Interactive scenario visualization for home care technology

J.W.J.R. van 't Klooster, B.J.F. van Beijnum, A. Eliens

0. ABSTRACT

Scenarios are commonly used to develop new systems in multidisciplinary projects. However, written scenarios are sequential, not dynamic and can be too abstract or difficult to understand. The goal of this paper hence is to extend the use of scenarios in design methodologies, using an interactive scenario visualization (ISV) approach. We show that ISV can be used beneficially to develop a new system and that ISV aids in reflection upon the design trajectory. Comparing two software platforms, we found it was possible to develop such ISVs inexpensively, rapidly and with good visual quality. As a case study, we demonstrate the use of a home care system in 3D for discussion and development purposes[1]. A small-scale panel evaluation suggests that this ISV clarifies the home care system, its functionalities, and aids in getting feedback on the development of the system. Finally, we discuss generalization of the use of ISVs.

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Keywords: interactive scenario visualization; scenarios; scenario-based design; home care system design.

1. INTRODUCTION

In situations where the exact use of a new system is not known a priori, scenarios are used to conceptualize and discuss the system's properties, the behavior of people interacting with the system or the interaction context (Sutcliffe, 2000; Alexander, 2004). Written scenarios may however be difficult to understand, especially when they concern abstract concepts. Moreover, their stories are sequential and non-interactive. Also, knowledge barriers may induce unfamiliarity with the proposed technologies, which hampers input of domain experts and end users (Tanriverdi, 2007). Finally, the visualization and imagination of the scenario has to be performed by the reader, based on the given (lengthy) text. When multiple users are involved this may lead to interpretation differences or incompleteness.

In this study therefore, we developed an interactive scenario visualization technique, to extend the use of scenarios in design methodologies. The goal of visualization is two-fold: to clarify the system to be designed and to facilitate discussion with stakeholders. This paper discusses the results of this explorative study using a case study; a multi-disciplinary design effort to develop an ICT-mediated home care system for independent elderly living at home.

[1] The ISV of the case study is available online at http://bit.ly/isv4hct.

The remainder of this paper is presented as follows. Section 2 discusses the use of scenarios and scenario visualization for development purposes. Section 3 explains our approach. Section 4 discusses the results of the case study. Section 5 presents the outcomes of a small-scale panel evaluation. Section 6 presents an outlook to discuss the generalization of our approach. Section 7 finally presents the conclusion.

2. BACKGROUND

A *scenario* is a story about the concrete use of a (future) system or technology and the consequences of the usage. (Carroll, 1995; Carroll, 2000; Jarke, 1999). Scenarios are especially useful in multidisciplinary development projects to perform needs analysis, to guide the development of novel systems (Hsia, 1994; Benyon, 2002) and to articulate constraints from different stakeholders (Widya, 2009). Hence, scenarios are used for understanding requirements and they aid in prototyping and evaluation of design concepts.

The *scenario product* is a description of who does what for what purpose (Kaindl, 2000) on a more or less abstract or concrete level, depending on the goal of the scenario and the moment of delivery in the development lifecycle (Beynon & Macaulay, 2002). In early stages, the scenario takes on a user perspective revealing PACT (people, activities, context of use and technology used) properties (Huis in ‘t Veld, 2010). As the development effort continues, scenarios become more concrete and system-oriented, reflecting (snapshots of) the FICS properties (functions, interactions, content and style/service) of the system.

Scenarios can be produced in different modalities: apart from a written storyline they can be a mockup, sequence of maps, animation, theatre, audio-visual or interactive format (Sutcliffe, 2000; Caroll, 1995, Alexander 2004). Whereas visualized modalities have impact on understandability and consumability of the scenario (Zudilova, 2007), they come at the price of translation and interpretation of the storyline. The resulting product may be less flexible, e.g. a video version is difficult to modify as the scenario evolves. Moreover, they tend to be time-consuming and expensive to produce. This holds e.g. for video formats and for theatre plays (McGee, 2007).

