DELIVERABLE 1.4

Phase Two Scenario

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Short description

The scenarios developed in the ACCOMPANY project as reported in deliverable 1.3 were used to steer technology development in the project year 2. A functional scenario 1 was demonstrated by the end of year 1 and project development continued by realising scenario 2. The functioning scenario 2 has been located at Zuyd University of Applied Sciences in the Netherlands. During the realisation of the scenario the elements developed in the technical work-packages have been integrated. The robot, the arm, the user identification, the user interface (tablet) all have been integrated within the action sequence described in the scenario. When materialising the robot system functioning many lessons were learned regarding the detailing of the scenario. Part of these lessons have led to adaptation of the technical details in order to build a realistic and functioning scenario, other lessons were recorded as feedback for the further technical work in the project.

This deliverable reports on the lessons learned, both those that led to adjustment of the details of the scenario in this phase and those that may lead to further adjustment in the remainder of the project. This deliverable is part of WP1 and does not report on the results of the user evaluations held with the functioning scenario in the Netherlands, as this will be reported in WP6. In terms of summative and formative evaluations, this report contains the results of year 2 summative evaluations derived from the functional scenario 2, as made available in the Netherlands.

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1 Introduction

This document is the fourth deliverable of WP1 (see Figure 1). The previous three deliverables included the *Status of elderly care in Europe and the potential for service robotics* (D1.1), *Report on user and system requirements and first outline of system functionality* (D1.2) and *Phase one scenarios and report on system functionality* (D1.3).

In D1.1 the results of an inventory of problematic activities in independent living was reported from the literature and of current care provisions supporting independent living in four European countries (i.e. the Netherlands, Italy, UK and France). In D1.2 the needs, outlined by the literature and societal perspective on care provision reported in D1.1, were specified on the basis of user feedback (user group meetings).This led to an initial scenario for the ACCOMPANY robot development. D1.3 reported on the first outcome of the iterative detailing of the scenario which resulted in the phase 1 scenario. This was set in the perspective of three sub-scenarios leading to an end state scenario for the ACCOMPANY robot system supporting elderly by maintaining their independence in their home situation.

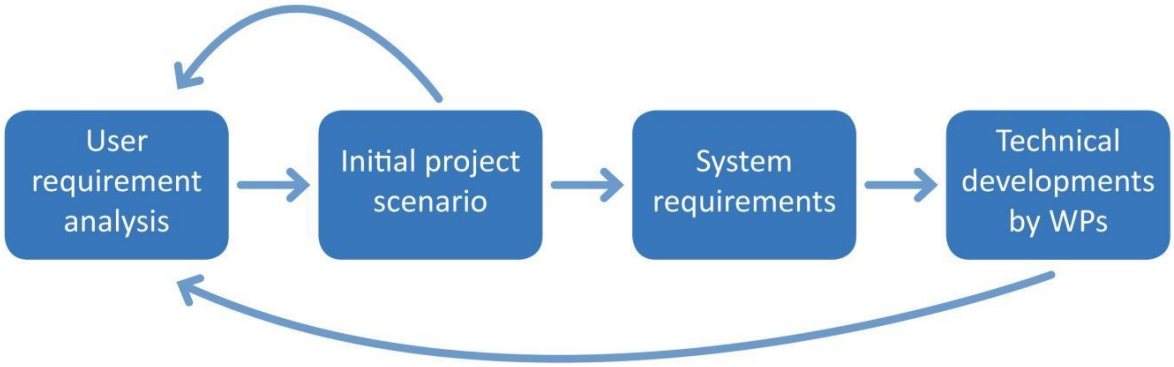

Figure 1. Progress in WP1 from user requirement elicitation to scenario definition and formulation of system requirements.

This deliverable reports on the lessons learned from the scenario development. These include both those that led to adjustment of the details of the scenario in this phase and those that may lead to further adjustment in the remainder of the project. Section 2 of this deliverable will describe the first adaptations to the scenario as described in D1.3. Section 3 will outline the method used for evaluation, followed by the results (Section 4) and the conclusion (Section 5).

In the ACCOMPANY DOW this deliverable was positioned as an update on the scenario development during the project. Originally only an initial scenario was to be developed and then during the project further scenario development would take place. In reality on the basis of the results of WP1 three scenarios were developed by the end of year one. These would

be realised throughout the project as described in D1.3. For this reason no new scenarios will be introduced in this deliverable. This deliverable will report on the detailing of the formulated scenarios to make them more realistic and contain a better integration of the work achieved in the technical work packages.

