Improving Interdisciplinary Communication – Use Case Focused User Interaction Diagram 2.0

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***Abstract*— In this paper, we present the results of further research according to a communication improvement method within projects with interdisciplinary disposition. This method was used in the Active and Assisted Living (AAL) pilot-region project Smart VitAALity, to encourage elderly people to interact with state of the art technologies and formulate their needs. In addition to various research partners (computer science, economics and health management), business partners and Non-Profit Organizations (NPOs), end-users are also involved, and all these project partners speak a different language, according to their profession. The Use Case focused User Interaction Diagram 2.0 should provide a non-technical translation for every stakeholder independent of their prior knowledge to enhance the development process and capture various aspects, ideas, and suggestions for improvements and, furthermore, it should represent the interaction needs of elderly people. Therefore, the diagram was evaluated by elderly people to improve the feedback method.**

Keywords - Interaction Design; Human-system Interface; Interaction Diagram; Communication method; AAL.

I. INTRODUCTION

During applied research projects, it is common that communication takes place between different stakeholders with diverse background knowledge. These stakeholders often use the same terms with different meanings; to avoid misunderstandings, the Use Case Focused User Interaction Diagram [1] (UC-UI-Diagram 1.0) was developed according to the development process of systems with a human-system interface. This tool improves the communication base in interdisciplinary projects and gives every stakeholder a quick overview of the ongoing interface development per use case.

Referring to the first version of the chart notation, the Use Case Focused User Interaction Diagram 2.0 (UC-UI-Diagram 2.0) was developed with the approach to minimize the notation elements in order to improve the learning curve for understanding the diagrams. Therefore, the number of notation elements was decimated from eight to three and the elements were adjusted according to the UML 2.5 [2] standard element design. One of the reasons for the element design change was that the used element design of the UC-UI-Diagram 1.0 required different color expressions and the contrast and discriminability was not useable for a possible involvement of older adults with visual impairments. To also use the UC-UI-Diagram for this stakeholder group during the development process, the idea of the pre-evaluated element design of the UML 2.5 interaction diagrams (sequence diagram and communication diagram [2]) was used. This makes it possible to create the diagrams with common diagram drawing tools like Microsoft Visio, because the element designs are pre-installed and, furthermore, computer scientists are familiar with them and can also use the diagrams during the implementation into the system.

In the project Smart VitAALity, an Active and Assisted Living (AAL) pilot region project in Austria (Carinthia), the UC-UI-Diagram 2.0 method was initially used to improve the communication between technical and non-technical stakeholders. The involved stakeholder group is an interdisciplinary consortium of researchers in health management, economics, computer science and engineering, as well as Small and Medium-sized Enterprises (SMEs) with the emphasis of technical development and NPOs as caregivers. The entire project team was involved in the development process of the use cases. To extend the perspective of each use case, the UC-UI-Diagram 2.0 is additionally used. This information is provided on a shared platform to every stakeholder and, based on this, everyone can make proposals for improvements. To let the user group participate in the development process, it is necessary to evaluate the used tool with their prior-knowledge and usability. Therefore, during the Smart VitAALity project, the UC-UI Diagram 2.0 was evaluated and the results are presented in this paper.

The rest of the paper is structured as follows. In Section II, we discuss the materials and method. Section III presents our results. Section IV addresses improvement and discussion. We conclude this paper in Section V.

II. MATERIALS AND METHODS

This section explains the background for the UC-UI Diagram 2.0. Furthermore, it presents the evaluation strategy according to the human-centered design approach [3].

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A. UML 2.5 Communication and Sequence Diagram

The concept of time-related interaction between entities, as well as the illustration of relations between entities, can be realized with communication diagrams in combination with sequence terms. Because of its structure, this diagram extension is hard to understand for non-technical stakeholders. To get a quick overview of the different interactions, the UML standard uses a nesting strategy.