Interactive scenario visualizations, like audio-visual visualizations, also have interpretations of the storyline, but have interesting properties when it comes to understandability, dynamicity and production effort. In interactive scenario visualization, the story becomes dynamic and reversible, and may hence be traversed in the user’s order of choice, e.g. useful in educational situations or serious gaming (Taekman, 2010). The ISV tempts to activate its audience and is not ‘consuming-only’ anymore. Like audio-visual scenarios, ISVs can be streamed over the internet to reach a large audience. Unlike movies however, interactive scenarios can be linked to data sources, web services and news feeds to increase the actuality of the scenario. Though powerful in potential, ISVs for home care technology development purposes is still, as far as we know, very limited.

3. METHODOLOGY

Now that the use and modalities of scenarios have been described, we come to the description of the process to realize the case study ISV. Thereto this section describes (i) the comparison process to select the software to develop the visualizations, and (ii) the content selection process to create the visualization itself.

To develop the actual ISV, we considered two freely available software packages, Alice and Unity. Alice [www.alice.org] is an easy-to-use model-driven engineering drag-and-drop programming environment aimed at teaching Object-Oriented programming using characters in 3d virtual worlds (Cooper, 2000). As of version 3.0, its created output can be exported to Java sourcecode for further manipulation or addition. Characters of 'The Sims' can be used in the created virtual world, so the result can be appealing but it remains cartoonesk.

Unity [www.unity3d.com] on the other hand has a steeper learning curve but offers more flexibility in terms of graphics, story design and realistic representation of daily activities in 3d virtual worlds. This is not surprising as it is meant for (serious) game design instead of storytelling / learning to program, as is the case for Alice. Using Unity it is easier to produce interesting and entertaining results, which is important for serious games, games and visualizations.

After developing and comparing prototyped ISVs in both packages, we choose to use Unity because of the more realistic visualization and the better functional and graphical possibilities. To evaluate the adequateness of this decision we developed a small questionnaire to enquire a panel. This will be discussed in Section 5.

For the content of the ISV, existing written scenarios from a multidisciplinary home care development project were taken as a case study (van 't Klooster, 2009a). The story in the virtual environment is based on a storyboard. Storyboards ease the administration of choices in the story design and the tracking of logical sequences. An example storyboard is shown in simplified form in Figure 2. Diamonds (choices) refers to interactivity in the scenario; sequential (movie-like) scenes may start in the processes that follow (eg. 'take medication').

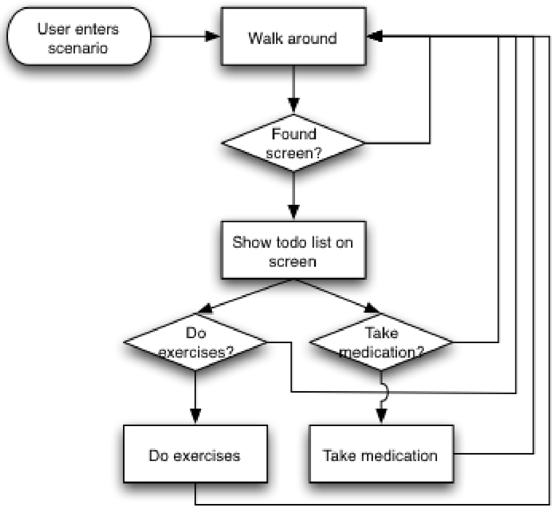

Figure 2. Simplified flow chart representing the story board of the scenario visualization. When the user finds a screen, a todo list is displayed with activities to conduct. The screen in the scenario visualization is visible in Figure 3.

The control flow of the visualization becomes clear through the use of a storyboard. However, the available options should be presented to the viewer of the ISV in a consistent and clear way as well (Kulyk, 2007). Hereto, different dialogue box designs were tried.

4. RESULTS

In Unity, an interactive virtual environment is created. This environment is inspired by the actual nursing home 'Parc Hoogveld' in Sittard, the Netherlands. It shows two elderly apartments, a nurse office and a corridor connecting these three spaces, as visible in Figure 3. The interactive scenario evolves around the role of one of the inhabitants in his apartment; he is able to use the installed home care system freely. The concept of this home care system is an easy to access touch screen on the wall, offering services like medication reminders, agenda, social interaction and aid in doing exercises. The system can also be accessed through the TV in the living room, as indicated by the two screens in the inset on the right. Once the user is in the vicinity of the screen, the options of the home care system become usable as shown by the Figure's inset on the left. The graphical interface in the virtual world is similar to the actually prototyped version (van 't Klooster, 2009b; Scholten 2010).

