome the limitations in cognitive, language, and motor skills all have a profound impact on computer usage as e.g. difficulties in memory, processing information, understanding abstract concepts, reading, writing, communication, navigation, typing, and the use of the mouse. These limitations present a major challenge not only for users, but also for designers.

A recent study [6] focussing on the computer usage of children with Down’s syndrome shows that 72% of the sample started using a computer by the age of five. 99% of the sample had access to a computer at home, other main access points being school and library. Thereby computers are mostly used for learning (80%), entertainment (95%) and communication within ones peer group members (33%).

Focussing even more on the usage of computers etc. and possible preferences of the target group one can find some interesting suggestions in literature regarding fonts, colours, graphics, animations and buttons [9].

The European standards for making information easy to read and understand, “Information for all” have been developed in the framework of the project “Pathways to adult education for people with intellectual disabilities” [10]. These focus on general guidelines on language, written information and most importantly on standards for electronic information. The guidelines on the language refer to how words need to be chosen, sentences formulated and information ordered. Further on, the written information guidelines focus on the general appearance of text: design and format of a text, wording, details like footnote usage and punctuation, the use of images, representation of numbers and dates, etc. For creating accessible websites the specific guidelines address the necessity to take into account the hardware users own, how easily the website can be found on the web, the design of the homepage and the information displayed on it and what the screen should look like.

Taking the two sources for design guidelines together [9], [10] one can conclude in the overview presented in Table 1. While [9] focus on the preferences of people with Down’s syndrome, the
standard “Information for all” focuses on the larger group, people with intellectual disabilities. Kirijian et al. present a study on a group of 10 people with Down’s syndrome, carefully chosen on the basis of their computer usage [9]. In general both share the idea of using as simple wording as possible and both strongly suggest the use of photographs and images to support the idea presented with words. However, there are also contradicting statements, like the usage of animations. This is due to the different purpose for which each animation is used. For example, if it is always placed on the screen it can be distracting. On the other hand, some personalized animations used as reward system can be motivating. In general, both share the idea of using as simple wording as possible and they both strongly suggest to use photographs and images to support the idea presented with words. However, there are also contradicting statements, like the usage of animations. This could be understood by the different intention of the animation. Furthermore a general rule is to avoid everything unexpected, like e.g. pop-up windows.

Table 1 Overview of design guidelines

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Font</td>
<td>- Bright, adding depth</td>
<td>- Don’t use serif fonts, rather Arial, Tahoma</td>
</tr>
<tr>
<td></td>
<td>- Large</td>
<td>- Enough spacing between letters</td>
</tr>
<tr>
<td></td>
<td>- Bold</td>
<td>- Don’t use italics, underline</td>
</tr>
<tr>
<td></td>
<td>- Stylized</td>
<td>- Don’t use shadows, special writing design</td>
</tr>
<tr>
<td></td>
<td>- No font decoration</td>
<td>- Large, at least like Arial 14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- one font throughout text</td>
</tr>
<tr>
<td>Colour</td>
<td>- Darker: blue, purple, grey</td>
<td>- Avoid colours of text</td>
</tr>
<tr>
<td></td>
<td>- Combinations of primary colours</td>
<td></td>
</tr>
<tr>
<td></td>
<td>with high contrast</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Tints and tones</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Complimentary colours</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- No dull colours</td>
<td></td>
</tr>
<tr>
<td>Graphics/Images</td>
<td>- Clearly identifiable</td>
<td>- Photographs, drawings, symbols</td>
</tr>
<tr>
<td></td>
<td>- Naturally coloured not digitally manipulated</td>
<td>- Don’t use images for younger people than the target age group</td>
</tr>
<tr>
<td></td>
<td>- With people of similar age or older</td>
<td>- Clear, not too disturbing to look at</td>
</tr>
<tr>
<td></td>
<td>- Action images</td>
<td>- Fit to the text</td>
</tr>
<tr>
<td></td>
<td>- Photographic better than illustrated</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Fun and whimsical illustrations</td>
<td></td>
</tr>
<tr>
<td>Animations</td>
<td>- Bright colour</td>
<td>- No animations on screen</td>
</tr>
<tr>
<td></td>
<td>- With motion</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Animating colour</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Personalized</td>
<td></td>
</tr>
<tr>
<td>Buttons</td>
<td>- Largest was clicked first</td>
<td>- Large button to change size of the writing</td>
</tr>
<tr>
<td></td>
<td>- Dark background</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Light text on top</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Expected action clear</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Framed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Arrows pointing to buttons</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- No spatial preference</td>
<td></td>
</tr>
</tbody>
</table>
| General on websites | - No pop-ups  
| | - No large programs (hardware,  
| | internet speed restrictions)  
| | - Search tool  
| | - Easy-to-read in metadata  
| Homepage | - Clear what website is about  
| | - Phone number  
| | - Postal address  
| | - E-mail address  
| | - Easy-to-read symbol  
| Navigation | - Clearly show on which part of the  
| | website one is  
| | - One click to homepage  
| | - Same navigation bar on the same  
| | place throughout the website  
| | - Not more than 7-8 headings  
| Screen | - Whole text on one screen  
| | - No lateral scrolling  
| | - Menu of sections at top  
| | - Easily return to top  
| | - Space between paragraph  
| | - No animations  
| Links | - Words should be links, not pictures  
| | - Underline  
| | - Hide long link behind word  
| | - Blue if not clicked  
| | - Purple if already clicked  
| Words | - Well known  
| | - Explain complex words  
| | - Use examples  
| | - No initials  
| | - Do not use metaphors  
| | - Do not use word from other  
| | languages  
| | - Use words in full, no initials  
| | - No percentages, no large numbers  
| | use “few”, “many” instead  
| Sentences | - Short  
| | - Direct speech  
| | - Address in 2nd person e.g. “you”  
| | - Positive  
| | - Active  
| Information order | - Group information about topic  
| | - Important information at the top  
| | - Repeat important information  
| | - Repeat explanation of difficult  
| | words  

All the findings in [9] suggest that computers and computer devices are of great importance for people with Down’s syndrome because they can help to increase confidence and motivation through creative
activities and web browsing. Using the computer has other benefits as well, including errorless learning, patient and immediate feedback, self-paced learning and independence of learning. It should be also stated that all those benefits and useful features are dependent on developing a technology which meets the heterogeneous demands of the target group.

3.2.3 Requirement analysis

The POSEIDON project performed as a first step a requirement analysis. In this scope an online questionnaire was sent to relatives or professional carers of people with Down’s syndrome. At this online questionnaire a total of 397 carers took part. The complete results identified by the questionnaires can be found in D2.1 Report on requirements.

Some directly related results to the topic of interface design will be presented in the following, especially the questionnaire results of the use of technology and assistive technology.