1.2b.1: function2(param1, param2) (1)

As shown in (1), the notation for communication diagram interactions with sequence terms is realized. The designation 1.2b.1 means: the first interaction in the content led to a second interaction which was a parallel interaction denoted with b (the other parallel interactions will get an "a" or a "c"). The interaction after the parallel one (2b) will be the executed interaction in this example with function2, which contains two parameters. This can be hard to understand if the usage of such UML standards is not a daily business. To ease the understanding of the interaction diagram, two measures were undertaken:

1. Simplify interaction sequences: no parallel interactions illustrated with characters or complicated numbering to show dependencies between interactions
2. Context change: the interaction diagram is specific for one named use case – to make it easier to understand

The UC-UI Diagram 2.0 should use the idea of use case based interaction of the prior 1.0 version of the diagram and combine it with the idea of the time and relation related interaction concept of UML 2.5. Furthermore, the diagram should be developed in a way that even non-technical experts should be able to understand and give feedback to improve the navigation strategy.

B. UC-UI Diagram 2.0 Evaluation Strategy

For the evaluation of the developed UC-UI Diagram 2.0, an assessment was made with the aim to analyze the diagrams to determine acceptability, understanding and potential areas for improvement. The evaluation process can be divided into the following five phases.

The participants of the chosen user group were selected based on their age - between 50 and 75 years. In the first phase (**step 1**) of the evaluation, the participants completed the TA-EG survey [4] ("Technology Affinity for Electronic Devices") which is a tool to assess the technical affinity and serves to determine the attitude towards electronic devices of the participants. The TE-AG consists of 19 items structured in four subscales "Enthusiasm", "Competency", "Positive impacts", "Negative impacts" when dealing with electronic devices like mobile phone, computer, TV, etc.

The second phase (**step 2**) was about the comprehension of the diagram. For this purpose, the developed diagram with a corresponding legend, was shown to the test persons for the first time. Since it is a UC-UI Diagram, the use case "show weather forecast" was chosen, because the participants may be familiar with this scenario from daily routines. The task of this phase was to understand the diagram with the enclosed legend after the documents were explained in detail.

The next step (**step 3**) in the evaluation process was about the graphical representation of the interaction elements in the diagram, such as buttons or text elements. Therefore, the participants were asked to design a mock-up based on the current use case. The emphasis in this assignment was to see if the participants get a picture in their minds according to the diagram elements and if they distinguish different element types (e.g., text, buttons, etc.). After the completion of this task, the created mock-up design was compared to an existing design representing the same use case, and the results were discussed.

In the fourth phase (**step 4**), an incomplete interaction diagram was presented, representing the use case "emergency call". In this scenario, one element was omitted deliberately: A "Cancel" button that prevents the user to cancel a particular part of the scenario. The goal was to look more closely at the navigation paths within the diagram to find the mistake.

Finally, in the fifth phase (**step 5**), the test persons were asked if they had already worked with a UC-UI Diagram and if such a diagram could be a straightforward way to display navigation paths. Furthermore, the participants were asked about the difficulties while working with the diagrams during the evaluation process. In the end, suggestions for potential improvements were discussed.

The used language for all documents was German. The session had one hour duration.

III. RESULTS

Within this section, the results of the diagram conceptualization and the evaluation are presented.

A. UC-UI Diagram 2.0

To get a step further into the understanding improvement, the diagram notation was reversed from the 1.0 version and, according to the feedback of project partners, the learning curve of the elements was too high. Hence, the main ideas of the sequential and communication diagram [2] are combined in the 2.0 version.

Diagram Notation

Based on the feedback regarding the chart notation of the UC-UI Diagram 1.0, the used elements needed to be

reduced. From eight elements, the reduction leads to three elements – because it is not necessary for non-technical stakeholders to distinguish between elements like external influencer, decisions or merges by diagram design. For any additional information, the elements will get a unique understandable label.

As shown in Figure 1, there are three elements to distinguish. The use case container includes all possible interactions of a specific use case. The agent container represents agents like views, people, interaction elements like buttons or checkboxes as well as descriptions. The user can interact in different ways with the agents; the agent container represents a human being itself. Every agent has a specific non-technical labeling. The agents can be nested into each other.