Figure 3. Virtual nursing home. The large photo shows 2 apartments and a nurse office, the inset on the right shows 1 apartment, its inhabitant (the main character played by the user in the visualization) and the two screens (1 on the wall and 1 as TV in the lower right) of the home care system. In the inset on the left, the screen on the wall is active, showing Agenda, Photo Album, Television and Video Telephony options to explore by the user.

In this ISV, different services of the home care system can be explored from the viewpoint of both care receiver and care giver. Thereto, interactive parts are combined with sequential scenes. An important point of attention in this regard is the self-explaining property of an ISV: depending on the intended use of the ISV, the visualization should be more or less self-contained. This means that for our discussion purposes, audio and visual comments were added alongside the visualization. However for standalone operation, these comments should indeed replace a person presenting the ISV. In that case extensive hints for the operation of the ISV should be added.

5. EVALUATION

We performed a small evaluation to assess the attitudes of a focus group towards the visualization. The focus group consisted of n=10 people, which is not large enough for rigid conclusions, but does provide some circumstantial evidence on the adequateness of developing ISVs. Five of the members of the focus group work in academia, 2 are care professionals, 2 work in SMEs in care technology industry and 1 at an ICT enterprise. To prevent a pro-adoption bias, they were not asked beforehand to participate in a focus group study. After an explanation and demonstration of the visualization, a questionnaire was handed out.

Using a 5-point Likert scale (totally disagree coded as '1', totally agree coded as '5'), we measured whether or not scenario visualization:

(i) Clarifies innovative care scenarios;
(ii) Gives insight in the care platform's proposed functionality;
(iii) Gives insight in the platform's technical requirements;
(iv) Eases giving feedback on the development of the platform.

Beforehand, non-negative outcomes were expected, except for (iii). Question i-iii are inspired on the FICS framework (clarification of interaction (i), functionality (ii) and technical /service requirements (iii)) whereas question iv is used to assess the clarification the ISV was supposed to bring.

The results of the evaluation are shown in Table 1. Constructs i, ii, and iv (clarification, functionality and feedback) scored positive attitudes. Scores on construct iii varied. This indicates disagreement between the stakeholders on whether or not the visualization gave insight in the technical requirements of the platform. This is somewhat surprising as it was not in the aim and implementation of the visualization to clarify technical details, so a more 'confirming' disagreement was expected.

Table 1. Results of survey for non-acedemic (NA) and academic focus group members. Likert-scale items for constructs i-iv coded as 1..5. Panel answers vary on usefulness for giving insight into technical requirements, but are more consistent on clarification of innovative care concepts, usefulness for giving insight into the systems' functionalities, and to ease in giving feedback on the presented system.

Respondent	Clarify (i)	Functionality (ii)	Technical (iii)	Feedback (iv)
NA_1	5	4	3	4
NA_2	4	3	3	2
NA_3	5	4	1	5
NA_4	4	4	3	4
NA_5	4	4	3	4
A_1	3	4	2	5
A_2	3	4	4	4
A_3	4	4	3	4
A_4	4	4	3	4
A_5	4	5	2	5

In addition, the respondents gave comments on how they would use the visualization themselves. Three respondents indicated that they would use it for receiving feedback. Three other users wrote down they would use it for communication with end users or stakeholders. Two indicated that use for visualization of working processes would be appropriate. Use for organizing, clarification, brainstorming and usability for patients were all mentioned once.

Finally, three respondents remarked that 1) it would be more difficult to visualize web portals with this tool, 2) though it can be an aid for people without background knowledge to clarify, it is still a risk when the visualization differs from the final realization, and 3) the visualization was attractive.

