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Network based requirement specification

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ABSTRACT

Requirement specifications often resemble static design briefs. Whereas such unequivocal references are essential, the dynamics of product development require more insight, nuancing, flexibility and evolvement. This encompasses relative importance, context and provenance of the requirements related to the different stakeholders involved. In developing responsive requirement specifications, the so-called actor network is employed. Such a network maps the relevant stakeholders over the development life cycle, thus expressing the set of requirements as a whole, as well as the evolving coherence between them. This publication demonstrates the structure and purpose of network based requirements and the added value for product developers.

1. Introduction

Designers tend to maintain a love–hate relationship with requirement specifications. Especially in the earlier phases of the design cycle, such specifications can impose uncomprehended constraints on the designer's work and they may act as straitjackets in the process. On the other hand, requirement specifications are indispensable and cogent ways of bringing guidance, transparency and structure to a project.

Additionally, an adequate requirement specification is an indispensable means of communication in any design project. This immediately explains the two-faced interpretation of requirement specifications as experienced by designers: the specifications are essential interfaces between stakeholders in a design project, but at the same time, they depend on, and evolve with, the course of that same project. This renders them rather intangible, as they appear fixed and unsettled at the same time.

In environments that are characterised by relatively static product portfolios, consistent markets and ways to address those markets and well-understood consumer behaviour, a requirement specification for a new product (variant) may be a pre-defined, sound and secure steppingstone for the entire design cycle [1]. In more volatile environments, for products that involve high risks (because of complexity, or because of sheer production volumes) or for products without clear-cut prospects, the requirement specification will be accordingly dynamic, while requiring much more flexibility and adaptability. This directly influences all decision-making processes in the design cycle.

Here, the amalgamation of product definition and requirement specification becomes relevant. The product definition depicts the consequences of decisions that have already been reached, and information on possible alternatives for subsequent decisions. The requirement specification must render insight in the criteria that have been instrumental in those decisions and will be decisive in future decisions. Given the amount of interrelations in and between parts of the product definition and the requirement specifications, a structured overview over the entangled realm of decisions is difficult to maintain. A network-based approach can be instrumental in facilitating all stakeholders, by offering them adequate information related to a design decision, while integrating all perspectives involved.

2. Requirement specification

Many design methods assume that at the beginning of a design project, a univocal, structured and well-balanced requirement specification is available, or can be established [2]. Such requirement specifications address the quantifiable variables of the design process, leaving as little room for interpretation as possible. This aligns with the converging character of (especially) the embodiment and detail phases of design trajectories, but it contradicts the uncertainties and equivocalities that are inherent to the earlier phases. In those earlier phases, requirements that are inordinate or over-specified may inadvertently bias decision-making or conceal auspicious solution directions for unclear reasons. This mainly happens if the requirement specification is 'written in stone' or is formulated in a way that is either too specific or too detailed. Such specifications may inadvertently fix constraints and possibilities too early in the process. This is even more true for specification types that inherently are not quantifiable as long as there is no embodiment of the solution that is available for evaluation or testing. For example, consumer or user behaviour is difficult to capture in terms of outlined requirements, although they are extremely relevant for, or even leading in, the design project.

Consequently, requirement specifications need flexibility and elaboration as concerns the level of aggregation. The required flexibility relates to the fact that requirement specifications need

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to evolve with the design project. The more information becomes available on the chosen solution (path), the more the requirement specification can be tailored to the actual product definition in the design project [3]. Thus, the requirement specification must evolve with the product definition and the project.

Next to this flexibility, it is important to have different ways of expressing requirements [4]. Dependent on the level of aggregation, requirements can refer to specific variables with specific values or to general depictions of what variables may be appropriate in the requirement specification of a product. For this reason, the requirement specification is subdivided in a number of levels (see Fig. 1) [5]. The first level comprises of the pre-imposed requirements of (external) stakeholders:

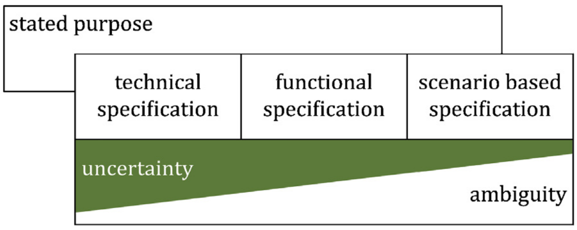

Fig. 1. Cohesion of requirement specification types.

- The stated purpose is the predefined, formalised and static reference of a development process. It reflects the design brief, i.e. the original description of the design problem. With this, the stated purpose depicts keynotes (including e.g. laws, marketing and safety) that cannot be meddled with.