2 Scenario

In Deliverable 1.3 the functioning of the robot within the drink fetch and carry task was broken down into a number of steps, together building the overall scenario. As we also included different roles for the robot, the steps in the scenario may differ depending on the role the robot is supposed to take. In the overview below we consider a) the robot as an assistive device/butler, b) the robot as a re-enablement coach, and c) the robot as co-learner.

The overall scenario is composed of the following steps:

1. Robot sits with user
2. Visitors come
3. Robot reminds user of need for drinking
4. Need for drink
    a) Robot signals agreement for drink
    b) Robot discusses need for drink
    c) Robot is sensitive for user preferences in suggesting the user to drink something
5. Go to kitchen
    a) Robot goes to kitchen
    b) Robot and user go to kitchen
    c) Robot knows under which conditions joining the user in going to the kitchen is required
6. Get water
    a) Robot fetches water and prepares drink
    b) Robot supports user in getting drink
    c) User indicates how the robot is to support the process of obtaining a drink
7. Bring drink to sitting room
    a) Robot brings water on tray
    b) User brings water
    c) Robot helps user by carrying when needed
8. User drinks water

2.1 Scenario year 2

The desired end-state scenario will be realized –in part– at the end of every year. Therefore sub-scenarios were formulated for every year. The functionalities available through the sub-scenarios together build the functionalities of the robot in the end-state scenario which will be available in final form at month 36. A functional scenario 1 was demonstrated by the end of year 1 and project development continued by realising scenario 2. In this scenario the

“getting a drink from the kitchen” task features besides and additional “getting a parcel by mail” activity.

1. The user sits on the sofa, while the robot is located in its default location (charging). The doorbell rings.
2. The user selects the action possibility “go to the door” on the tablet.
3. The robot leaves charging station and moves to the door.
4. At the door the parcel is placed on the robot’s tray.
5. The user selects the action possibility “bring me the parcel” on the tablet.
6. The robot moves towards the user and stops at a socially appropriate distance/orientation from the user.
7. The user takes the parcel from the robot and the robot goes back to its default location.
8. The user has not drunk in 3 hours and the robot notice this.
9. The robot leaves charging station and approaches the user.
10. The robot stops at a socially appropriate distance/orientation from user.
11. The robot reminds the user that he/she has not had a drink for 3 hours. The tablet shows the following action possibility “accompany me to kitchen”. The robot can cope with different languages, depending on user preference.
12. The user selects “accompany me to kitchen” (*re-ablement* or *co-learner variant*) and goes together with the robot to kitchen.
13. When arriving in the kitchen the user fetches a drink from the fridge and places it on robot’s tray.
14. Both robot and user move back to the sofa, while the robot is carrying the drink (*re-ablement* or *co-learning variant*). Robot places the drink on sofa table (based on its memory of the user’s preferred location to place objects in the living room).
15. The robot observes the user to check if the user is drinking. If he/she does, the robot will go back to the default position. If the user is not drinking, the robot will wait and remind the user to drink within 10 minutes by displaying the related action possibility on the GUI and using expressive behaviour to attract the user’s attention.

To evaluate the functioning of this scenario a number of evaluations were performed. This deliverable reports on the improvement of the quality of the materialised scenario as assessed by usability experts. This deliverable does not report on the effects of the scenario as assessed by users. This will be reported separately under WP6. The goal was to have the functioning scenario 2 assessed for quality at Zuyd University of Applied Sciences in the Netherlands.

3 Method

During the technical realisation of the scenario the technical elements developed in the technical work-packages have been integrated. The robot, the arm, the user localisation and identification, the user interface (tablet) all have been integrated within the action sequence described in the scenario. When materialising the robot system functioning, evaluation sessions were conducted in order to contribute to a realistic and functioning scenario. Two experts were invited for two separate sessions. These sessions were based on a heuristic evaluation. After both sessions item lists were created together with the experts. Additionally a log book with observations on system functioning was created throughout the user

evaluation sessions with elderly users at Zuyd. From these observations a third item list could be created. This logbook is different from the evaluations performed in WP6 as it concerned only system functioning not usage with end users.