6. OUTLOOK

Although this paper focuses on interactive scenarios for discussion and development purposes, ISVs may just as well play a role in later phases of the product lifecycle. In this section, we discuss two challenges based on expert talks with the focus group members and other professionals from care industry:

(i) using ISVs to train users in the operation of an actual system once implemented, and
(ii) connecting ISVs to data sources, to generalize the use of ISVs to other settings (in our case study e.g., using it for exercise purposes), and to make the ISV even more dynamic.

For many years, visualizations are used for training purposes, e.g. in flight simulation. Hence, an ISV can be used to demonstrate usage, and train users of the system. A challenge in this regard is to train end-users, in our case elderly and nurses, in using the home care system by demonstrating the functions and by showing them the overall functioning of the system. In this way, users may gain understanding on what the care system offers to the different parties involved. Using the ISV, it is e.g. shown how the home care system reminds the client on medicine intake using one of the screens, or how the system notifies care professionals in case of emergencies.

On the other hand, ISVs can also be extended to make use of other information sources such as web services, electronic client dossiers or training programs. This way, interactive visualizations can be used for more applications. An example related to the case study is the use of ISVs in physical exercise training environments: the client follows exercises shown in the virtual home. The ISV becomes an instrument for giving feedback at training sessions, which opens up new possibilities for teletreatments.

Currently, we are developing a physical exercise training program, aimed at COPD patients. These patients must follow the example movements of a virtual agent in the 3D environment. The movements to follow have been captured by the XSens Moven motion capturing suite [www.xsens.com] and will be used in the virtual environment to demonstrate the exercises in a customizable way. E.g., speed and number of repetitions can easily be modified. A further step would be to give direct feedback (via the screen) or indirect feedback (by a professional) on the training performance, by measuring exercise execution using motion sensors. In this way, the exercise execution can also be stored, or the exercise program can be carried out simultaneously among different clients in their own homes.

7. CONCLUSION

This paper proposes interactive scenario visualization (ISV) as an extension of scenario-based design methods. We showed how interactive scenario development can be used beneficially in the process to develop a new telemedicine system. ISVs make scenarios more dynamic in storytelling and they are more flexible than other visualization techniques. Scenario visualizations can be created rapidly nowadays, are appealing to work with, and can be extended or modified easily without the need of producers or experienced professionals. In a small evaluation, we noticed that the ISV was received well with respect to clarification and functional aspects: It seems to be promising to use interactive scenarios to clarify care innovations, to give insight in care system functionalities and to gain feedback of stakeholders. However discussing technical requirements of a system to be designed is more difficult; such discussions do not benefit from scenario visualization directly. Attention should be paid to the degree to which the ISV is self-contained: a visualization that runs autonomously requires more audiovisual guidance than the ISV developed in the present study. The current state-of-the art enables generalization of the use of ISVs to other settings and domains.

ACKNOWLEDGEMENT

Fred Vuijk, Herjan Treurniet, Douwe Bart Mulder and Jan Kolkmeier (students at the Remote Monitoring and Treatment Group) are acknowledged for their contributions to the creation of the visualizations. This work is part of the IOP GenCom U-Care project (http://ucare.ewi.utwente.nl), sponsored by the Dutch Ministry of Economic Affairs under contract IGC0816.

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Resultaten Enquête scenario visualisatie (n = 10)

- Workshop UT 2-7-10 (n_1 = 7)

- Bezoek Orbis 27-7-10 (n_2 = 3)

0. Organisatie:	IBM	IZIT	Mobihealth	Orbis	Isolektra	UT
	1	0	2	2	0	5

1. Scenario visualisatie - verduidelijkt innovatieve zorgconcepten.

Helemaal niet mee eens	*Niet mee eens*	*Neutraal*	*Mee eens*	*Helemaal mee eens*
0	0	2	6	2

Gemiddelde: 4.0 Standaarddeviatie 0.67

2. Scenario visualisatie – biedt inzicht in de functionaliteit van het getoonde systeem.

Helemaal niet mee eens	*Niet mee eens*	*Neutraal*	*Mee eens*		*Helemaal mee eens*
0	0	1	*7*	<-1->	1