3.2.3.1 Using information technology

![Figure 2 Using information technology](image)

Information-technology is not as widespread as the entertainment electronics but it is quite common within our group of people with DS. More than half of them are using mobiles and smartphones; while laptops/PCs and tablets are used by about three quarters. But the percentage of those needing help while using these technologies is higher than the equivalent one for entertainment technologies. Most easy seems to be the use of a tablet, in which only 44.9 percent of the carers report that their protégées have to be supported.

Answering an open question on the usefulness of smart technologies one carer formulates it this way: “The smart phone is not as useful to my son visually or manually, too easy to make mistakes and cause frustration. The I-pad is bigger and is useful for his self-esteem and his chill out time, and he can use some of the features unaided”.

49,1 55,1 65,6 44,9 55,4 56,4

0 20 40 60 80 100

uses it

needs help with using it
3.2.3.2  **Difficulties using apps**

Participants were asked with which kind of app the described person experiences difficulties and how often (“Do they experience difficulties to use it?” Often/sometimes/seldom/never). Apps on the smartphone such as notes, communication aids, and calendars seem to be easy to. A majority of our population “never” has problems using them and only a small minority “often” encounters problems (see Figure 3). Using the camera on a smartphone, gaming and learning seem to be more complicated.

![Figure 3 Difficulties using apps on a smartphone](image)

Similar results are obtained when asking for the use of apps on a tablet (see Figure 4). In general, people with DS seem to have somewhat less problems with the use of a tablet.

![Figure 4 Difficulties using apps on a tablet](image)
Important design aspects of assistive technologies

A major aim of the questionnaire was to get input for the development of assistive devices which could make the life of people with DS more independent and autonomous. Therefore we asked the carers which type of technological support would be helpful. We wanted to know what they think on assistive technologies in general and which features would be most important in constructing such technologies. In addition we wanted to know which type of technology would make their own life easier.

Only a small minority of the people answering the questionnaire thinks that assistive technologies will not be helpful for their protégées (5.4%). A majority of 57.7 percent considers them as being helpful. Again a great minority (36.9%) finds it difficult to say. This again can be appraised as a lack of information on the chances modern assistive technologies are able to offer for people with DS.

Figure 5 Design aspects being important for people with Down’s syndrome

Three features of assistive technologies were evaluated concerning their importance: design, hardware and functions they should provide.

Concerning the design, fun and motivating aspects are stressed (61.1% and 59.7%) (see Figure 5). Equally important are: the adaptability to individual needs (61.1%), the device robustness (56.4%) and the avoidance of a need for fast reactions (52.6%). Other aspects that are often regarded as "not very important" include large buttons (21.0%), a display with strong contrasts (18.8%) and a flexible change between icons/symbols and text (26.1%) are not as often regarded as “very important”, although they should not be neglected.

Hardware aspects of assistive technologies

Regarding hardware, it is of utmost importance that the assistive device can be used everywhere (should be mobile, 60.5%). In line with this demand are two other requests: the device should be usable
on a tablet (54.8%) and – to a less extent – on a smartphone (32.7%). Again, the carers show a clear preference for using tablets instead of smartphones (a difference of 22.1 percentage points). The question on how much such a device should cost, will be investigated in subsequent parts of the project. The demand “should be cheap” which we added to the questionnaire as a first assessment of the financial dimension was met by 32.7 percent of the respondents. This can be assessed as a comparatively weak demand on the new technology, strengthening the point that it is most important for carers to adequately function, helping people with DS in that way to live more autonomous and independent.

Figure 6 Hardware aspects being important for people with Down’s syndrome

3.3 Best practice in interface strategy
In the following section we will describe two initiatives for best practice in interface strategy: WCAG and responsive web design.

3.3.1 Web content accessibility guidelines
The Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C) have published a series of guidelines for making web content accessible, for all users but primarily for people with disabilities. The Web Content Accessibility Guidelines (WCAG) standard is currently at its second version WCAG 2.0, published in 2008, while the WCAG 1.0 was published in 1999. The WCAG 2.0 currently is also an ISO standard.

The guidelines present the best practice in designing web interfaces and provide lots of documentation on how to meet the guidelines¹, on how to understanding the guidelines right² and on how to implement the guidelines in practice including common failures³ and tools to test the degree of web

¹ How to Meet WCAG 2.0 - http://www.w3.org/WAI/WCAG20/quickref/
² Understanding WCAG 2.0 - http://www.w3.org/TR/UNDERSTANDING-WCAG20/
³ Techniques for WCAG 2.0 - http://www.w3.org/TR/WCAG20-TECHS/
accessibility of a webpage\textsuperscript{4}. Figure 7 presents an overview of the provided documents and shows the relations between them.

![Figure 7 WCAG 2.0 - Overview of relations between documents [11]](image)

In the following section the guidelines of the WCAG 2.0 are briefly presented and described. Following the different available documents, the WCAG 2.0 guidelines present different layers of guidance:

![Figure 8 WCAG 2.0 - Layers](image)

3.3.2 Listing of WCAG Guidelines in version 2.0

1 Principle: Perceivable

1.1 Provide text alternatives for any non-text content so that it can be changed into other forms people need, such as large print, braille, speech, symbols or simpler language.

1.2 Provide alternatives for time-based media.

1.3 Create content that can be presented in different ways (for example simpler layout) without losing information or structure.

1.4 Make it easier for users to see and hear content including separating foreground from background.

\textsuperscript{4} WAVE Web Accessibility Tool - http://wave.webaim.org/
2 Principle 2: Operable
   2.1 Make all functionality available from a keyboard.
   2.2 Provide users enough time to read and use content.
   2.3 Do not design content in a way that is known to cause seizures.
   2.4 Provide ways to help users navigate, find content, and determine where they are.

3 Principle: Understandable
   3.1 Make text content readable and understandable.
   3.2 Make Web pages appear and operate in predictable ways.
   3.3 Help users avoid and correct mistakes.

4 Principle: Robust
   4.1 Maximize compatibility with current and future user agents, including assistive technologies.

3.3.3 Responsive web design
Responsive web design is a web design approach aimed at crafting sites to provide an optimal viewing experience, including simplified navigation and easy reading that minimizes the efforts for resizing, panning and scrolling. It should work on a variety of devices from small mobile phones to large screen desktop systems [7].

Postulated by Ethan Marcotte it tells us to:

“Rather than tailoring disconnected designs to each of an ever-increasing number of web devices, we can treat them as facets of the same experience. We can design for an optimal viewing experience, but embed standards-based technologies into our designs to make them not only more flexible, but more adaptive to the media that renders them. In short, we need to practice responsive web design.” [7]

Newer versions of the CSS interface description language for the web support the design of such interfaces\(^5\).

