

# Ubiquitous RE: Breaking down Barriers

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## Category

Vision

## Target Group

We will present our vision of how Requirements Engineering (RE) should evolve in order to break down the barriers impeding its smooth performance and hindering the creation of innovative business in the Digital Transformation era. The target group of our presentation therefore comprises researchers and practitioners interested in the future directions of RE approaches.

## Context

We have witnessed many changes in business and society caused by the application of digital technologies. As software engineers, we have driven these changes on several occasions. Software systems have moved from isolated systems via corporate systems to services available on the Internet; they have spread across numerous business domains and conquered the entertainment industry. Thanks to embedded and mobile technologies, software is everywhere, even when we are jogging in the neighborhood. Digitization versus Digitalization, Digital Revolution versus Digital Transformation: It really looks like a word play, but people are discussing the differences and tracking the trail from Digitization via Digitalization to Digital Transformation. For our purposes, the definition of Digital Transformation suffices: the profound and accelerating transformation of business activities, processes, competencies, and models aimed at fully leveraging the changes and opportunities of digital technologies and their impact across society in a strategic and prioritized way [1]. Fraunhofer IESE has actively participated in projects aimed at Digital Transformation. Two prominent project areas are Smart Ecosystems [2] and Digital Villages [3].

In this context, we also envision the transformation of the way RE is being performed.

## Problem

In the past, RE researchers and practitioners aimed at simplification, local automation (meaning the automation of individual tasks), and some level of innovation. In the Digital Transformation era, it is necessary to break down barriers and to go:

- *From geographic colocation (B1) to worldwide distribution (U1)*<sup>1</sup>: While companies can decide about the geographic location of their units and

about whether or not to outsource their software development, strategic ecosystem partners can be located anywhere in the world. As a consequence, requirements engineers should be capable of conducting RE activities with end users remotely and even asynchronously, depending on the time zone.

- *From wishing for experienced end users (B2) to empowering newbies (U2)*: Digital Transformation aims at having an impact across society. In Digital Villages, the end users are mainly citizens who have never contributed to the development of a software system and have no special technology affinity.
- *From wishing for well-understood processes and groups of end users (B3) to accepting openness (U3)*: The business value of a software ecosystem relies on new processes made possible only by orchestrated cooperation among partners. However, concrete partners might still be unknown or might change; even if the actual partners are known, their contributions to the ecosystem might still be unclear/undecided. In this context, groups of end users and processes tend to be not well understood; requirements, in the sense of a perceived need for a functionality or quality attribute, might not exist.
- *From supporting direct interaction with a set of representative end users (B4) to also allowing a crowd to indirectly provide requirements (U4)*: In some situations, the group of users might be so heterogeneous that it might be easier and more effective to allow anyone to provide potential requirements than to try to identify a set of representative end users or think about appropriate personas.
- *From focusing on software (B5) to holistically taking into consideration people, things, and services (U5)*: Nowadays, people, things, and services can have a digital identity and be interconnected via the Internet (IoPTS [4]). Things can communicate with humans, web services, and other things. This requires a completely different way of understanding the context and the components of a software system.
- *From dealing with one domain at a time (B6) to dealing with multiple domains (U6)*: A software ecosystem is, by nature, cross-domain, as partners

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<sup>1</sup> The letters B and U followed by a number are used to identify barriers and dimensions of ubiquity, respectively.

from different sectors with different services decide to join strengths and offer upper-level services. A classic example is an agriculture ecosystem with partners from the chemical industry and from the machinery and equipment industry.

In addition, RE should undergo digitalization in order to be part of the Digital Transformation. This goes beyond the local automation aimed for in the past, e.g., through automatic verification of requirements, and requires new approaches for obtaining requirements in a completely digital way.

## Solution

RE should become ubiquitous and address the transformations stated in the previous section through dimensions of ubiquity. We envision a set of RE approaches that address one or more of these dimensions and can be combined depending on the project characteristics. An initial set of approaches at different stages of maturity is discussed below. The creative and human aspect is very strong in some dimensions and clearly indicated.

- *Everywhere (B1→U1)*: In this dimension, we envision the development of software environments to support Virtual RE, so that stakeholders can engage in RE activities regardless of their physical location and time zone. Motivation mechanisms are of crucial relevance here. Elements of Virtual Reality [5] and Gamification [6] might be useful.
- *Everyone (B2→U2)*: Civilian RE is what we want to call the set of approaches in this dimension. We envision the adaptation of Participatory Design [7] techniques originally used to support public administration as well the development of further Participatory Design techniques aimed at empowering citizens to actively participate in the process of Digital Transformation of their cities.
- *Everything (B5→U5)*: As already mentioned, RE approaches for IOPTS are expected to holistically take into consideration people, things, and services. It would be beneficial to have top-down and bottom-up approaches. A Digitalization Potential Analysis could be a top-down, human-based approach for defining the vision of the software solution, whereas automatic context modeling followed by the derivation of context-aware requirements would be a bottom-up, automated approach.
- *Openness (B3→U3) & Cross-Domain (B6→U6)*: Approaches for performing RE for software ecosystems are under development and are expected to address these dimensions. In any case, there will be a shift of the skills needed by requirements engineers: Instead of eliciting requirements, they will need to strongly support stakeholders in shaping the ecosystem vision, by proposing requirements and validating them with different partners. Creativity techniques [8] are expected to

play an important role, while software tools can support the search for the right partners and the mapping of relevant concepts across domains.

- *Global Automation (B4→U4)*: Crowd RE [9] stands for performing RE with the support of a crowd of stakeholders, usually current or potential users, in an automated way. It does not require direct interaction with a set of representative end users or the creation of personas. Groen et al. [9] propose two complementary mechanisms: User Feedback Analysis and Usage Mining. Both mechanisms have the goal of extracting requirements for the evolution of the target software and allow stakeholders to contribute requirements without being aware of it.

As the approaches themselves are either under development or merely ideas, it is too early to investigate how to combine them. The ultimate goal is to support the collection or creation of requirements anywhere, ideally in an unconscious or implicit way, but at least in a fun way.

## What is new?

Some of the RE approaches mentioned in the previous section have already been published (e.g., Crowd RE [9]), but this contribution provides an overview of the future directions for RE from our mixed practitioner / researcher perspective. The idea of looking at common assumptions for the smooth performance of RE and how these pose barriers to the development of the software solutions required nowadays is new. The purpose of making RE ubiquitous by defining dimensions of ubiquity that break down these barriers is also new.

## References

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