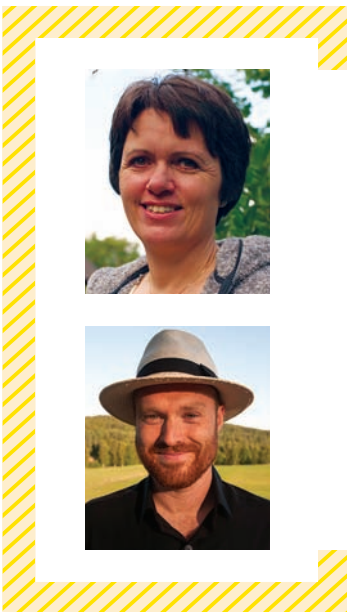




# Aligning Requirements and Testing

## Working Together toward the Same Goal

Elizabeth Bjarnason and Markus Borg



**THE TESTER SHOULD** be a requirements engineer's closest ally. The tester is the one who verifies the product and ensures it fulfils the requirements you specified. He or she instinctively reacts to unclear and unverifiable requirements and can be an asset in your requirements work. Even so, we've observed that in many companies, the direct connection between requirements and testing is weak. The requirements engineer often isn't available to the tester to discuss and clarify requirements. One example is when the analyst who defined the current product's requirements has moved on to projects targeting the next product generation.

Also, testers often have no insight into when and how requirements are defined. They might not know who wrote the requirements they're verifying against. They might even ask the developers how to interpret the requirements, which short-circuits the assignment to verify that the product meets customer and user needs. Subsequently, requirements engineering and testing (RET) alignment is a significant challenge for many companies. As one developer said, "Alignment is very important in creating the right system"<sup>1</sup>—the system the customer and users require and expect.

The challenge of coordinating requirements and testing activities in-

creases with the product's and development organization's size and complexity. Operating in a domain with fast-changing requirements and short delivery cycles also exacerbates the difficulties of RET alignment. This situation becomes more common as organizations use continuous delivery to keep up with fast-moving market demands for functionality and quality. Weak RET alignment's effects include late discovery of customer issues, rework done late in the development cycle, project delays, and the loss of customers and market share.

A skilled requirements engineer might manage to capture customer and user requirements through solid requirements-engineering practices. But these intentions might get distorted as the requirements trickle down to development and test engineers. Similarly to the telephone (or Chinese whispers) game, requirements are often misinterpreted and understood differently from what was originally intended.

Frequent communication is necessary to ensure that a project works continually toward the same goal and requirements. The testers must be connected to the organization's business and requirements side to ensure good RET alignment through continuous requirements communication. Simply "throwing requirements over the wall" won't ensure

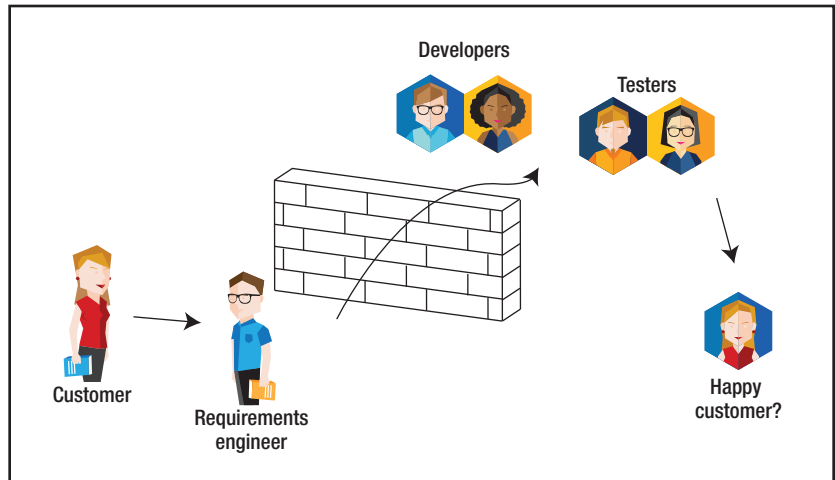
a good end result and happy customers (see Figure 1). Instead, RET alignment must occur throughout development for a smoother ride. We've noticed that experienced requirements engineers (irrespective of the development model) stay in touch with their developers and testers throughout a project. In this way, they avoid unpleasant surprises at the end and ensure that the final product meets the requirements.

## RET Alignment

RET focuses on aligning requirements and testing by improving the connection between them. This strengthens project coordination by ensuring that everyone is pulling in the same direction. RET alignment can be achieved when the project members have a uniform understanding of the requirements throughout the project. But there's no one-size-fits-all solution. Each development organization is different and requires a solution tailored to its needs and characteristics.

A project's size and development model influence the practices that can be applied to achieve RET alignment. A project's organizational side also has a large impact on how to handle alignment. For example, geographically distributed projects require more extensive artifact-centric practices than small-scale, colocated ones. Finally, the regulations around safety-critical systems affect the return on investment for tracing and documentation and thus the motivation to implement alignment practices.<sup>1</sup>

Next, we illustrate these variations in project context by presenting three RET solutions we've encountered in practice or research. For each solution, we outline an example scenario and describe the challenges.



**FIGURE 1.** Simply “throwing requirements over the wall” won’t ensure a good end result and happy customers. Alignment of requirements and testing activities must occur throughout development.

## Using Test Cases as Requirements

Agile developers often say, “We have no requirements,” meaning that they don’t use traditional requirements specifications. Instead, they often invent requirements during development and document these as test cases—reducing the overhead of maintaining a separate requirements specification.<sup>2</sup> Using an active artifact in the shape of test cases as an executable specification helps keep the documentation up to date.