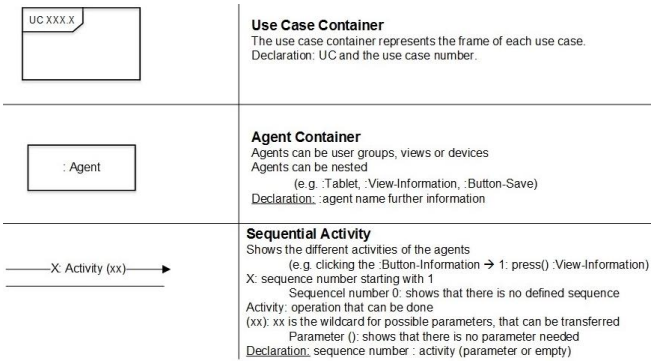

Figure 1. UC-UI Diagram 2.0 diagram notation (English translation). Description of the three used elements: use case container, agent container, and sequential activity.

In the case of a software project like Smart VitAALity, a tablet application is implemented. Every application shows different views to a user and every view contains different elements, like text or buttons. In this example, the first agent will be the view, and in the view agent container, the agent container for the button is nested.

This interaction diagram type focuses on human-system interaction and, therefore, the sequential activities are optimized. Users are able to do one interaction after another – real parallelization is no human possible interaction so no special notation is needed [5]. This type of diagram (UC-UI diagram 2.0) focuses on human-system interactions; all interactions a user can do with the system and the main function is displayed. In the following, one sample scenario is given:

Scenario: the user enters some content into a text-field. Instead of representing every key down interaction, only the save-interaction is shown. Moreover, further distinctions and system-to-system interactions in the front- and backend like "content send to backend" → "backend receives content" → "content stored in the database" have been excluded from the diagram.

Therefore, sequential activities are numbered one after another with simple counting one, two, and three. After the counting, the interaction receives a function name and a possible parameter. This parameter can be a decision parameter as for a checkbox (option 1 and 2) or in some cases, it can be empty.

In comparison to the UC-UI Diagram 1.0, the second version renounces to any color usage as well as different line style. Furthermore, the diagram has the highest possible contrast according to the black/white diagram notation; according to the conformance stage of the Web Content Accessibility Guidelines – WCAG 2.1 [6] this is needed for a barrier-free usage. This makes it easier for people with vision impairments (color blindness or ametropia) to understand the diagrams – and according to AAL projects, it is one aspect for the inclusion of elderly people to minimize the barriers and to enhance the participation during the implementation phase.

In the Smart VitAALity project, 71 use cases are defined. All use cases are written with the use case template of Alistair Cockburn [7]. For every single use case, the different possible procedures (standard procedure and multiple alternative procedures) are explained. This helps on the one hand the developers to have an exact implementation guideline and furthermore it increases the reading flow and understanding for non-technicians.

The strategy used in the project was to combine the use case template of Cockburn with a method that gives a quick overview of all possible interactions. Therefore, the UC-UI Diagram 2.0 was used.

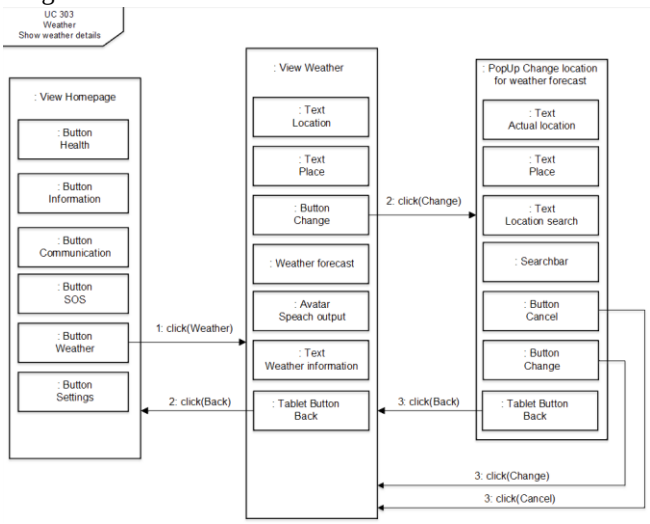

Figure 2. Example of the use case "UC 303 Show weather details" of the Smart VitAALity project. Shown are the different views of a tablet application to realize a weather forecast.

