Challenges in Modeling Non-Functional Requirements Collaboratively

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Abstract. Modeling Non-Functional Requirements (NFRs) is a challenge, mainly from the subjective character of their elicitation. Modeling NFRs as a collaborative process may create a consensus among stakeholders, combining modeling and elicitation in a learning cycle. However, the collaboration presents challenges, such as the different viewpoints, the influence of creativity, the modeling tool, the domain/scope of the target software system, and the fundamental aspects of configuration management. This paper reports our observations on collaboratively modeling an intentional model for the handling of fruits and vegetables in a futuristic kitchen.

Keywords: Non-Functional Requirements, Qualitative Requirements, Intentional Modeling, Collaboration, Configuration Management, Smart Homes.

1 Introduction

i* stresses the "why" rather than only the "what" in software production [1], focusing on organizational actors' dependencies to address system goals. Since groups may perform software modeling, a collaboration between stakeholders contributes to achieving a shared understanding of the desired software through negotiation, the convergence of ideas, and the identification of problems [2]. However, despite the increase of collaboration in agile practices for RE [3], few initiatives support collaborative modeling [4]. To the best of our knowledge, collaboration in modeling NFRs lacks more research. Collaboration has been primarily used in software coding, mainly due to configuration management (CM) support, which is central in software evolution [2][4][5][6]. Leite [7] stresses the characteristics that make the prevalence of coding over the modeling, as platforms such as GitHub promotes collaboration, traceability, and transparency [5].

Notwithstanding, collaborative modeling initiatives (browser and cloud-based solutions) are starting to come out, using CM strategies similar to coding environments [4].

This paper reports on observations gathered during an experience of modeling the handling of fruits and vegetables in a futuristic kitchen[1]. This work relies on requirements information elicited by a vignette based interviews, and a questionnaire. This information was elicited from prospective stakeholders of a 2045 kitchen [9]. Using a

[1] The vignette technique [8] (Fig. 1) uses small impressionist narratives to enhance understanding.

model-driven elicitation [10], which fills in the model in question (***i**** model), we modeled as softgoals (Fig. 2), the qualities found in the questionnaire answers. Later, we evolved the model by adding awareness quality by reusing the Awareness catalog [11].

Imagine a kitchen in 2045 where the fruit and vegetable delivery service is done through a Drone that uses the kitchen window to leave orders. For food to be ready for consumption, they must go through a food belt to follow a cleaning, organization, and cooling process.

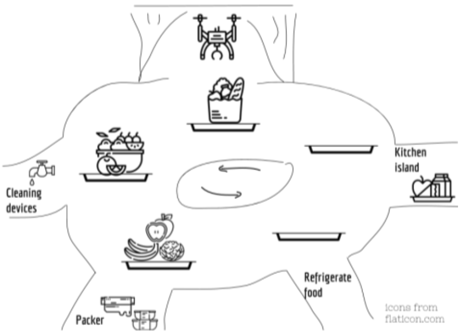

Figure 1. Futuristic Kitchen – Vignette

2 Background

Several authors report concerns when dealing with NFRs. Yu [1] states that NFRs are updated late in the development process, or are developed in parallel, separately, from the functional design. Chung & Leite [12] stress that real-world problems are heavily dependent on quality issues e.g. “productivity, cost, security, esthetics ...” Ameller et al. [13] argue that NFRs elicitation is an iterative process, corroborating with the view that it has to be addressed throughout the system construction. Modeling with a focus on "why" creates uncertainty in modelers as NFRs are subjective and may conflict among themselves [14]. Thus, as modeling does not happen in a vacuum, it is influenced by the modeler's background [15]. As a result, different groups of modelers may produce different models, with different quality. Prescriptive methods [16] are a possible strategy to improve quality, but as pointed out by [17], this is a function of several socio-cognitive issues affecting modelers.

We modeled a futuristic kitchen within a group with different level of expertise in ***i**** [1]. In [18] we provide the history of our modeling process. Besides the elicited qualities (Table 1), we had a particular interest in the awareness quality [11], given the level of automation in a 2045 kitchen. Believing in Linus law ("given enough eyeballs, all bugs are shallow"), the group collaboratively built the model. We describe the challenges observed during this process.

3 Modeling Software Awareness for Susana

Susana is the name given to a humanoid that will be able to act as a Requirement Engineer by 2045 [9]. We follow Lutz vision [19], in which near to 2045, we would have requirements elicitation tasks performed by humanoids specialized in certain types of software. As such, Susana was conceived to understand kitchens of the future. Our ***i**** model describes the knowledge needed by this humanoid.