Gemiddelde: 4.1 Standaarddeviatie 0.50

3. Scenario visualisatie – biedt inzicht in de technische benodigdheden van het getoonde systeem.

Helemaal niet mee eens	*Niet mee eens*	*Neutraal*	*Mee eens*	*Helemaal mee eens*
1	2	6	1	0

Gemiddelde: 2,7 Standaarddeviatie 0.82

4. Scenario visualisatie – Maakt het mij gemakkelijk om feedback te geven op de ontwikkeling van het getoonde systeem.

Helemaal niet mee eens	*Niet mee eens*	*Neutraal*	*Mee eens*	*Helemaal mee eens*
0	1	0	6	3

Gemiddelde: 4,1 Standaarddeviatie 0.88

5. Ik zou zelf visualisatie-hulpmiddelen inzetten voor:

1- Organizing...

2- Verkrijgen feedback stakeholders

3- Support communication between end-users and solution providers. Brainstorm about innovative scenarios, before technical implementation

4- Bespreken van nieuwe solutions met klanten. Het verduidelijken van onze visie op de gezondheidszorg

-5 menselijke processen. Usability voor patienten. Te onderzoeken of dit ook werkt voor care I would like to use it to show my work (making service plan) and visualize it te steps of tailoring process -profs.

-.

6- Gathering user requirements for the future system.

7- (Werk)processen flow

8- feedback op ontwikkeld (geschreven) scenario -- > verbetering aanbrengen.

SAMENGEVOEGD”

Organizing	I	1
Feedback	III	2,6,8
Communication prov/user	III	3,4,5
Brainstorming	I	3
Clarification	I	4
Working processes	II	5,7
Usability for patients	I	5

6. Opmerkingen:

- Mooie tool!

- Denk dat scenario’s voor webportalen hier minder goed mee te visualiseren zijn.

- Het kan een hulpmiddel zijn voor mensen die geen achtergrondkennis hebben om te verduidelijken. Risico is wel als visualisatie afwijkt van de uiteindelijke realisatie

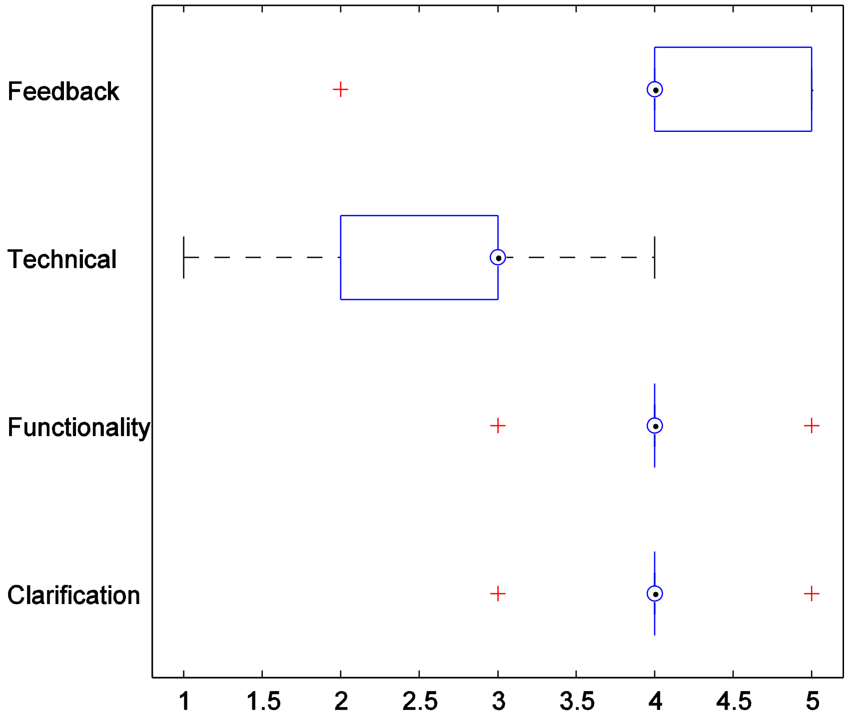


Figure XX. Box-plot of questionnaire results. Median indicated by dot, outlier by cross. Panel answers vary on usefulness for clarifying technical requirements, but are more consistent on clarification of innovative care concepts, usefulness for clarifying functional requirements, and for giving feedback on the presented system.