As shown in Figure 2, the first agent container on the left ":View-Homepage" includes the possibility to do more

interactions like clicking on Button-Information or Button-SOS, but the UC-UI Diagram 2.0 is in context of a pre-defined use case "UC 303 Weather – Show weather details". This helps to minimize and regulate the shown interactions and to get a clean and neatly arranged interaction overview. Nonetheless, it should represent the whole context of each view to give the user the big picture and an idea whether the navigation in the context would be understandable.

B. Evaluation Results

For evaluation purposes, five people (3 female, 2 male) were tested according to the five-step evaluation strategy chosen. The youngest participant was 51 years old and the oldest 73 years. All these people are living in the urban-rural area of Klagenfurt and Villach in Carinthia – Austria. According to their pre-knowledge of using technical devices like smartphones, computers or tablet computers, 4/5 people have a smartphone and tablet computer and 5/5 people have contact with at least one technical device.

Step 1: TA-EG

At the beginning of the evaluation process, the participants were asked to complete the TA-EG questionnaire with a five-level Likert response format (strongly disagree – strongly agree). For each participant, the mean values of all items of the individual subscales "Enthusiasm" for electronic devices (5 items), perceived "Competency" (4 items), perceived "Positive impacts" (5 items) and perceived "Negative impacts" (5 items), were calculated to get an overview of the technology affinity. Table I shows the mean value and the standard deviation of the technology affinity for electronic devices of all five participants, where value 5 is the maximum and means "strong agreement" and value 1 "strong disagreement".

TABLE I: RESULTS OF TECHNOLOGY AFFINITY QUESTIONNAIRE FOR ELECTRONIC DEVICES (N=5); MEAN VALUE 1…STRONGLY DISAGREE – 5…STRONGLY AGREE

Subscale of TA-EG	Mean Value	Standard Deviation
Enthusiasm for electronic devices	3.4	0.9
Perceived Competency	3.2	0.7
Perceived negative impacts	2.3	0.5
Perceived positive impacts	4.4	0.3

On average, the participants have a "neutral" response ("neither-nor" agreement) on "Enthusiasm" for electronic devices, with a high variance and range from slightly disagree to strongly agree on "Enthusiasm". The results for the perceived "Competency" are similar and show on average a "neither-nor" agreement on "Competency", with a range from slightly disagree to slightly agree.

For the subscales perceived "Negative impacts" and "Positive impacts", on average the participants show a slight disagreement on perceived "Negative impacts" when using electronic devices and a moderate / strong agreement on perceived "Positive impacts" when using electronic devices.

Overall, and besides varying agreement to "Enthusiasm" and "Competency", the attitude towards usage of electronic devices is positive.

Step 2: Use Case "Weather Forecast" + Diagram Key

After some general instructions, the UC-UI Diagram 2.0 example was shown to the participants and discussed according to the use case on the one hand and the different elements on the other. Furthermore, the diagram key was given to the participants to have a look at it. The following results, presented in Table II, are evaluated:

TABLE II. QUESTIONS, RESULTS, AND REMARKS ACCORDING TO THE WEATHER FORECAST USE CASE.

Question	Result & Remarks
Is the diagram key helpful to understand the UC-UI Diagram 2.0?	4/5 said it was not necessary or would confuse them 1/5 understood it, but an example and a short spoken introduction were preferred.
Is the "Weather forecast" –UI Diagram understandable?	5/5 mentioned that it was clear for them
Do you know what a View is?	3/5 answered right 2/5 people told after further questioning that they did not recognize that every view was a different page.

Step 3: Mock-Ups Use Case "Weather Forecast"

The next step was to draw the different views shown in the UC-UI Diagram on sheets of paper. 4/5 participants did not really want to draw anything at first because they thought they were not talented enough in the drawing. Two out of this group disliked the exercise a lot, they just drew anything but talked more about the results. After their drawing exercise, the real mock-ups for the UC-UI Diagram were shown and the differences between their interpretation and the real mock-up discussed. The results of this step are shown in Table III.