In the area of interfaces for mobile devices, all important systems (of 2014) support layout designs for differently sized devices, supporting smart phones as well as tablets. Android has the fragment paradigm that encapsulates parts of the interface and can be displayed in different forms on tablet or

\(^5\) http://www.w3.org/standards/history/css3-mediaqueries
smartphone\textsuperscript{6}. Similar features are supported by the ViewControllers of iOS\textsuperscript{7} and Windows\textsuperscript{8}. The concept is commonly called Universal App.

\textsuperscript{6} https://developer.android.com/guide/components/fragments.html


4 Interface strategy

The interface strategy explains the overarching principles and the mission of designing the different user interfaces within the POSEIDON project. An interface strategy will describe the initial considerations with regard to the user interfaces and how they are developed throughout the project run time. The initial considerations should include technical prerequisites, information about the potential users of the interface and the goals that should be achieved with the specific interface. In this section we will describe all the different aspects of the interface strategy. It is structured by giving a short overview of the interface strategy template and its progression throughout the project runtime.

4.1 Strategy rationale

The interface strategy is based on the requirements created throughout the requirement gathering phase of the project as noted in D2.1 - Report on requirements. The interface strategy will be updated several times throughout the project runtime. As shown in Figure 10, after the initial strategy presented in this document there will be two intermediate strategy updates, informed by the piloting and referring to the project plan as shown in Figure 1.

The interface strategy is distinguished into three different layers as shown in Figure 11. On the top level we define a set of goals we like to achieve. This level is informed by the requirements collected and assumptions given in the description of work. The middle layer is comprised of prerequisite that are shared among all technical platforms and may also include Personas to drive the further description of scenarios and use cases and how they may influence the design of the user interface. The bottom layer is a collection of the concrete technical implications - that is both requirements on design, as well as specific decisions regarding the design of the different interface components.
4.2 Interface strategy adaptation method

![Strategy adaptation process diagram]

The adaptation of the interface strategy follows a simple three-step process that is outlined in Figure 12.

1. In the scope of the strategy review the results of performed user studies and experiences of the implementation process are taken to analyze the different layers of the interface strategy in order to check if it is still viable. Most likely the scope will be extended and certain parts of the strategy will be further detailed.

2. In the scope of the strategy update the list of change requests will be taken to modify the different layers of the interface strategy. The change requests should be incorporated as far as possible. There should also be some sort of prioritization that will define which parts of the changes are to be implemented first. This part is associated with the different updates of the interface strategy.

3. The technical update will update the concrete technical implications according to the updated strategy. Most likely this will add further parts of the interface to the different technical components.

The adaptation process will be performed three times throughout the project duration. After the first update that occurred in M11, a second update will occur in M20, closely following the goals of the first update, preparing the interfaces for the piloting. The last update will outline all aspects of the interface and thus create the final interface strategy in M31.

The description of the adaptation method is abstract and not intended to change within the POSEIDON run time unless some extraordinary events occur. The adaptation will be performed primarily by persons involved in Task 4.1 Interface language, with informed collaboration to WP4 lead and the task leads of the remaining tasks in this work package. The circle of persons should be kept small, in order to prevent an overly specific strategy. The detailed specification of the interface strategy should instead be done in the scope of the single tasks.

4.3 Initial strategy

This section will outline the initial interface strategy. After briefly revisiting the hardware architecture, a set of Personas is introduced, a short overview of prerequisites is given and the goals of the interface are described. The resulting list of technical implications will be given in the following section.
Figure 13 DoW component architecture

In order to build the initial strategy, it is necessary to have the most recent hardware architecture for reference. The architecture is currently distinguished into two different components. Figure 13 is the component view (both hardware and software) as specified by the DoW, focusing also on different services and new components that have to be developed.

Figure 14 Initial technical component view and mapping to prototype iterations

In the technical kick-off an initial set of functions and components was determined and mapped to different iterations of the prototypes within the project run time, as shown in Figure 14. We can distinguish three different user centric systems: 1. The mobile system, intended for being carried around while the end user is out of his home. 2. The stationary system intended to be used by the end user, as well as family, while being at home; and 3. The server that provides a set of user interfaces for administration of the system and configuration of certain aspects.
In the following subsections we will refer to these architectures when required and additionally we will structure the technical implications part according to the technical component view.

4.3.1 Personas

Regarding personas we can distinguish three different groups of users. The first are persons with DS that are using the POSEIDON system to its full extent. The second are family and associates that use the POSEIDON system together with the end users. The final group are carers and care administrators that are assigned to the specific end user. The overview of the different personas can be found in Table 2.

Table 2 Overview of personas

<table>
<thead>
<tr>
<th>Name (country)</th>
<th>Type</th>
<th>Gender, age</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jennifer (UK)</td>
<td>End-user</td>
<td>Female, 19</td>
<td>• Living with her parents</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Moderate learning disability</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Visits college</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Problems in managing time and money</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Uses PC</td>
</tr>
<tr>
<td>Erik (Norway)</td>
<td>End-user</td>
<td>Male, 25</td>
<td>• Living in supported living home</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Mental age lower than physical</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Very independent</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Gets help from Assistive Technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Struggles with concentration</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Uses every kind of technology</td>
</tr>
<tr>
<td>Dorothy (UK)</td>
<td>Family</td>
<td>Female, 44</td>
<td>• Mother of Jennifer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Works part-time</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Supports independence of Jennifer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Concerned about Jennifer when outside of home</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Low use of technology - manages mail on PC</td>
</tr>
<tr>
<td>Anders (Norway)</td>
<td>Family</td>
<td>Male, 51</td>
<td>• Father of Erik</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Engineer working out-of-town very frequently</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Uses every kind of technology - owns smart phone, laptop, etc.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Uses different forms of communication to stay in touch with Jerik daily</td>
</tr>
<tr>
<td>Michael (UK)</td>
<td>Carer</td>
<td>Male, 38</td>
<td>• Assigned carer for Jennifer’s family</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Visits once a week</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Corresponds to Jennifer and family using the POSEIDON web system</td>
</tr>
<tr>
<td>Marit (Norway)</td>
<td>Carer</td>
<td>Female, 31</td>
<td>• Works in Erik’s supported living home</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Organizes a number of events</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Manages assistive technology</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Uses POSEIDON to stay in touch with a number of patients</td>
</tr>
</tbody>
</table>
### 4.3.2 Shared prerequisites