4 Results

4.1 Expert 1

The first expert consulted was an external usability ergonomist experienced in user interaction in robotics for the elderly. The following item list was created together with this expert:

- Currently different elements of the Accompany systems have different roles, the tablet is the main medium used for communication with the user. The Care-O-bot is mainly the actor for fetching, carrying and delivering a physical object. When attempting to communicate with the user, the system should attract attention to the tablet and not the robot since that is where the user should focus when interacting with the accompany system.
    - *Suggestion 1*: If possible a noise (ping) or vibration of the tablet would be very helpful, as the current changes in the screen may be too delicate to be noticed when the user is engaged in other activities (or not physically close enough to the tablet to notice only visual changes on the screen).
    - *Modification 1 (proposed)*: Introduce settings in the GUI (a dedicated interface in addition to the user view and the robot view) that the user can select and change. For example, the user could select the sound or vibration he/she prefers to be used to notify him/her about a new action possibility.
    - *Suggestion 2*: Nodding gestures, blinking light of the robot should be avoided in case focus on the tablet is required, as this attracts attention to the robot and not the tablet (the robot as physical entity attracts much more attention than the tablet anyway).
    - *Modification 2 (implemented):* Nodding gestures and blinking lights of the robot were avoided when focus at the tablet was required.
- The LED lights are nice and should communicate information that cannot be observed visually.
    - *Suggestion*: Colour coding status could be included (Red: indicating need for user action on robot or getting out of its way; Green: ready for service/standby/charging; Blue (or yellow): “on a mission”). NB: The red blinking is new.
    - *Modification (implemented)*: Original COB colour coding status was slightly adapted, discussion on the need for colour coding taken up.
- The tablet has two modes (i.e. version with and without mask screen). The user now can switch accidently between both modes.
    - *Suggestion*: Tablet screen should have one mode –only the mask screen– to avoid the need for the user to switch back and forth.
    - *Modification (rejected)*: This was not included as it completely changes the concept. It may not be useful to have the robot view when the robot and the person face one another, but the robot view is useful when the robot is out of

sight of the person (e.g. in another room), so that the person can monitor the action execution.

- Selection options sometimes appear in the darkened area outside the mask and may be difficult for users to read.
    - *Suggestion*: Selection options should be more readable and in the mask. Preferably, also words in the action possibilities should not be hyphenated (there may be a might be a need for changing the texts or even increasing the size of the option circles somewhat).
    - *Modification (proposed)*: This can be part of setting preferences. The user could choose a bigger font if necessary. This was not changed in current version due to technical limitation; however this should be taken into account for the next prototype.
- Selection options (action possibilities) sometimes overlap each other, which may make them difficult or impossible for the user to read.
    - *Suggestion*: Selection options should not overlap.
    - *Modification (proposed)*: This was not changed in current version due to technical limitation; however this should be taken into account for the next prototype.
- Automatic timeouts of action buttons on the tablet result in confusion and un-clarity on what should happen next.
    - *Suggestion*: For the purpose of testing the technical functioning during development, automatic timeouts were introduced to mimic user activity 9system automatically using default values as user input after a certain elapsed time period. During this evaluation the time outs were abusively still active, overruling the real time user input.
    - *Modification (implemented)*: Time outs were removed.
- The doorbell is not made audible to the user. Strangely, the doorbell switch only results in a change in software status, not in a doorbell sound. Doorbell should sound as it is the starting signal for the scenario.
    - *Suggestion*: Make the doorbell sound.
    - *Modification (implemented)*: Although the purchased Zwave doorbell won't work with the receiver, we use its sound in conjunction with a separate “doorbell” switch. It requires pressing two switches.
- As the scenario is an artificial situation the user may not be aware of the purpose of the scenario during experimentation. The aim of the scenario at a certain point may be unclear to the user. It would clarify the situation to the user when there would be status messages on the tablet screen. This is only relevant in scenario based experimentation; in real life this would not be relevant.
    - *Suggestion*: Introduce status messages on the tablet screen (e.g. “the doorbell rings”, “item on tray”, “you should take a drink”).
    - *Modification (under development)*: The GUI displays only action possibilities. It is not a domotic system control. The message “the doorbell is ringing” is not an action possibility, while "bring me the water" is an action possibility for the robot. So if need of drinking water is high, this action possibility will be displayed with a bigger font to mean that the action should be executed first.
- The robot does not react when the parcel is taken from the tray by the user, we already suggested an icon on the screen (item on tray) that could disappear after this, but maybe the robot could bow butler-like as well. This would indicate that the robot is “ready” with the delivering action and stopped moving. Moreover, it could be beneficial in terms of empathic interaction as well.