3.1 Eliciting Future Needs

Previously, a four-member research group worked towards the understanding of what a humanoid elicitor would need to meet inhabitant's needs [9]. Would it use the same techniques that RE engineers apply nowadays? What knowledge would it need to attend the future demands? As such, the group used a vignette to conduct interviews with 11 stakeholders that identified 10 future needs that we modeled as objectives in Fig. 2. Later, we used a questionnaire with 109 people to evaluate and suggest other needs [9]. They suggested another 32 needs.

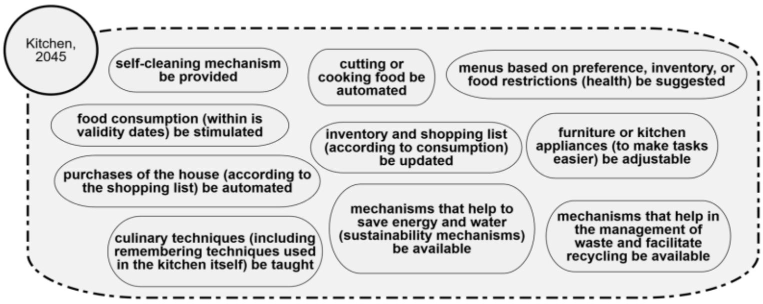

Figure 2. Ten future goals for the 2045 kitchen

Fig. 3 shows the modeling of the elicited goals [9] with relation to one goal of the actor (Kitchen, 2045) in Fig. 2: *menus based on preference, inventory, or food restrictions (health) be suggested*.

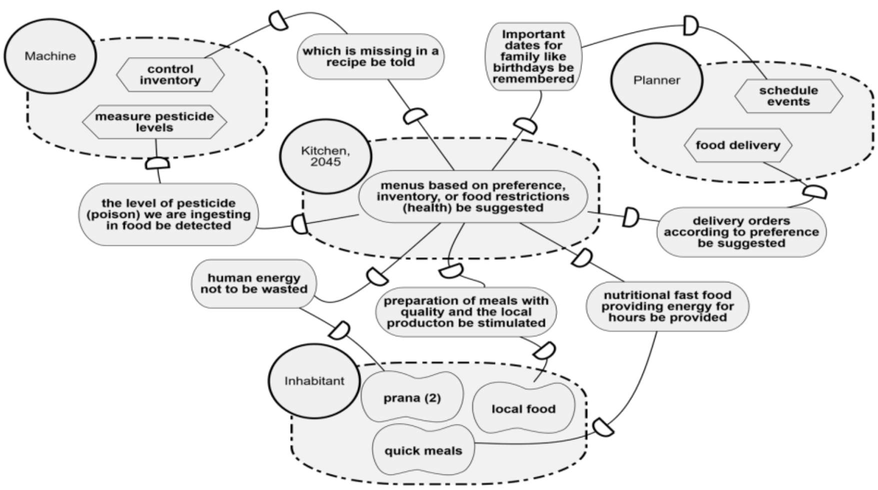

Figure 3. ***i**** model for the Kitchen 2045 goal - *menus based on preference, inventory, or food restrictions be suggested* [2].

[2] Prana: (in Hindu philosophy) the force that keeps all life in existence. Source: Oxford Dictionary

3.2 Non-functional Requirements for Susana

Three researchers (including the two co-authors) performed the collaborative modeling aiming to understand how a Softgoal Interdependency Graph (SIG) for software awareness [11] would be part of Susana's reasoning. We modeled collaboratively and synchronously (in a research meeting), using GitHub as support for Configuration Management.

With the previous elicited information [9], we conducted a series of meetings. The meetings used an ***i**** model-driven elicitation [10], anchored on the information of needs [9], and the awareness catalog [11]. After a post mortem review, we found that the model produced [18] (Fig. 4) was highly influenced by three correlated NFRs, explicitly stated in Fig. 2: sustainability, automation, and self-cleaning. Others NFRs were implicit since they were inferred from the elicited information (Fig. 2). Table 1 traces the inferences used to name the implicit NFRs.

Table 1. Future NFRs of the kitchen in 2045

Explicit NFR	self-cleaning, sustainability, automation
Implicit NFR	efficiency (facilitate recycling, consumption in validity dates, shopping list updated), learnability (taught), timely (automated), usability (adjustable)

Concerning the effort, about 90 person-hours were spent in modeling without awareness, and about 54 person-hours were used to add awareness [1111] (See the gray elements in Fig. 4).