**Table 3 Overview of user interface languages (UIL) [12]**

<table>
<thead>
<tr>
<th>UIL</th>
<th>Models</th>
<th>Methodology</th>
<th>Tools</th>
<th>Supported languages</th>
<th>Supported platforms</th>
<th>Level</th>
<th>Tags</th>
<th>Concepts</th>
</tr>
</thead>
<tbody>
<tr>
<td>DISL</td>
<td>Presentation on, dialog and control</td>
<td>Specification of a generic, platform-independent multimodal UI</td>
<td>Rendering engine</td>
<td>VoiceXML, MIDP, Java Swing, Visual C++</td>
<td>Mobile and limited devices</td>
<td>Model level</td>
<td>Not specified</td>
<td>Head element, interface classes (structure, style, behavior), state, generic widgets</td>
</tr>
<tr>
<td>GIML</td>
<td>Presentation on, dialog, and domain</td>
<td>Specification of a generic interface description,</td>
<td>GITK (Generalized Interface Toolkit)</td>
<td>C++, Java, Perl</td>
<td>Not specified</td>
<td>Meta-model</td>
<td>15 tags</td>
<td>Interface, dialog, widget, objects</td>
</tr>
<tr>
<td>ISML</td>
<td>Presentation on, task, dialog, domain</td>
<td>Specification of a generic UI description</td>
<td>Under construction</td>
<td>Java, Microsoft foundation class, Java swing classes</td>
<td>Desktop PC, 3D screen</td>
<td>Model level</td>
<td>Not specified</td>
<td></td>
</tr>
<tr>
<td>RIML</td>
<td>There is no information</td>
<td>Specification of a generic UI description</td>
<td>There is no information</td>
<td>XHTML, XFORMS, XEvents, WML</td>
<td>Smart phone, pd, Mobile, Desktop PC</td>
<td>Model level</td>
<td>There is no information</td>
<td>Dialog, Adaptation, layout, element</td>
</tr>
<tr>
<td>Sesco aXML</td>
<td>Task, Presentation on, dialog</td>
<td>Specification of a generic UI description</td>
<td>CCOM (BetaVersion 1.0 2002) PoodleLite MSC Editor</td>
<td>Java AWT, Swing, HTML, java.microedition, applet, VoXML, WML, Juggler</td>
<td>Mobile, desktop PC, Palm III</td>
<td>Model level</td>
<td>Not specified</td>
<td>Component, port, connector, contract, participant, blueprint, instance, scenario, pifform, user, device</td>
</tr>
<tr>
<td>SunML</td>
<td>Presentation on, dialog, domain</td>
<td>Specification of a generic UI description</td>
<td>SunML Compiler</td>
<td>Java, voiceXML, HTML, UIBL</td>
<td>Desktop PC, PD</td>
<td>Model level</td>
<td>14 tags</td>
<td>Element, list, link, dialog, interface, generic events, synchronization</td>
</tr>
<tr>
<td>Teresa XML</td>
<td>Task, presentation on, dialog</td>
<td>Specification of a generic UI description</td>
<td>CTTE Tool for task Models Teresa</td>
<td>Markup: Digital TV, VoiceXML, XHTML/SVG, X+V Programming: C#</td>
<td>DigitalTV, Mobile, Desktop PC</td>
<td>Model level</td>
<td>19 tags</td>
<td>Mappings, models, platform, task, input, output</td>
</tr>
<tr>
<td>UIML</td>
<td>Presentation on, dialog, domain</td>
<td>Specification of a generic UI description</td>
<td>UIML.net, VoXML, XGML, render, WML, render, XGIMML</td>
<td>HTML, Java, C++, VoXML, XGML, XML, QT, CORBA, and WML</td>
<td>Desktop PC, a handful device, tv, mobile</td>
<td>Model level</td>
<td>30 tags</td>
<td>Interconnection of the user interface to business logic, services</td>
</tr>
<tr>
<td>WSX</td>
<td>Presentation on, dialog, domain</td>
<td>Specification of a generic UI description</td>
<td>Not specified</td>
<td>HTML</td>
<td>PC, Mobile phone</td>
<td>Model level</td>
<td>12 tags</td>
<td>CU=XML, WSDL, Mapping, XLang Workflow=WSDL, Logic=XML event</td>
</tr>
<tr>
<td>XCL</td>
<td>Presentation on, dialog, domain</td>
<td>Specification of a generic UI description</td>
<td>XCL Studio</td>
<td>HTML, ECMAScript, CSS e DOM</td>
<td>Desktop PC</td>
<td>Model level</td>
<td>Not specified</td>
<td>Component, structure, script, events, properties, interface</td>
</tr>
<tr>
<td>XIML</td>
<td>Presentation on, task, dialog, domain</td>
<td>Specification of a generic UI description</td>
<td>X3ML Schema</td>
<td>HTML, Java Swing, WLM</td>
<td>Mobile, desktop PC, PDA</td>
<td>Model level</td>
<td>32 tags</td>
<td>Mappings, models, sub models, elements, attributes and relations between the elements</td>
</tr>
</tbody>
</table>

As far as shared prerequisites are concerned we are looking primarily at two different aspects. We have already presented a number of sources and overview of best practice in interface design. For our initial strategy we also consider two other sources that are specific to the POSEIDON solution. There is a multitude of different interface languages that support creating expressive, easy-to-use user interfaces. To find an informed selection of which language to choose we can look at previous surveys in this area. We are taking into account a number of well-regarded publications that cover two different aspects.

The first aspect is the expressiveness of user interface languages. Guerrero-Garcia et al. [12], have performed a review of different user interface design languages. The results are shown in Table 3. They are distinguishing different models, methodology, available tools, supported languages, supported platforms, level of abstraction, number of tags and supported concepts. A similar web-centric analysis was performed by Pohja [13].

The second aspect is adaptive user interfaces. A recent work by Bongartz et al. [14] analyzes these in the scope of smart environments. We consider adaptive user interfaces separately, as they are important for the personalization aspect of POSEIDON. Again there is a large body of literature...
available. Bongartz et al. describe a system the architecture of which “... is built upon the concept of model-based UI design extended by context aware and adaptive features. Model-based languages provide the software development process with useful support for, building design prototypes and actual implementations for devices with various interaction resources. The proposed architecture is able to adapt to selected aspects of the context during run-time by communicating with a context server and applying the specified adaptation rules. In order to show the possibilities of the proposed solution, we report on its application in the development of an adaptive user interface prototype to be used in a warehouse picking system.” [14]. Similar considerations are taken into account when building the context adaptive aspect of the POSEIDON system.

4.3.3 Interface goals
After we have specified personas and prerequisites we can create a list of interface goals that we would like to achieve in our first interface strategy. There is a fairly small set of main goals that are supported by a set of subordinate goals. They are collected in the following Table 4.