  - *Suggestion*: Make robot behaviour richer by introducing non verbal behaviour in accordance with its role.
  - *Modification (proposed)*: Introduce torso nods and turns and fine tune robots movements and positioning.
- It may be unclear when the first task is completed.
  - *Suggestion*: After having delivered the parcel the robot should move away to docking position signalling “mission completed”.
  - *Modification (implemented)*: After the parcel is removed the robot returns to charging position
- When delivering the drink the robot should ideally “look” at the user (face the user) instead of sliding in sideways while facing in the opposite direction to the user.
  - *Suggestion*: The robot should turn his torso towards the user when delivering the drink.
  - *Modification*: The turning of the torso towards the user was implemented.
- The space between couch and coffee table is very narrow.
  - *Suggestion*: Move table and/or couch to create more space.
  - *Modification*: The coffee table and couch were moved as much as possible, keeping the mapping of the room in mind to avoid remapping, to create more space.
- There seems to be a conflict in positioning the robot to enable it to place the cup on the middle of the table and positioning the robot such that it interacts with the user while not being too close.
  - *Suggestion*: There are two possible new positions (depending on the user position): 1) The robot is opposite the couch with the arm side to the user to place the drink for the user in the chair, and 2). The robot is opposite the chair slightly turned away from the user on the couch and compensates for this by rotating the torso towards the user. Both positions are potentially good for placing the cup on the table but differ from each other in terms of being directed towards the user. In evaluations preferences could be assessed.
  - *Modification*: Only the second possible position was implemented as the first new position caused safety problems with the arm being next to the user in the chair.
- User could be offered the option of postponing the drinking.
  - *Suggestion*: A “not now” button could be included in the action possibilities. But this should be followed by repetition of the message (step 10 of scenario year 2 in chapter 1.1) or once the drink has been brought repeating message you really should drink (angry mask) until the user has taken a drink (step 14 of chapter 1.1 scenario year 2).
  - *Modification*: Only in step 10 of the scenario year 2 list an extra action possibility button was added with the text “remind me later. Additionally, the mask also changes to mean that the robot is sad if the elderly did not accept the invitation to drink.

In more detail the suggestions are summarised in the scenario sequence in the table 1 below, specifying the robot action, the lights and the tablet view.

Table 1: The suggestions made by expert 1 to build a realistic and functioning scenario for user testing.

	Action	Robot		Tablet			
		Action	Robot LED lights	Masks	Selection options	Sound/vibration	Status indication
	Pre-scenario	At charging position	Green	Neutral			
A	Doorbell (really) rings		Black out	Surprise	“ignore” and “go to door”	Yes	“doorbell ringing”
B1	User selects “ignore”		Green	Neutral			
B2	User selects “go to door”	Robot moves to door and brings out tray	Blue	Happy			
C	Parcel is delivered	Stands at door	Blue	Surprise	“Bring it to me”	Yes	“item on tray”
D	User selects “bring to me”	Drives to user	Blue	Surprise			“item on tray”
E	Delivery	Stands near user for delivery and robot slightly bows	Red	Neutral			“item on tray”
F	User takes parcel	Robot folds tray and leaves for docking position	Blue	Neutral			
A	User sits without drinking	Charging position	Green	Neutral		Yes	“you did not have a drink in some time”

B		Charging position	Green	Sad	“go to the kitchen” or “ignore”	Yes	“you did not have a drink in some time”
C1	User selects “ignore”	Charging position	Blue	Sad	<Repeat after 20? seconds>	Yes	“you did not have a drink in some time”
C2	User selects “go to the kitchen“	Moves to the kitchen	Blue	Happy			
D	User opens fridge	Robot waits at fridge	Red	Neutral			
E	User puts cup on tray	Robot waits at fridge	Blue	Neutral			
F	User sits on sofa	Robot drives to user	Blue	Neutral			
G	User waits for drink	Robot delivers cup to table	Blue	Neutral			
H	User can drink	Robot moves to charging position	Green	Neutral		Yes	“your drink is available”
I1	User does not drink		Green	Sad	<Repeat after 20? seconds>	Yes	“you really should drink”
I2	User drinks		Green	Happy			
	End of scenario						

4.2 Expert 2

In the consultation with expert 1 several interaction problems were mentioned. Therefore a partner of the consortium and WP3 was consulted as second expert. While experiencing the scenario a list of observations and suggestions for improving the interaction aspects between robot and user was compiled. Some of these can be implemented given the current technical

capabilities, for others technology development needs to progress before the requested interaction can be made available. In some cases a shortcut needs to be implemented to overcome short term technical shortcomings, in some cases the difference between projected use at home and experimental use during the project evaluations require interim solutions, and finally a need for more fundamental technical progress requires ad-hoc (wizard of Oz) solutions to mimic the type of interaction we would like to be able to develop in the project. The following comments and suggestions were given by this expert:

- When the doorbell rings the user is not triggered to look at the tablet, the user will look at the door or possibly at the robot but not at the tablet.
    - *Suggestion*: Tablet should attract attention by auditory signaling when action possibility appears on tablet screen. This should only be in case of interfering action possibility, as the normal action possibility grows and diminishes in context. In other words, the tablet should ring with the doorbell.
    - *Modification (proposed)*: Introduce settings in the GUI that the user can select and change. For example, the user could select the sound or vibration he/she prefers to be used as notification of when the doorbell rings. This was not changed in current version due to technical limitation; however this should be taken into account for the next prototype.
- Since the participant is not in his/her home situation, ringing of the doorbell might fail to trigger the user to do something *(I am just a guest here so why should I open the door*), while in his/ her own home a ringing doorbell would trigger the participant. So, additional stimulation during experimentation seems required.
    - *Suggestion*: Stimulate the user to act by attracting the attention, by robot (a bodily hint; looking at the door in a 'waiting' position), tablet or experimenter.
    - *Modification (implemented)*: The robot looking at the door in a 'waiting' position.
- When the doorbell rings the robot does nothing, it just stands there and ignores doorbell.
    - *Suggestion*: The robot turns towards the door; on the tablet the robot view would be provided and the action possibility "open the door" would appear on top of this image. Ideally this would happen always in the tablet's "robot view mode"; action possibilities would be placed on the item in view of the robot (provided on the screen) and would disappear as soon as the object or location would no longer be in view. In the pre-defined scenario the objects/action possibilities can be pre-programmed and do not need detection.
    - *Modification (implemented)*: The robot turns towards the door, on the tablet the robot view is provided and the action possibility "open the door" appears.
- The messages/action possibilities on the tablet should only offer (positive) action possibilities.
    - *Suggestion*: The messages/action possibilities "the doorbell is ringing" and "ignore doorbell" should be deleted.
    - *Modification (implemented)*: The messages "the doorbell is ringing" was deleted.
    - *Modification (proposed)*: The action possibility "ignore doorbell" was not deleted. There is a difference between the real situation and the test setting;

from the user perspective they should be given the option not to open the door.

- There is no sense of urgency to open the door in the system; a mailman will go away if the door is not opened within a short space of time (some feedback to the mailman could solve this for the mailman). Nonetheless, the user also needs to be urged to act.
    - *Suggestion*: The action possibility button should grow gradually and maybe some increasing unrest should be introduced when time goes by e.g. shaking button on screen, buzzing sound from tablet. Also the mask should change. After some time, when the mailman is gone because the door did not open, the action possibility “open the door” should disappear again.
    - *Modification (proposed)*: Action possibilities should also grow gradually when becoming more urgent. Also settings in the GUI should be introduced in which the user can select and change their preference concerning attention seeking of the tablet. For example, the user could select the sound or vibration he/she prefers to be used as a notification about an urgent action possibility. This was not changed in current version due to technical limitation; however this should be taken into account for the next prototype.
- The drinking reminder currently given as action possibility on the tablets screen “you should drink something” is no real action possibility and is rather blunt.
    - *Suggestion*: Delete these messages.
    - *Modification (implemented)*: The message “you should drink something” was deleted.
- Action possibility “shall we go to kitchen together?” pops up out of the blue without clarifying its relation to a need to drink.
    - *Suggestion*: Replace the text with “get a drink from the kitchen together”.
    - *Modification (implemented)*: Text was replaced.
- The button “get a drink from the kitchen together” expresses a need for drinking which remains (increasingly) relevant until the user has taken a drink.
    - *Suggestion*: The button should grow in size and after some time addition attention attracting features should be activated (buzzer, ping). In addition, the robot may turn towards to kitchen resulting in an image of the kitchen through the robots camera being displayed on the tablet. This places the action possibility button in context as it is placed on top of the image of the kitchen, the location for this action.
    - *Modification (proposed)*: Action possibilities should also grow gradually when becoming more urgent. Also settings in the GUI should be introduced in which the user can select and change their preference concerning attention seeking of the tablet. For example, the user could select the sound or vibration he/she prefers to be used as notification about an urgent action possibility. This was not changed in current version due to technical limitation; however this should be taken into account for the next prototype. Moreover the situation during the test is not realistic; people did not fail to drink for three hours in the test, so the user triggering will be of an artificial nature.