Based on this, the other types of specification are established:

- Technical specifications are complete and unequivocal expressions of product requirements. In general, technical specifications express quantitative or easily quantifiable demands (e.g. thickness of a suitcase shell).
- Functional specifications provide a description of desired future product behaviour. In general, they express concrete demands to abstract product models (e.g. allowed consequences of a suitcase that falls from a staircase).
- Scenario based specifications depict a 'possible future', thus placing emphasis on the product's environment and the interaction between product and that environment. Product behaviour is indicated in terms of what the environment, e.g. the user, can do with a product and how it will interact (e.g. what might happen to the suitcase on a trip by aeroplane).

The rigour and expressiveness decrease from stated purpose to scenario based specification. Scenarios have a narrative character as compared to the structure and tangibility of the stated purpose and technical specifications. Consequently, scenarios give more room for interpretation and haggling. Translating scenarios via functional requirements into technical requirements is not straightforward: by definition, univocality and quantification entail subjectivity. The same stakeholders have to converge to the appropriate requirements, while executing the design cycle. Thus, product developers aim at problem solving, while requiring adequate ways of capturing, framing, converting and embedding the contingencies involved in selecting the individual (values of) requirement specifications to consider.

To be useful, the requirement specification must be reliable. However, it always contains uncertainty. Here, uncertainty means that consequences, extent or magnitude of circumstances, conditions or events are unpredictable – or credible probabilities to possible outcomes cannot be assigned. Although too much uncertainty is undesirable, manageable uncertainty gives the freedom to make creative decisions. This directly relates to the phasing in development cycles, ranging from the fuzzy-front-end to the nitty-gritties of near-production stages. Interestingly enough, this coincides with the observed need for quantification when evolving from scenarios via functional to technical specifications, and the convergence while doing that.

At the same time, requirement specifications also suffer from ambiguity; ambiguity is the situations in which it is not obvious or predictable which entities/uncertainties play a role. As such, it is a kind of second order uncertainty.

By neglecting or omitting uncertainties and ambiguities, designers may easier converge to adequate solutions, however, they cannot asses the risks involved [6]. This leaves designers with the need to integrate uncertainties and ambiguities in requirement specifications that evolves with the project: the product definition always correlates with the requirement specification and vice versa, under influence of the decisions of all stakeholders.

3. Stakeholders

All activities in product development, whether aimed at specifying requirements or establishing the related product definition, involve contributions from a variety of stakeholders within and across the borders of an organisation. Inversely, a stakeholder is any (legal) person that has an interest in and influence on a product development cycle. These stakeholders continuously influence and decide on the future life cycle of the product under development. This specific life cycle, however, is interwoven with many other life cycles, of e.g. related products, its packaging [7], other projects, organisations or people. Thus, stakeholders encounter a large variety of interrelated variables and requirements, in different states of evolvement, belonging to many different life cycles. Moreover, all stakeholders have their interests in different, possibly conflicting, aspects. Where the rationale of a design decision might be perfectly valid from one specific viewpoint, this might not be inherently true for all the other perspectives involved. For example, a packaging concept that is perfect from a marketing perspective may be infeasible from a production point of view. Therefore, all stakeholders need to collaborate and negotiate to reach consensus on the set of decisions and the way in which requirements will be met. It is advisable to reach such consensus through logical reasoning rather than through sheer hierarchical privilege or dominance.

There are many reasons for this process of reasoning and aligning to stagnate. Well-known causes of inefficiency and ineffectiveness in the process are stakeholders forced to await input or decisions of others, misapprehensions caused by divergent terminologies, myopic attempts for local optimisation and the infamous 'force of habits'. To reach an adequate set of requirements and a correlating product definition, stakeholders collectively need to understand each other's motives and consider on (the rationale behind) contradicting proposals. Stakeholders must establish, retrieve and reconsider decisions in relation to their rationale and the context that constitute a decision. Here, it is important to discern the consequences of individual decisions in a larger context, preventing from inadvertently imposing constraints on other decisions or stakeholders.

To achieve awareness of the entire product development cycle and the subordination of individual interest to a higher purpose, a non-hierarchical overview is required that provides insight in the entire set of decisions, alternatives, justifications, trade-offs and interrelations. In this, it is the relation between these elements and the different viewpoints involved that will provide additional context to the information. In employing these relations, the information that is required to reach a decision adequately can be identified, variants can be considered and consequences of decisions may be predicted. Such a non-hierarchical structure can also simultaneously adapt to different viewpoints, doing justice to all stakeholders involved.

4. Actor network

The development of an overview as mentioned in the previous section should not be hampered or biased by imposing a priori