<table>
<thead>
<tr>
<th>Interface goal</th>
<th>Subgoal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suitability for persons with DS</td>
<td>• Follow specified requirements from WP2</td>
</tr>
<tr>
<td></td>
<td>• Follow best practice for accessible systems</td>
</tr>
<tr>
<td></td>
<td>• Define scenarios based on personas Jennifer and Erik</td>
</tr>
<tr>
<td>Suitability for family</td>
<td>• Follow specified requirements from WP2</td>
</tr>
<tr>
<td></td>
<td>• Design task efficient aspects</td>
</tr>
<tr>
<td></td>
<td>• Define scenarios based on personas Dorothy and Anders</td>
</tr>
<tr>
<td>Suitability for carers</td>
<td>• Functional approach to designing interface</td>
</tr>
<tr>
<td></td>
<td>• Task efficiency should be ensured</td>
</tr>
<tr>
<td></td>
<td>• Define scenarios based on personas Michael and Marit</td>
</tr>
<tr>
<td>Support for adaptive user interfaces</td>
<td>• Analyze best practice for most suitable interface</td>
</tr>
<tr>
<td></td>
<td>• Define adaptation aspects and context</td>
</tr>
<tr>
<td>Conformance to standards of the different technical systems</td>
<td>• Adhere if possible to standard practices on the different systems</td>
</tr>
</tbody>
</table>

4.4 List of technical implications
In the following Table 5 the different technical implications are listed. We are also following the set of different requirements that can be associated to the different interfaces as defined in D2.1.

<table>
<thead>
<tr>
<th>Technical component</th>
<th>Implication or feature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile interface</td>
<td>• Create technology base for mobile interface</td>
</tr>
<tr>
<td></td>
<td>• Define common aspects for different mobile platforms</td>
</tr>
<tr>
<td></td>
<td>• Evaluate languages for platform conformity and adaptation potentials</td>
</tr>
<tr>
<td>Stationary interface</td>
<td>Web interface</td>
</tr>
<tr>
<td>----------------------</td>
<td>--------------</td>
</tr>
<tr>
<td>- Find suitable interface description language for user oriented interfaces&lt;br&gt; - Early test of interface with end users</td>
<td>- Create technology base for VR&lt;br&gt; - Define suitable tools for VR interface creation&lt;br&gt; - Create technology base for interactive table&lt;br&gt; - Define interface language for interactive table interface&lt;br&gt; - Find suitable interface description language for user oriented interfaces&lt;br&gt; - Ensure alternative usage scenarios for personalization</td>
</tr>
<tr>
<td>- Create technology base for web interface&lt;br&gt; - Find suitable interface description language for task oriented interfaces&lt;br&gt; - Early test with family and carers</td>
<td></td>
</tr>
</tbody>
</table>
5 Conclusion regarding the initial strategy

On the previous pages we have outlined the interface strategy for POSEIDON in its initial version. There will be additional versions of this deliverable in M11, M21 and M31, leading to the final interface strategy.

The document at first gave a rationale for the strategy, including a short presentation of the timeline, a collection of user requirements as specified in WP2 and a collection of best practices, focusing on aspects of interface development that will act as guide for the different tasks within WP4. There was a focus on presenting best practices already available in this domain, in order to avoid repeating work, already performed.

Finally we presented the interface strategy, comprised of strategy rationale, methods and procedures to adapt the interface in the following iterations, an introduction to the interface strategy, a collection of Personas and shared prerequisites that are necessary for developing interfaces for the specified hardware devices. This part concludes with a concrete list of technical implications associated to the different interfaces that will be developed within POSEIDON.

This document will act as a basis for all further activities within WP4, driving the development of user interfaces in the different tasks for all different device categories that are part of the POSEIDON architecture.
6 Interface strategy after second User Group Workshop

The strategy we have presented in the first version of D4.1 Interface strategy represents our first approach of this project. We emphasised the main characteristics of the technology we are developing based on user studies and general guidance indications. We considered the expressiveness of the user interface languages and the development of adaptive user interfaces.

We illustrated this initial strategy by the means of demos covering the main aspects of interest in developing the system. Thus, we have investigated topics related to the interactive table, the virtual and augmented reality system and the context awareness. The process consisted of presentations where the concepts and examples for these technologies were shown to primary and secondary users coming from 5 countries: Germany, Portugal, Luxemburg, Ukraine, and Switzerland. All these presentations were followed by feedback sessions where the developers and the users interacted with the aim to discover the best design and implementation decisions. We will present this process in the following subsections.

6.1 Prototype 1 – second User Group Workshop – Mainz, Germany

The second User Group Workshop took place in Mainz, Germany 29th – 31st of August 2014. Its goal was to bring developers and users together in order to discuss and conclude about the strategy update process.

The users who attended the workshop were both primary users (people with Down’s syndrome) and secondary users (families and carers). A short overview of some of the participants is presented in Table 6.

<table>
<thead>
<tr>
<th>Name (country)</th>
<th>Type</th>
<th>Gender, age</th>
<th>Characteristics</th>
</tr>
</thead>
</table>
| Dennis (Germany)  | End-user   | Male, 29    | • Living with his parents  
• Moderate learning disability  
• Visited college  
• Uses PC and tablet for games  
• Gives regular talks at universities |
| Rita (Germany)    | Family     | Female, 55  | • Mother of Dennis  
• Works at a Down syndrome association  
• Supports Dennis’ independence  
• Moderate concerned about Dennis when he is outside the home  
• Moderate usage of technology |
| Frank (Germany)   | End-user   | Male, 36    | • Living with his parents  
• Works with wood in a workshop  
• Travels by train to work  
• Plays guitar and has the brown belt in Thai Chi  
• Uses PC for games |
| Ana (Portugal)    | End-user   | Female, 21  | • Lives with her parents  
• Completed 9th degree at 18 years old  
• Moderate use of technology |
| Amandine (Luxemburg) | End-user | Female, 18  | • Lives with parents but she will move soon to a supported living home |

Table 6 Overview of the participants at the Second User Workshop
### Users

<table>
<thead>
<tr>
<th>User</th>
<th>Role</th>
<th>Gender</th>
<th>Age</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ivan (Ukraine)</td>
<td>End-user</td>
<td>Male</td>
<td>21</td>
<td>Uses every kind of technology, very independent, lives with his parents, plans to move alone, works at jewelry workshop, owns and uses smartphone, tablet</td>
</tr>
<tr>
<td>Tetyana (Ukraine)</td>
<td>Family</td>
<td>Female</td>
<td></td>
<td>Ivan’s mother, supports Ivan’s independence, moderate usage of technology</td>
</tr>
<tr>
<td>Delfine (Luxemburg)</td>
<td>Family</td>
<td>Female</td>
<td></td>
<td>Amandine’s mother, she doesn’t work – she dedicated her life to taking care of Amandine, moderate concern about Amandine falling asleep when traveling, moderate usage of technology</td>
</tr>
<tr>
<td>Tania (Luxemburg)</td>
<td>Carer</td>
<td>Female</td>
<td>29</td>
<td>Amandine’s carer, visits once a week, uses every kind of technology - owns smartphone, laptop, etc.</td>
</tr>
<tr>
<td>Damian (Switzerland)</td>
<td>End-user</td>
<td>Male</td>
<td>23</td>
<td>Independent, lives with his parents but plans to move alone, travels around the world with a theater team, uses smartphone, PC and tablet</td>
</tr>
<tr>
<td>Ursula (Switzerland)</td>
<td>Family</td>
<td>Female</td>
<td></td>
<td>Damian’s mother, she is working from home, supports Damian’s independence, concern for every time he needs to go somewhere new</td>
</tr>
<tr>
<td>Claudia (Switzerland)</td>
<td>Carer</td>
<td>Female</td>
<td></td>
<td>Damian’s carer, manages assistive technology</td>
</tr>
</tbody>
</table>

The sessions consisted of three main parts: personal presentations made by the primary users, technological presentations made by the developers, sessions where feedback about different aspects of the system was gathered.