- The action possibility “remind me later” also in this screen, is not an action possibility, it is rejecting an action.
    - *Suggestion*: Remove this button
    - *Modification (rejected)*: Although this is clear in a real home situation, the scenario is tested with elderly who are not thirsty. There is a difference between the real situation and the test setting; in the real setting an action possibility will grow when becoming more relevant and/or ignored by the user. This feature is not yet included in the test setting and the user should be given an option to postpone the message.
- In order to activate an action possibility the user needs to select an action possibility and then conform activation. In effect buttons need to be pressed twice. This need for selection of the action possibilities buttons twice should be deleted as it proves to be unclear to some users.
    - *Suggestion*: Delete pre-selection. A “go back” or “oops” button to cancel wrongly selected action routines is required.
    - *Modification (proposed)*: This was not changed in current version due to technical limitation; however this or another solution should be taken into account for the next prototype.
- Refreshing rate of robot view screen is very low. This makes the suggestion of an active robot very unrealistic.
    - *Suggestion*: Increase refreshing rate
    - *Modification (proposed)*: This was not changed in current version due to technical limitation; however this should be taken into account for the next prototype.
- When moving through the room the robot should express goal directedness by looking at its target position.
    - *Suggestion*: The carriage may need to follow the (obstacle avoiding) route (so no sliding movement), but torso rotation could strengthen the message of where it is heading.
    - *Modification (proposed)*: This was not changed in current version due to technical limitation; however this should be taken into account for the next prototype.
- The robot’s journey to the kitchen is now separate from the user’s journey. There is no “togetherness” expressed in the movement and behaviour of the robot. The robot makes no attempt to coordinate this journey with the user; the robot drives sideways or backwards towards the target position.
    - *Suggestion*: The robot should travel along a different path with its carriage in the direction of movement. Three suggestions: I, II and III (see Figure 2).
        I. The user sits at A1 and the robot goes towards the user, turns into the direction of the path to follow to the fridge and waits for the user to stand up before starting to move towards the fridge.
        II. The user sits at A2, further the same as for I.
        III. The user sits at either positions but the target position of the robot requires the user and robot to cross paths. The robot makes a sharp z

movement to facilitate the user to follow his/her path (tricky because the robot cannot adapt the speed depending on the user position). In the current status the user needs adapt speed in order to make this crossing of paths possible.

- *Modification (proposed):* This could only be implemented to a limited extent due to technical limitations. Also more knowledge should be gathered on the way to reach the desired togetherness. It will be further investigated in WP3.

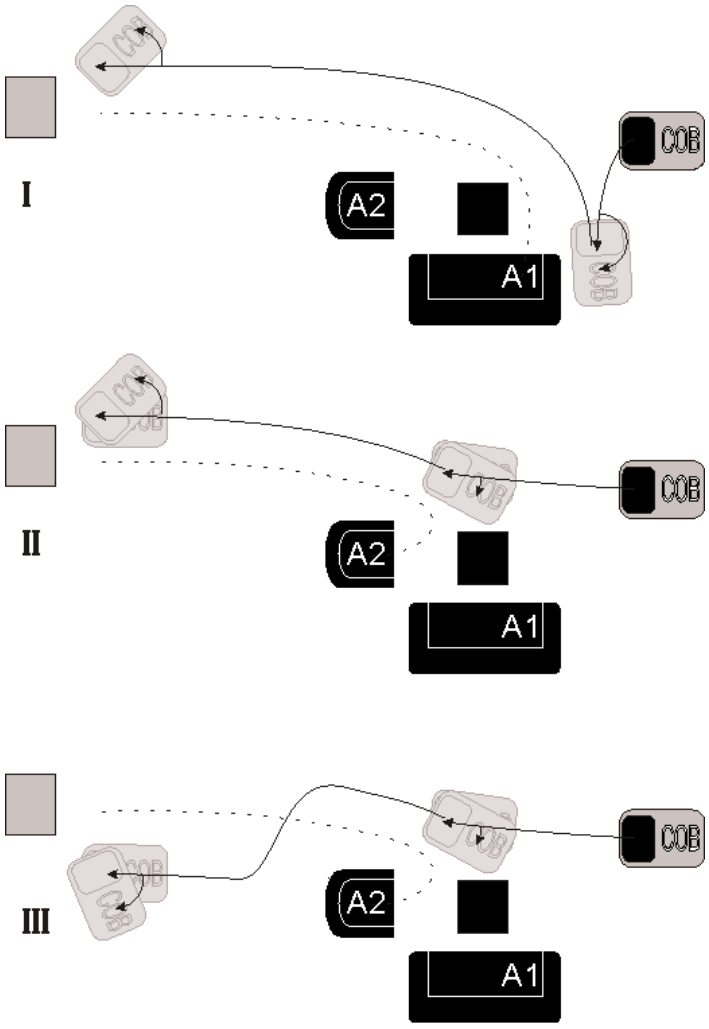

Figure 2: Three suggestion on how the robot should travel along a path with its carriage in the direction of movement.

- On the way back from the fridge to the sofa, the robot's mission is delivering the drink; this is in itself an incentive for the user to follow.
  - *Suggestion*: Again the driving should appear to be goal oriented and looking at the user by turning the torso implies interaction with the robot.