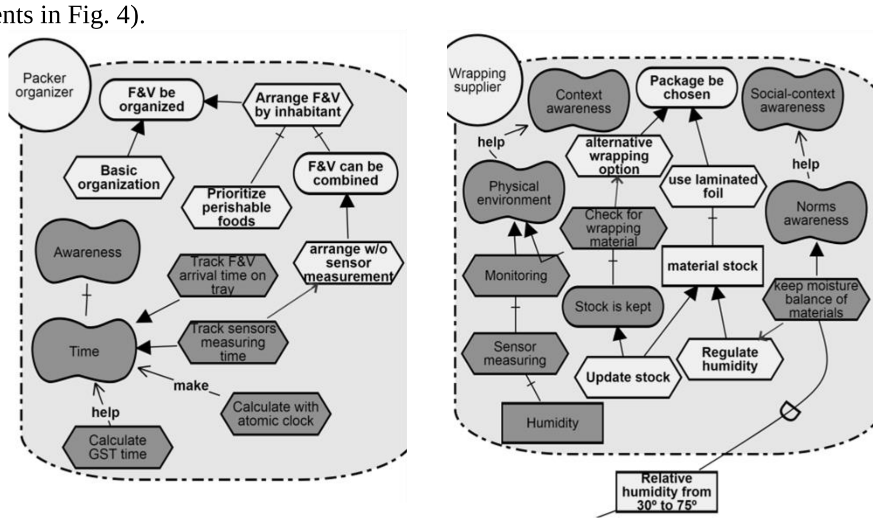

Figure 4. Part of the model for handling fruits & vegetables (F&V)[18]

Briefly, the meetings' dynamic was: 1) Project the latest version of the model using the tool [20]. 2) Free use of creativity. 3) Modeling in the whiteboard while discussing the proper ***i**** notation. 4) What we agreed in was persisted by the tool [21]. 5) Making notes of tool limitations related to usability, as well as limitations of the ***i**** language.

This dynamic intertwined modeling with elicitation based on the needs and the Awareness SIG.

On three occasions and outside the meetings, two members of the group performed the verification of the model produced in meetings. Also, before some of the meetings, one of the researchers performed asynchronous work on the tool [21].

4 Challenges in collaborative modeling of NFRs

During the modeling, we observed the following challenges: the support of a modeling tool, the different viewpoints, creativity, the problem scope, and, through all of them, the basics aspects of CM.

An **intentional modeling tool** for web browsers suited our needs for ease of access and the portability of a web browser, together with the freedom provided by a cloud server to persist the models. Also, the availability of the source code of a tool [20] allowed us to adapt it to our needs. We also needed to differentiate the characteristics related to software awareness by using other colors of elements, and arrows as proposed in [11]. The result is an adapted tool [21].

We use GitHub CM to **track versions of models** made by similar initiatives such as GenMyModel [4]. However, we see as a challenge for the tool, a feature that would allow the model to evolve using visual comparison with previous versions. This limitation affected our model when we began to add aspects of awareness [11] that triggered more significant changes in the model, thus limiting the easy revision of the reasoning used in previous versions.

Leite [15] believes that requirements must be obtained using **different viewpoints**. We used the diversity of opinions, which allowed identifying the identification of missing information and conflicts in the requirements. In our experience in the meetings, we learned to understand each modeler point of view, so that the model evolved more where we had more consensuses and shared understanding; for instance; in the objectives related to the organization of food and packaging (Fig. 4).

However, a challenge encountered in reaching consensus among modelers is the strong influence of explicit NFRs (Table 1) that cross multiple goals, as seen with the sustainability NFR. The implicit NFRs, such as learnability and usability if used, could have taken our model to another result. Another challenge is the time it takes to reach consensus when the requirements for addressing NFRs are being invented [22] in a model-driven elicitation. In time constraints projects, a challenge would be to deal with situations where all points of view win. It is important to stress that different viewpoints strategy is a validation process in itself [15], which corroborates the Linus law. However, it is a challenge to identify errors in an asynchronous collaborative environment.

Creativity in collaboration is a quality that can be affected due to some concerns. As we follow an ***i**** model-driven elicitation, we found that in the first meetings, the expertise of one of the members had a negative influence on the equilibrium of interests of modelers [23]. The necessary training in the technologies used [24] also restricts creativity. In this sense, the tool [20] often reduced our reasoning for lack of undo function. Another technology, such as GitHub CM, which will be central to the evolution of modeling editors [4], poses a challenge as it allows for individual collaboration in an asynchronously way. A positive influence towards creativity was the fact that all modelers had similar knowledge of the problem [24], as the group also participated in the elicitation of needs performed previously [9].

Finally, the **scope of the problem** is a challenge when dealing with NFRs. We have identified the lack of modularization techniques to help model-driven elicitation. With more NFRs in the model, whether due to the reorganization of already modeled structures or the addition of new ones, dependency links grew. With more links, visualization became a problem, which led to problems in model understanding.

5 Conclusion

This work presents some of the challenges in NFRs collaboratively modeling, but other studies may be done on the model evolution as registered in the GitHub CM [18]. Future work should address challenges to improve the tool [20]. On the other hand, we are continuing the modeling of Susana as a means to better understand how awareness driven software may profit from intentional modeling.

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