The presentations made by the people with Down’s syndrome were meant to show different aspects of their personalities (degree of independence, level of cognitive disability, technology usage, hobbies, personal characteristics). Discussions with secondary users revealed details about their life, their concerns with regard to the people with Down’s syndrome, their proficiency in using technology.

This phase was extremely important because it provided a set of initial information that has been used accordingly with other information gathered during this workshop in validating and updating our interface strategy.

### 6.2 Virtual and augmented Reality interface strategy

Virtual and Augmented Reality are emergent technologies with great potential in improving life for everybody, including people with cognitive disabilities.
During this workshop, we explained the concept behind these technologies and we presented how they could improve the daily life of our target users. This was accomplished by exemplifying with three applications: the home navigation system, the planning and organisation system, the remote assistance application.

The presentation was followed by a session of questions and answers. To conclude, the users were asked to fill in a short questionnaire where they were asked to evaluate the potential of the presented applications in improving aspects of their life. All the applications were rated positively (maximum grade given by the secondary users and enthusiasm shown by the primary users). The discussions brought up other strategy aspects that we will expose below.

The main questions we wanted to address are related to:

1. Considerations about the usefulness of this type of application, where the users can train things at home, before exploring the real world
2. The interest of the participants in a potential use of this system
3. Design of the technology, essential in having a clearer view on how the information should be structured for people with Down’s syndrome
4. Interaction information, essential in choosing the right devices, able to maintain the attention and to entertain the users
5. The validation of the chosen tasks

6.2.1 Home Navigation System
The aim of this system is to speed up the learning process of new routes for people with Down’s syndrome. Every time when the primary users need to go to a new destination (e.g., a new place to meet friends, a new work place), they can rehearse the route before using our system. The carer is able to customise the system by adding information as preferred by the primary user. The primary user is able to train to navigate between two different points while she is supported by multi sensory feedback provided in a safe context. We focus on walking routes, but we could also provide public transit indications, depending on the secondary users’ customisation. The environment is displayed on a large screen and the users will have different ways to interact with it.

6.2.1.1 Usefulness and interest
When asked about the usefulness of the presented system, the users gave a positive answer. The present travel preparation routine for some of the users consists of exploring places on Google Street View with the help of the carer. Their visual memory is good, thus they are able to remember easily buildings or landscapes.

However, the secondary users emphasised the need for this system to be alternated with real world practice. The people with Down’s syndrome should combine both methods of training (in virtual and real environment) in order to assure the transfer of knowledge and skill from one environment to the other.

The unanimity of the positive answers confirms and supports the technology we are proposing. Users were generally enthusiastic about the demo presenting the main idea of the navigation system. Moreover, they saw it as a means to help them in their daily lives.
6.2.1.2 Design of the technology

Another important aspect in the design of the application is choosing the right and most intuitive ways to provide feedback and to keep the user focused. Having this in mind, we demonstrated different types of information that can be provided by the proposed system (see Figure 15).

In Figure 16 we present a snapshot of the demo we showed at the workshop in Mainz. The snapshot illustrates the carer interface and presents the information offered by the system. The carer can set up different addresses of interest for the primary user and can configure the types of information to be delivered at each step.

The users appreciated the types of feedback we designed and were especially enthusiastic about the possibility to add customised information. Moreover, they suggested that the presence of an avatar could help them remain focused on important events (i.e. crossing streets).

Context awareness is also a desirable feature because extra information can be offered depending on the user’s destination. Thus, the user could learn to take different decisions depending on external factors (i.e. weather, day of week). A conceptualised multi-layer architecture is presented in Figure 17.

6.2.1.3 User interaction

As we outlined in D4.4 Virtual reality system, our goal is to offer different interaction options that could enable the user to alternate between them. Based on the literature research, we proposed as interaction means the use of a Kinect sensor, of the interactive table and also of the keyboard/mouse.
This workshop provided the opportunity to test the user’s reaction to the interaction methods we proposed. The users were engaged in trying to use the interactive table. They looked motivated and expressed their enthusiasm about the interaction with the table. The Kinect sensor was also positively appreciated. These observations validate the chosen interfaces, showing that people with Down’s syndrome learn easily how to control such devices and their attention is maintained in this process.

6.2.2 Contextual reminders and Remote assistance

6.2.2.1 Usefulness and interest

The Augmented Reality technology can be integrated in a variety of ways in building solutions for both learning and support. The workshop held in Mainz provided the context to present demos and ideas related to the inclusion of this technology in the life of people with Down’s syndrome and to gather feedback from both primary and secondary users.

The Augmented Reality application ideas and demos presented at this workshop consist of: (i) a daily planner application that offers interactive feedback based on calendar activities, and (ii) a remote assistance application that can be used by the people with Down’s syndrome when they need extra information to enhance the real environment.
The feedback session we conducted showed the importance of a daily planner application in the life of a person with Down’s syndrome. Moreover, additional support can be added if the daily planner is aware of the context changes. Considering different contexts (location, time, weather) we can enhance the planning process showing primary users information about what objects to take with them or what to wear on a certain day.

6.2.2.2 Design of the technology

All the proposed applications are based on a similar architecture to the one described in Figure 18. The mobile devices we considered for these applications are the tablet and the smartphone. Observations made in the second user workshop confirm results from Figure 2; the primary users show dexterity and enthusiasm when handling these types of devices.

Users suggested as the most proper feedback we can provide:

- Custom photos
- Written notifications
- Audio notifications
- Speaking avatar who can help with focus maintenance

6.3 Interactive Table interface strategy

The second user group workshop aimed at trying out an application using the interactive table, using different ways of interaction. For this purpose we connected two applications to the mobile interactive table: a car racing game and Google Earth. In the following the mobile interactive table and the two applications will be described.
6.3.1 Mobile interactive table (Mobile CapTap)
For the second user group workshop and further development of applications we have designed a mobile version of the interactive table. At the end of the project, after the pilot evaluations, the interactive table is unobtrusively integrated into a common couch table, making hand movement interaction possible.