TABLE III. EXERCISE ISSUES, RESULTS, AND REMARKS ACCORDING TO THE MOCK UP DRAWING OF THE WEATHER FORECAST USE CASE

Exercise issues	Results & Remarks
Allocation of elements	4/5 started drawing on the upper left corner and drew very few elements. After telling them that they had enough space and more than one paper, they started drawing bigger elements.

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Symbols or text elements	4/5 drew predominantly symbols instead of text for the buttons; 1/5 was the total opposite. After re-asking them why, they started mixing more because they had the feeling that it was not right what they are doing.
Label & drawing	5/5 drew all elements in boxes like they were drawn in the UC-UI Diagram. Asking why: they didn't care while they were drawing if it was a text or button and they could not do it better.
Labeling	5/5 could not differentiate between texts. It was not clear if the text was a label or a text-input or some information. All participants had problems in drawing the ": View Weather" because of this issue.
Wording	5/5 did not know what an "Avatar" was and 4/5 did not know at first what a "PopUp" was. After explaining it, it became clear but they could not work with these words.
Showing the mock-up	5/5 connected the mock-up to the diagram; 3/5 told that it looked nice and that they had something similar in mind but they were not able to draw like that.

Step 4: Use Case "Emergency Call"

The second use case shown was "Emergency call", and it was prepared with a mistake – a navigation trap; the participants needed to identify that they were caught in a loop in one view and could not navigate to another view anymore. Furthermore, they should explain what they saw in a Think Aloud manor. The following results in Table IV were detected:

TABLE IV. EXERCISE ISSUES, RESULTS, AND REMARKS ACCORDING TO THE EMERGENCY CALL USE CASE

Exercise issues	Results & Remarks
Explaining the use case	5/5 could explain what they saw on the diagram
Evaluate the navigation process	3/5 started to evaluate the given navigation strategy and they focused on how to improve the "Emergency call" as such.
Mistake detection	3/5 could find the mistake by themselves; two needed some hints to get it. 3/5 told that they first thought it was no mistake because on tablet computers they always had the "Home"-button option to cancel, (not shown in the diagram).
Drawing mistake improvement	4/5 mentioned the mistake with speech, 1/5 participant drew a button as it should be.

Step 5: Reflection

After all the tasks were done, the last part of the evaluation was to get some reflection based on pre-defined questions. These questions, together with results and remarks, are shown in Table V.

TABLE V. QUESTIONS, RESULTS, AND REMARKS ACCORDING TO THE REFLECTION OF THE UC-UI DIAGRAM 2.0 EVALUATION

Questions	Results & Remarks
Are you used to such diagram representations?	4/5 never used such diagrams or other similar ones before. 1 participant had experience in process management (former occupation).
Is it a good method to represent navigation purposes and could it improve/replace written manuals?	4/5 thought it was a clearly structured way to describe navigation processes; 2/5 would have preferred this description according to written manuals 3/5 would have suggested it as a supplement to written manuals
Could there be difficulties by using the UC-UI Diagram 2.0?	5/5 wanted a clear wording according to interaction and non-interaction elements like the text element. The word text alone was not clear enough. 1/5 said that maybe non-technical affine people could have problems in general with technical diagrams.
Have you had any difficulties using the diagram?	5/5 mentioned the wording of the element; it was not clear enough 1/5 said that the elements were too close to each other
Do you think you are able to give feedback according to the navigation strategy (mistakes or improvement)?	5/5 said that they thought, after an explanation of the diagram, that they were able to give feedback or improve the use case navigation strategy. 3/5 already did it in the second use case;
Do you have now ideas for improvement?	2/5 mentioned that there was no need for the relations to be labeled with "click" 1/5 mentioned that all Anglicisms should be avoided 2/5 mentioned that non-interaction elements should be removed 1/5 mentioned - fewer rectangles would be better, elements could be combined

The results shown in Table V influence further research and improvement of the diagram.