    - *Modification (proposed):* This was not changed in current version due to technical limitation; however this should be taken into account for the next prototype.
- Once the delivery is finished (drink on table) the robot does not indicate finalisation of the mission.
    - *Suggestion*: The robot could make a short bow and drive away backwards after folding arm and tray or the robot could drive backwards to the charging position while folding away tray and arm.
    - *Modification (implemented)*: The robot moves backward to the charging position after placing the drink on the table.
- When the user does not drink a difficult to perceive reminder is given on the tablet screen.
    - *Suggestion*: A signal could indicate the appearance of a new action possibility but the reminder is not a new action possibility. It would be even better if the robot could drive up to the table again and start looking at the untouched drink on the table (bowing its head) until the user drinks. In the view on the tablet would be the cup and the mask could strengthen the “impatience” of the robot.
    - *Modification (implemented)*: The robot drives to the table and looks at the untouched drink on the table (bowing its head). On the view of the tablet the masks turns sad and the text “you should really drink” appears.
- When the robot is waiting for a user action to be able to continue (waiting for parcel on tray, or waiting for cup on tray) it give now no indication of the “waiting” status.
    - *Suggestion*: The LEDs could be used but it requires the learning of colour coding by users, much more direct would be a repeated slight up/down movement of the tray to indicate the waiting status.
    - *Modification (implemented)*: The colour blue was used to indicate “available” status of the robot. The colour yellow was used to indicate the robot is “on a mission”.

4.3 Observations

Besides the two evaluations with the experts a log book with observations on system functioning was created throughout the user evaluation sessions with elderly users at Zuyd. From these observations the following list with suggestions were created:

Human robot interaction

- The tablet could wake up at the sound of the doorbell – *implemented*
- The action sequence could be adjusted to real life response of users – *not implemented as this will deviate from the scenario.*
- After the doorbell it may take some time before the robot is actually at the door – *not solved yet*
- When the robot stops at an appropriate distance with the parcel, it may be too far for the user. The robot could respond by getting closer after a time out – *not implemented, users adapted to the robot.*

- There is an awkward situation when the user is supposed to join the robot in going to the kitchen. Some users get unsure what to do next. The robot could respond to this by gesturing more invitingly to make clear that the user is supposed to stand up. Another option is to display a message on the tablet to ask the user to follow the robot/generally walk to the kitchen – *new text on tablet was implemented*
- Positioning of the robot at the fridge is not adaptive to the user's position. The robot plans the end position immediately at departure from the sofa. Checking the availability of end position by the robot may lead unexpectedly to the robot stopping when there is a person blocking this position. This is hard to detect for users; they do not know the robot plans that far ahead. The robot should rather take a different position when the user is at the targeted position the robot just stops (realisation through rule "User at Location Fridge → proxemics to position of user", this is dependent on continued tracking of user throughout scenario) – *not implemented, under investigation in WP2.*
- When driving the robot should be looking in the direction of driving, it makes the robot behaviour much more predictable for users – *not implemented, proposed for future version*
- Unloading the drink is only possible on the coffee table. If the user is standing elsewhere this would not be appropriate. To solve this in the experimentation the user needs to sit at a place near the table. Fixed position can, again, be replaced with proxemics as long as tracking works for the extended period – *not implemented yet.*
- The monitoring of the drinking is now a bit difficult, the user may not be aware of the robot doing this. There could be additional layers of reminding added, to ensure user attention or to increase pressure – *the robot moves towards the table and looks at the untouched drink when giving the reminder to drink*
- The tablet could "close" when the robot goes back to docking to make clear the scenario (robot action) is completed – *Not implemented in this version*

4.4 Technical Wish-list

All three lists could be added with the feedback from the technical team and be transformed into the following wish-list:

1. Cup Prototype improvements:
   - No open batteries
   - No silicon glue
   - Move heavy components to bottom or replace them
   - Cup would be safer to transport with a wider base

2. Siena GUI:
   - Fix crashes
   - Only display buttons in bright mask area
   - Stop buttons overlapping
   - Buttons should be able to hold more text
   - Add a text field for messages to the user that are not Action Possibilities
   - Play click sound when an Action is confirmed, not only when it is selected
   - Make "Executing"-Status of actions more obvious
   - Remove login screen if stability issues cannot be resolved

- Removal of buttons from the screen should be instantaneous to not require additional sleep commands from the scheduler.