![Fig.19. Overview of the design of the mobile interactive table](image)

The mobile version of the interactive table is intended to be placed on top of a surface. It is smaller (90cm x 50cm) than the implementation of the interactive table in the regular living room table (115cm x 60cm) but still large enough to allow wide movements. In Figure 19 we show the initial design while Figure 20 depicts the final implementation of the mobile interactive table.

The design of the mobile interactive table is adjusted to the usage of a single user. We show the user from which side he is expected to interact by having that side of the edge bended. The table can be used single handed or multi handed. However, the two applications are used single handed. Further on, one can interact with the table on multiple levels: one level for touch and three levels for free-air gestures. On the touch level knocking, taping and swiping can be used as input while dwelling in the air, swiping in the air and the change between air interaction levels can be used as input for the free-air interaction. For more details refer to D4.1 Interactive Table, where the implementation and the functionality of the table is described in more detail. For more information on the mobile interactive table, please refer to the second version of D5.2 Prototypic systems where in Section 6 the manufacturing process and the software is described in detail.

![Figure 20 Completed mobile interactive table](image)
6.3.2 Car racing

![Car Race Game](image)

The car racing application is a simple game in which one has to avoid crashing into the other cars. The speed of the cars constantly increases. We have adapted this game to be used with the input of the mobile CapTap. Figure 21 shows a screenshot from the game. The original game is controlled by using the left and right arrow of the keyboard. Translating these commands into the interaction possibilities of the table we have come up with two different solutions to control the game. These solutions are both based on the execution of the left and right swipe using one hand. However, for the second user workshop we tried out the swipe by touching the table or swiping in free-air.

These two interaction methods were compared by letting six primary users participating at the second user workshop try both of them while playing the game. The initial feedback after the session regarding which interaction method they would prefer for this game was mixed. Most of the primary users were in favour of controlling the game by touching the table, but one primary user very strongly made the point that he likes the free-air interaction since he does not have to touch the surface of the table. We found out that this primary user has some problems with the skin on the hands and fingertips. This is a quite common condition. Hence, we can understand the preferred free-air interaction.

This is an example where the diverse capabilities of the table offer a significant advantage in comparison to other technologies. From this initial feedback the importance of the adaptability of interaction is confirmed. There were no general issues during the workshop regarding the interaction.

6.3.3 Google Earth

Google Earth is a map browsing tool similar to Google Maps in which 3D buildings can also be seen. It can be controlled with the mouse, zooming in and out and moving in the desired direction. We translated these controls into controls of the table by stepwise moving into the desired direction when touching the desired areas of the table, like shown in Figure 22. Holding one’s hand on the top area would move the map up. The same functionality is achieved by holding the hand above the table in the defined areas. The difference between browsing the map by touch and by dwelling in the air is that one is browsing in two predefined zoom settings. So if one browses by touching, once the hand is held in the air, the view is zoomed out. Here one can browse in bigger steps and zoom in by touching the table again at the desired position.
These two predefined zoom areas were intended as a simplification, knowing that people with Down’s syndrome have difficulties reading maps. So the workshop was intended to see if this simplification would help and the primary users would manage to deal with all the commands. Unfortunately at the event site of the user group workshop the internet connection was too slow to allow a usable experience of Google Earth. Hence, this approach could not be tested there.

6.3.4 Follow-up questionnaire
As a follow up on the user group workshops we prepared a questionnaire for the primary users which should be filled out with the help of the secondary users. Through the questionnaire we would like to have the opinion of all primary user participants which tried out the table, adapting the controls of future applications to their needs.
7 Future plans for Pilot 1

We aim to deliver a solution that provides a “user friendly” experience, while being functional and succeeding in improving different problematic aspects in the life of people with Down’s syndrome. This workshop gave us the opportunity to present demos of our strategy and to gather immediate feedback from the users. We presented demos and examples to both secondary and primary users and we designed questionnaires meant to help us evaluate the proposed solutions.

The conclusions were significant showing that our approach is appreciated and considered useful and giving us information about future steps in implementation. The solutions we want to provide for Pilot 1 will include all the observations made during Prototype 1.

For learning purposes, we will develop a Virtual Reality application that can help primary users to prepare for every new journey. The feedback provided consists of both Google Street View and custom information. This feedback will be multi sensorial: audio, written, images. As a result of this workshop, we consider also the use of an avatar that can speak the instructions. We think that it’s interesting to analyse how the primary users perceive this avatar and if the focus level can be increased as a result of this interaction. The learning application can also include sections that address small tasks (e.g., choosing the right clothes depending on the weather, making a sandwich). It is meant to be used in a series of places of interest, for Pilot 1 we will consider just home usage, but for Pilot 2 we can extend it to work place or school. As interaction methods, we have chosen to integrate it first with Kinect and as a next step, with the Interactive table. If the integration with the Interactive table will not be done until Pilot 1, we will develop it for Pilot 2.

For support purposes, we will develop an Augmented Reality application that can guide the users in the preparation process before certain events. The application can be interactive (asking for the user’s input to deliver the information) or it can automatically deliver notifications based on settings made by the secondary users. This application will be also aware of the context and will adapt to it in order to deliver the most appropriate feedback.

For Pilot 1 we will provide a stable and user friendly solutions based on literature research and user’s feedback. We also plan intermediary tests with a local Down Syndrome Association, in order to make sure that our implementation is on the right path. This continuous process of gathering feedback from the primary users will help us in accomplishing our goals.
8  Achieved interface strategy for pilot 1

For each component of the POSEIDON System we shortly describe in this section how the interface strategy has been implemented. We reference here the other parts of deliverables like “D4.5 HCI user and developer manuals” and other specific deliverables where the functionality of the interface is described in more detail.

8.1 Poseidon Web

For the past period of development for POSEIDON web, we put the accessibility and unified design of POSEIDON system as the first class consideration, e.g. the unified logo, slogan, web system color including good contrasts, help texts and large fonts. An important design perspective was to design a system that enables a number of essential accessibility features for POSEIDON’s target group (persons with Down syndrome). Already now, a certain family resemblance between the POSEIDON apps (parts of SW) has been both applied and enabled.

The past pilot case (Pilot 1) proved the usability and usefulness of the POSEIDON web. We also considered the users' learnability, efficiency in using the web system, i.e. we make the system easy to be used. One important aspect here is that complex interactions are avoided. Moreover, the SW pilot environments have been designed to reveal the most crucial usability, usefulness and accessibility aspects to be implemented in Pilot 2.

An important strategy was to design icons that are very easy to understand, nice (not silly, not complicated), and implemented in a graphics design style that allows the design to be continued in Pilot 2.