Question	**Mean**	**St.dev.**
1. Clarification	4.0	0.67
2. Functionality	4.1	0.50
3. Technical	2.7	0.82
4. Feedback	4.1	0.88

DIT sort warden zijn zinloos bij lickert. Zegt niks (echt)

ORDINAL data (!e -n-e)

permissable: median, percentile

what could be done.

sample-size n=10.

calculate p non-negative met alfa .95 dat is een t-test en die is niet toegestaan.

calculate chi-square? Kan om te zien of er systematisch verband is tussen 2 variabelen.

overeenstemming tussen de invullers:

spearman's rho

cronbachs alfa niet relevant: meet interne consistentie bij meerdere vragen over zlefde concept. Dat is hier niet het geval.

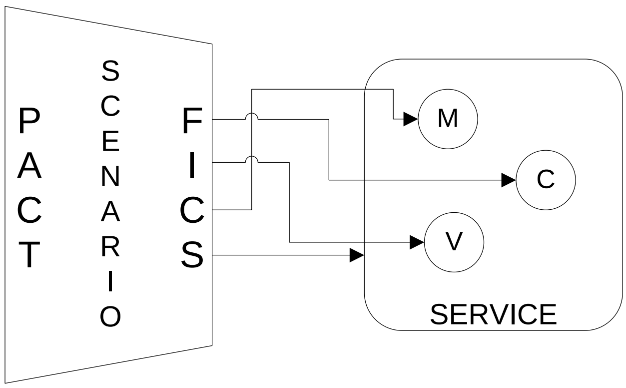
Descriptives

			Statistic	Std. Error
CLARIFY	Mean		4,00	,211
	95% Confidence Interval for Mean	Lower Bound	3,52	
		Upper Bound	4,48	
	5% Trimmed Mean		4,00	
	Median		4,00	
	Variance		,444	
	Std. Deviation		,667	
	Minimum		3	
	Maximum		5	
	Range		2	
	Interquartile Range		1	
	Skewness		,000	,687
	Kurtosis		,080	1,334
INS_FUNC	Mean		4,00	,149
	95% Confidence Interval for Mean	Lower Bound	3,66	
		Upper Bound	4,34	
	5% Trimmed Mean		4,00	
	Median		4,00	
	Variance		,222	
	Std. Deviation		,471	
	Minimum		3	

	Maximum		5	
	Range		2	
	Interquartile Range		0	
	Skewness		,000	,687
	Kurtosis		4,500	1,334
INS_TECH	Mean		2,70	,260
	95% Confidence Interval for Mean	Lower Bound	2,11	
		Upper Bound	3,29	
	5% Trimmed Mean		2,72	
	Median		3,00	
	Variance		,678	
	Std. Deviation		,823	
	Minimum		1	
	Maximum		4	
	Range		3	
	Interquartile Range		1	
	Skewness		-,806	,687
	Kurtosis		1,237	1,334
FEEDBACK	Mean		4,10	,277
	95% Confidence Interval for Mean	Lower Bound	3,47	
		Upper Bound	4,73	
	5% Trimmed Mean		4,17	
	Median		4,00	
	Variance		,767	
	Std. Deviation		,876	
	Minimum		2	
	Maximum		5	
	Range		3	
	Interquartile Range		1	
	Skewness		-1,465	,687
	Kurtosis		3,613	1,334

RESULTS OF DISCUSSION AND OPMERKINGEN.

Discussion



Respondent	Clarify	Functionality	Technical	Feedback
NA1	5	4	3	4
NA2	4	3	3	2
NA3	5	4	1	5
NA4	4	4	3	4
NA5	4	4	3	4
A1	3	4	2	5
A2	3	4	4	4
A3	4	4	3	4
A4	4	4	3	4
A5	4	5	2	5

Results of focus group survey: Nonacademic (NA_1..NA_5) and Academic (A_1..A_5) respondent results. Likert-scale items coded as 1 (totally disagree) to 5 (totally agree).