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IV. IMPROVEMENT & DISCUSSION

The intention to include the end-users from the very first steps during a development process should reduce misguided implementation. Therefore, new soft- and/or hardware tools enable users to participate in an appropriate way. That means that non-experts need to get a big picture of the development processes even before design issues are developed. To get feedback about the navigation and/or interaction concept, it is necessary to work with a tool that end-users easily understand so that they can concentrate on the main topic – to evaluate interaction proposals.

To develop such a tool and to prove that it is working for a certain user group, an evaluation was undertaken. Referring to the results of that evaluation, three major issues could be identified, which should be improved in future before working with the diagrams intensively.

Language

The element labeling still has the proper wording for the user group. The improvement should clarify if an element is an interaction element or not. Regarding the participants, maybe all non-interaction elements should be removed. If such elements are in the diagram, they should be labelled clearly, so that there are no misunderstandings possible. Easy language should be (German: Leichte Sprache [8]) used and all the English terms should be avoided. This could increase the acceptability and usability of the participants.

Diagram key

The diagram key may be important for research purposes, but for users it is not relevant at all. They are confused because of the given explanations. It is easier for the user group to give a simple example, maybe with a mock-up, and/or explain it before they use it in feedback sessions.

Relation-labelling

The participants did not notice the labeling referring to the click-action and two of them mentioned that it was not relevant and could be removed. This should be evaluated again; maybe if there was more than just click interaction it could also be relevant for the user group.

As for now, the UC-UI Diagram 2.0 version is used in AAL projects like Smart VitAALity. In the current development stage, it is possible to give elderly user groups who are non-technical a tool that helps them give feedback to the prior-defined navigation strategy. Still, there is room for improvement according to the prior mentioned topics with language leading the way. The next step for improving the diagram will be a survey (maybe online) according to the wording topic; the study will be supported by a linguist.

V. CONCLUSION

This paper shows the evaluation results of a simple diagram language (UC-UI Diagram 2.0), that should assist the participation of elderly users during development processes in AAL projects. According the results, this type of diagram will also be used in other projects and it will be improved iteratively, maybe with a bigger group of participants, to make it even more applicable.

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REFERENCES

[1] D. Krainer, D. E. Ströckl, and J. Oberzaucher, “Use Case Focused User-Interaction Diagram – A Communication Tool within AAL Projects” in: PETRA ’17: Proceedings of the 10th International Conference on Pervasive Technologies Related to Assistive Environments, 21-23 Jun 2017, Island of Rhodes, Greece, S. 193.196, 2017

[2] Object Management Group (OMG); OMG Unified Modeling Language – Version 2.5; http://www.omg.org/spec/UML/2.5, 2015 [retrieved: September, 2018]

[3] Germany.ISO. 9241-210: 2010. “Ergonomics of human system interaction-Part 210: Human-centred design for interactive systems.” International Standardization Organization (ISO). Switzerland, 2010

[4] K. Karrer, C. Glaser, C. Clemens, and C. Bruder, „Capture technology attraction– the survey TA-EG”. Original Title: “Technologieaffinität erfassen – der Fragebogen TA-EG” In A. Lichtenstein, C. Stößel und C. Clemens (Hrsg.), Der Mensch im Mittelpunkt technischer Systeme. 8. Werkstatt Mensch-Maschine-Systeme (ZMMS Spektrum, Reihe 22, Nr. 29, S. 196-201). Düsseldorf: VDI Verlag GmbH, 2009

[5] T. Schubert, “The central attentional limitation and executive control.” Front. Biosci. 13, 3569-3580. 10.2741/2950, 2008

[6] World Wide Wep Consortium (W3C). “Web Contenct Accessibility Guidelines (WCAG) 2.1”; https://www.w3c.org/TR/WCAG21/, 2017 [retrieved: September, 2018]

[7] A. Cockburn, „Effectively creating Use Cases.“ Original Title: “Use Cases effektiv erstellen.” MITP Verlach, 2003 ISBN 3-8266-1344-9, 2003

[8] U. Bredel and C. Maaß, „Simple Language: theoretical essentials. Orientation for the practice“ Original: „Leichte Sprache: Theoretische Grundlagen. Orientierung für die Praxis.“ Duden. ISBN: 978-3-411-75616-2, 2016

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