8.2 Poseidon App

A POSEIDON mobile app prototype has been developed for the pilot, based on the early prototype demonstrated at the user workshop at the end of the first prototype iteration. The main end-user functionalities are calendar with notifications and route navigation. The primary goal with the mobile app pilot has been to give the Down syndrome users access to this functionality, to assess their potential usefulness for this user group. The navigation is based on routes provided by Google and the calendar data is based on the simple model of events and reminders found in most online calendars. These data models are probably not ideal for our use, but their availability in existing online services as well as the relatively low level of effort required for carers to configure the data are important factors. We need to assess the data models to decide if the data which can be provided is sufficient or not, and for this it is important that the user interface isn’t a bottleneck in the use of the pilot.

Making the user interface suitable for persons with Down syndrome has been the primary goal in the user interface design. It has been important to keep the user interface as simple as possible. For instance we have tried to avoid scrolling when possible, which can be challenging due to the size constraint of a phone screen as well as the variability of some of the content. The development has been done with feedback from the end user organisations, which has been especially important regarding how to present information in a way which is understandable for the user group. An example of this is the visualisation of the time left until the start of an appointment using a coloured bar, which was added on request from the end user organisations as they knew that just writing the number of minutes left wouldn’t work. For easy of navigation in the app, a start menu icon is always present, to return to the first screen. In addition the back button of the phone can always be used to backtrack, as is the normal convention. The app has a POSEIDON colour theme, and also a high contrast theme. And all text is translated to all three project languages.
The app user interface is further described in deliverable D4.2 chapter 5, which has a focus on adaptivity. A technical description of the app is found in D5.2 chapter 5, while the technical user manual is found in D5.6 chapter 3.

8.3 Home Navigation
A Home Navigation app prototype has been developed for this pilot, based on the observation and feedback gathered after the user workshop, at the end of the first prototype iteration. The product was designed having in mind different functionalities: it allows for route customization, it provides a platform for learning and rehearsing the details of a route.

The navigation is based on data provided by Google and the steps of a journey can be configured through custom information that can be added by the secondary users. The custom information consists of personal material (photos) or photos that exist in the Panoramio (www.panoramio.com) database, that are suggested based on user’s location.

The interface is simple and allows to both secondary and primary users to use the application. It was built as a result of various iterations with the involved users who made several recommendations about the interface design.

8.4 Interactive Table
For pilot 1 we chose a learning application to improve the ability of people with Down’s syndrome to handle money. This was one of the most important domains where technology could support people with Down’s syndrome.

In order to use the advantages of the interactive table to support the learning experience we have developed an interaction strategy of combining screen visualization and real world interaction. The development and the rationale behind the learning application are explained in Appendix 1 of D4.3 Interactive Table-v2. Here we show how the initial idea of having the money on the screen in boxes and moving it around has generated the idea to have an overlay placed on top of the table, where finally real money can be placed and moved around.
Learning application screenshot and underneath the overlay of the interactive table. The colored fields activate the buttons on the screen.

The result is, that the money display has been moved in front of the user and the table recognizes the field where the hand is choosing a coin or bill. The user can acknowledge the selection of the coin or bill by tapping or knocking.

Interactive table with overlay and additional coins in front of screen of the application.

9 First comments and future plans

In this section we provide some general comments for each of these Poseidon components regarding the user interface strategy. The comments are feedback regarding the current implementation. In this section we also provide information on what has not been achieved to be implemented yet and what we plan to change and improve in the interface strategy for the next pilot.

9.1 Poseidon Web

We propose to further simplify the functional aspects of the POSEIDON web by

- adapting it to even more meaningful and understandable graphics, icons, etc.
• make the text very easily readable according to the principles in the POSEIDON HCI user and developer manuals.

Considering usability, we will apply more drag and drop interaction in the calendar for easy reading, the fonts will adapted to both mobile devices and PC-reader friendliness. Considering the end user's ability, we can include more functions in the POSEIDON web. One example of this is that the end user might be confused by complicated rules for creating multiple occurrence events. To avoid this, we will use drag and drop for duplication of scheduled events. In the interaction design, we will take advantage of drag and drop techniques, and also apply touch screen interaction methods to make the POSEIDON web more end user friendly and interaction friendly.

Accessibility aspect that will be applied are all connected to features that concern cognitive and visual accessibility (as far as the primary end users' applications are concerned), and similar to the relevant group of secondary end users.

Examples of design that will be applied are:

• Large (and adjustable) fonts
• (Very) High contrasts
• Multiple media (e.g. both text and image in icons)
• Voice output (e.g. synthetic speech)
• Visual media for the target group (e.g. icons from established icon banks for persons with learning disability)
• Etc.

One of the most important strategies is to create and implement a system of applications that meet the high accessibility requirements for precisely this target group.

During the rest of the project, an essential strategy will be to consult all relevant accessibility standards in order to create a highly accessible and useful service to POSEIDON's target group.

9.2 Poseidon App

Designing a user interface for people with Down syndrome is challenging, and we are sure there is more to learn and improve. Firstly we must get the results of the pilot, and analyse them to see how well the user interface worked. Any shortcomings must be addressed. New functionality will also be developed for the next version, which must be integrated with the current interface.

The amount of user adaptivity is so far quite limited. An ongoing task is to find more meaningful ways for the app to be adaptive and for primary users and carers to customise the user interface and content to their needs. Regarding multi-platform strategy on mobile devices, our conclusion has so far been that web applications are needed if a single application is to run on multiple platforms (at least Android and iOS). The POSEIDON web application is responsive so that it can be used on mobile devices. Things which can not be implemented as a web application, such as tracking and navigation, are so far only available on Android. Making such functionality available on other platforms requires implementation on such platforms, and whether that will be done or not in the remainder of the project is mainly a question of resource prioritisation.
9.3 Home Navigation

During the first pilot we encountered several challenges and different aspects of the interface had to be modified according to users’ recommendation. The feedback we will get at the end of the pilot will help us in improving the interface.

Based on the feedback we obtain, we take into account the possibility to integrate the Home Navigation as a web service that can be connected to the other modules of the POSEIDON solution.

In terms of suggested improvement for the next pilots, we are aware of the fact that the system needs to support a higher degree of customization of the route segments. This can be achieved by integrating a more detailed route planning system (one possibility is using MyMaps services).

9.4 Interactive Table

First trials of the Moneyhandling Application have resulted in a few observations regarding the interface strategy. One feedback was regarding the size of the table and the second regarding the overlay of the table.

The pilot participants have already positively commented on the size of the table. The fact that the interaction area is so big (90 x 50 cm) seems to be extremely liked.

Families would prefer another order of the coins and bills on the overlay. However, it is not clear if they would agree to the same order, or this should be fully customizable. The reason for this seems to be the way people with Down’s syndrome learn to calculate and their difficulty to distinguish between whole coin value and cents.

For future implementations of the MoneyHandling App from interface strategy point of view additional gestures supported by the table need to be used and implemented where useful. Additionally users could choose how to interact with the table, in mid-air or rather on the surface of the table.

For the next pilot the interactive table is also intended to work with the virtual reality Home Navigation Application which provides learning of new routes.
10 References