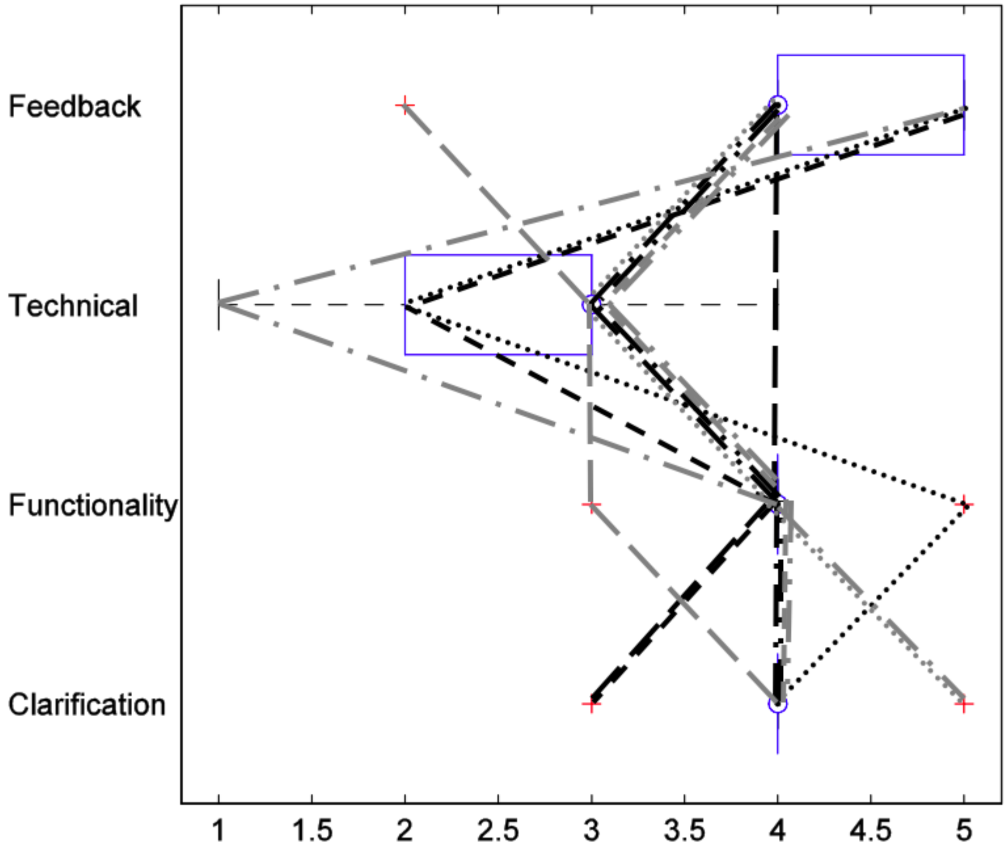
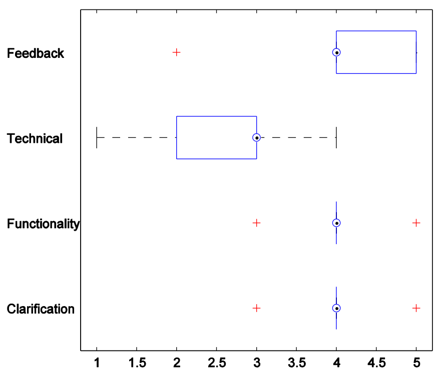


Figure 4. Box-plot of questionnaire results. Medians indicated by dot, outliers by cross. Panel answers vary on usefulness for clarifying technical requirements, but are more consistent on clarification of innovative care concepts, usefulness for clarifying the systems' functionalities, and for giving feedback on the presented system.



interessant maar weinig raakvlak:

Patrizio Tatti, Eldon D. Lehmann. Diabetes Technology & Therapeutics. March 2001, 3(1): 133-140. doi:10.1089/152091501750220118.

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grendel games endoscopy virtualisatie omgeving. Geen publicaties gevonden.

Use 3d worlds themselves in ehealth
http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2553247/