3. UH Components:
   - Sensor connection should not be blocked by malfunctioning zigbee updates
   - Scheduler crashes when display is changed with “display non-schedulables” during execution of reset all
   - Allow modification of window and table sizes within program GUI
   - State of some robot components is transmitted to database in numbers rather than words “full”/”empty” etc. The scheduler still expects the words, sync them up again
   - Make according changes in locations.py if UvA tracking is able to detect user orientation

4. IPA:
   - Fix or replace troublesome torso, arm
   - To allow implementation of Squeeze Me speed adjustment: Increase precision of ROS Navigation or make necessary changes to IPA Navigation
   - Navigation should react dynamically too far away obstacles instead of stopping immediately
   - If possible, find out what causes ghost-obstacles and associated stopping/resuming during navigation in the middle of the Heerlen test environment
   - Minor nuisances:
     - Tray only works on second initialization
     - Head displays error at startup, although it is in working state
     - After initialization, the first command to some or all components is skipped “controller/... action server not ready within timeout,aborting” error
     - MoveIt should be fixed to allow dynamic placement of bottle/cup
     - Tray orientation is offset by a large margin in rviz
     - Webportal doesn't allow restart of components after some time

5. UvA:
   - Sort out remaining issue of user detections jumping over to robot or being lost when they are close
   - Would it be possible to detect the users’ orientation? For proxemics, we are currently working with an estimation based on the last velocity vector.

5 Conclusions

The goal of the activities described in this report was to assess and improve the scenario year 2 and to create a realistic and functioning scenario for user testing. It is important to note that the scenario was not changed. When translating the scenario from all the steps on paper to a working scenario with an actual user performing the scenario with the robot, an additional step had to be made concerning the detailing of the scenario. Part of these lessons have led to changes in the details of the scenario, but have not changed the scenario itself, other lessons were recorded as feedback and may lead to further adjustment in the remainder of the project.

Overall it can be said that one of the main changes concerns the interaction between user and the robot. More physical feedback to the user was necessary to make the user understand the intentions of the robot (e.g. the bowing of the robot after delivering the parcel or turning its torso when placing the drink on the table). These changes were made based on the interaction between human and robot, and not influenced by the roles of the robot. The differences between the different robot roles still need to be studied.

With all the changes implemented the current scenario is as follows:

1. The user sits on the sofa, while the robot is located in its default location (charging). The robot mask on the tablet is “neutral” and the lights of the robot are blue. The doorbell really rings.
2. The lights of the robot turns yellow and the robot turns towards the door and the robot mask turns “excited”. The moment the robot sees the door the action possibilities “go to the door” pops up on the robot view on the tablet.
3. The user selects the action possibility “go to the door” on the tablet.
4. The robot moves to the door. Once at the door the tray moves up.
5. The parcel is placed on the robot’s tray.
6. The robot masks turns “happy” and the action possibility “bring me the parcel” appears on the tablet.
7. The user selects the action possibility “bring me the parcel” on the tablet.
8. The robot moves towards the user and stops at a socially appropriate distance/orientation from the user. The lights of the robot turn blue.
9. The user takes the parcel from the robot. The robot nods towards the user and then moves its tray down. The lights turn yellow and the robot goes back to its default location.
10. The user has not drunk in 3 hours and the robot notices this.
11. The robot lights turn yellow and the robot leaves charging station and approaches the table. The robot bows a little to look at the table. The robot masks turns “sad” and the action possibilities “go to the kitchen for a drink” and “remind me later” appear on the robot view of the tablet.
12. The user selects “go to the kitchen for a drink”, the robot mask turns “neutral” and the user and the robot go to the kitchen together.
13. When arriving in the kitchen the robot moves its tray up and the user fetches a drink from the fridge and places it on robot’s tray.
14. Both robot and user move back to the sofa, while the robot is carrying the drink.
15. The user is seated and the robot stops next to the table and turns its torso towards the user. After this the robot places the drink on sofa table.
16. The robot moves back to the default position and the lights turn blue.
17. If the user did not have a drink after a certain period the robot lights turn yellow and the robot moves back to the table and bows a bit to see the table. The mask on the tablet turns sad and the action possibility “you should really drink something” appears on the robot view on the tablet.
18. The user takes a sip and the action possibility disappears and the mask on the tablet turns “happy”. The robot moves back to its default position and the lights turn blue again.

Making changes to the scenario during the evaluation may look problematic in relation to the effect evaluation under WP6, but all changes implemented were aimed to maintain the scenario experience of the user. Some other proposed suggestions were not implemented yet, mostly due to current technical limitations. These suggestions will try to be included in the next user evaluation round that will take place in France. Also the *Squeeze Me* (developed in WP2) will be implemented in the user evaluation in France.