We’ve seen several variants of this practice in industry, ranging from simply having weak requirements engineering to applying a full-fledged behavior-driven approach that uses acceptance criteria (test criteria) in the requirements discussion with the customer. The time frame and format for defining requirements affect how well test cases function as requirements documentation. When the targeted product’s functionality and quality levels are defined and expressed as test cases before implementation be-

gins, they can be a uniting source of information. This isn’t the case when requirements specification occurs during testing (postimplementation) as a reengineering activity to capture the implemented requirements. The test cases can then serve as documentation of legacy functionality in future projects but not as a communication channel in the current project.

This practice requires good, continuous communication. In particular, strong collaboration must exist between the testers and the business roles, which interact with the customers. Customer involvement is a known challenge in agile development. Developers and testers often complain about lack of access to customers and insufficient requirements information. Also, communication between the business and development roles is challenged owing to varying perspectives and technical knowledge. Terminology and language differences cause frustration and misunderstanding of customer requirements and expectations.



Using a predefined structure for expressing requirements in a style that mimics or reflects development artifacts can support communication between customers and developers. This approach occurs in behavior-driven development, in which it reduces the risk of distortion when customer requirements are evolved into test cases. In this approach, customers and developers together express goals as user stories and define the acceptance criteria that must be fulfilled for the customer to sign off on the implemented functionality. This requirements format is then predefined and fixed, and enforced by tools that also produce a machine-executable specification based on the requirements. In this way, alignment is achieved through close, continu-

ous collaboration between the customer and development-side roles, supported by a lean documentation process closely coupled to the collaboration and to testing.

## Harvesting Trace Links

In safety-critical projects, requirements–test traces must be maintained to provide evidence for safe operation—and safety certification. However, trace links shouldn't simply rot in documents after the safety audits. They're hard currency in RET, formalizing how requirements and test cases relate to each other. As such, they can serve as input to tools supporting test planning when requirements change. Or, they can support change impact analysis—for artifacts on both sides of RET.<sup>3</sup>

Large projects traditionally involve huge amounts of documentation, and managing a large document space is a common RET challenge.<sup>1</sup> Although the agile movement reflexively questions documents, for some projects information overload remains an ever-present threat—without documentation there will be no certification. Furthermore, if the safety standards require an independent testing organization, direct communication can't be the main point of RET alignment. This context requires artifact-centric practices.

Traceability is fundamental to safety-critical development. But the work is tedious, and the developers who do the tracing don't always see its value. In a tracing-heavy organization, they need to perceive tracing as worthwhile—otherwise they'll view it as just a tax that must be paid. It's possible to provide developers with the direct value of their tracing effort through tools that employ the documented trace link information. Examples from the research frontier include support for software evolution, such as change impact analysis and test selection. Increased awareness of tracing's benefits and personal gains might motivate developers to keep trace links up to date—thus reinforcing artifact-centric RET alignment.

## Reducing Distances


You can improve communication in the requirements telephone game by shortening the distances between key players. One way to do this is by bringing people physically closer together while bridging temporal and sociocultural gaps. This applies to both global software development, in which project members are at different sites, and colocated develop-

ment.<sup>4</sup> We recommend frequent face-to-face meetings between distributed roles and teams. To maximize the return on the travel costs, these meetings should occur early during projects.<sup>5</sup> Physical meetings establish trust and team cohesion that facilitate later communication both face-to-face and through indirect channels such as videoconferencing and email. You can also strengthen communication with an offsite testing team by assigning a team member to be an information broker who stays at the main site for a while.

When direct communication is limited, the requirements specification's quality and solid requirements-engineering practices are even more important. A clear, accurate requirements specification is vital when you're communicating with offshore testers. Another important aspect of RET alignment over distances is facilitating project information's findability. For this, you can use tools that support distributed work. Defining a knowledge management strategy is also important—determining what information is produced and used, by whom and when, and where it can be found. Quick, concise access to documentation and project updates is essential—even more so when engineers don't meet at the coffee machine.

Coordinating requirements is challenging whether it's with an offshore testing team or in a colocated project. In both cases, a host of distances make communication, coordination, and control difficult. The geographical distance between requirements engineers and offshore testers is the obvious challenge. But other types of distances also affect this communication—for example, cognitive differences in knowledge, reasoning, and priorities.

It's helpful for development organizations to consider what type of distances exist between teams and individuals and how these affect the communication of requirements.<sup>4</sup> Addressing some of these distances is relatively easy—for example, by providing desks to guests to encourage physically distant project members to spend more time in a project area. Reducing other distances can be more difficult. However, awareness of distances in itself can improve communication. For example, a requirements engineer who's aware of a cognitive distance regarding domain knowledge can adapt his or her communication by providing a richer requirements description and checking how the tester interprets the requirements.<sup>4</sup>

**W**e encourage managers, requirements engineers, and test engineers to consider RET alignment as an important factor in delivering the right product. Good alignment is achieved by connecting people and by connecting artifacts. It's vital to ensure that requirements are communicated effectively throughout a project through the use of effective communication channels. The ideal balance between direct and artifact-centric communication varies and depends on the specifics of the development organization and product domain. Size, complexity, requirements velocity, quality level, and organizational location all must be taken into account in customizing an organization's requirements and test practices. Our vision for the future includes an empirically based body of RET knowledge that can guide industry practice and help projects achieve good RET alignment. 

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