

Development of a tool to improve traceability between requirements and verification and a study of different development models

In the development of a product or system it is important to know that all the requirements are verified in order to maintain a good reputation and standard. All the systems and components that makes up a product has to be verified by different tests and be carefully documented. Often documentation is not as prioritized as it should be nor the traceability between the requirements and the verification events.

In the process of verification and validation people often have difficulty in separating the two terms, a great way of easily understanding the differences are by asking two different questions:

- *Verification: Are we building the system right*
- *Validation: Are we building the right system?*

In a very complex industry it is also important to choose the right development model. The different models handle verification and validation differently. In a submarine verification process it is more important to find errors early on, in comparison to smaller less complex products, due to a less flexible and more expensive development. The different development models covered by this article are the V-model, the Waterfall model and finally the Agile model.

Today ThyssenKrupp Marine Systems AB and other companies do not have a perfect traceability between requirements, validation and verification when building their submarines. However they are all working on improving this situation.

To get a clearer understanding of ThyssenKrupp Marine Systems AB's situation and their problems concerning verification, validation and traceability for their requirements, a study of their developing process was conducted with a traceability

examination. This was mainly by an extensive literature research and qualitative interviews with employees at ThyssenKrupp Marine Systems AB. A benchmark was also carried out on how other companies in other industries work to maintain and improve traceability. The benchmarking was also carried out through literature research and interviews.

The employees interviewed were from different departments with different roles, but the focus was mainly on project leaders. Some work, documentation and planning programs were also investigated first hand, but there were limitations in this process due to security reasons and limited access.

This investigation made it possible to develop a new traceability tool, Trace. Trace is a planning tool, which creates a clear traceability between the requirements and the different verification events showed in figure 2.

In Trace a requirement can be followed from the start to the end. The program clearly shows the users were the requirement/requirements will be tested, which requirements that are tested at a certain test, if it is finished and if not where it failed, and more information needed to get a good traceability during the whole project

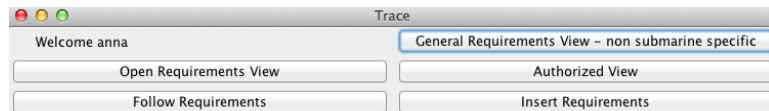


Figure 1- Trace start view

As showed in figure 1 Trace starts with some options. Open requirement view will only present the requirements that are not confidential and therefor a list made in this view can be shown to all of the employees. The Authorized view will show all the requirements that the one in logged are allowed to see, a list her cannot be showed to all. The General requirement view- non submarine specific will create list of the requirements that are not submarine specific, these could be personal safety requirement or work environmental requirements.

Follow requirements, is a function were you can find and change a requirement and insert requirement lets you insert a new requirement. The figure 2 will show you the options that will be presented after choosing either Open requirements view or Authorized view.

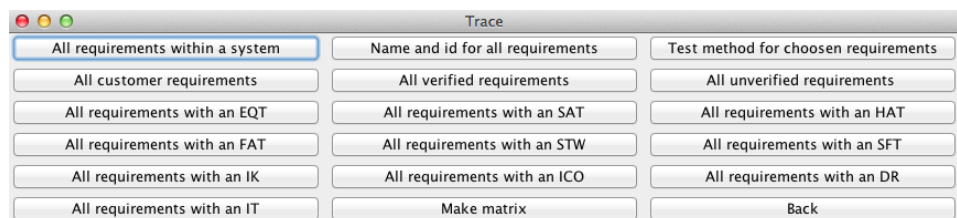


Figure 2- Options view

In this view the employee can generate lists of requirements within a specific system, category or at a specific event. The option to create a matrix of all requirements and their specifications is also a possibility.

The conclusion of the benchmarking is that ThyssenKrupp Marine Systems AB and all most of the other companies interviewed lack a complete traceability between requirements and verification. These companies are all looking for ways to improve traceability and have mapped out to different extent were traceability is missing.

A reason to why they have this common problem is that the consumption and technology today is different from 10 years ago. In today's society companies are expected to produce faster than before and the products life cycles are shorter, this leads to changes in the developing methods. And here the traceability gets lost in the change.

Another conclusion is that different industries and varieties of companies need to use different developing models. The three models in the study were, the Agile model, the V-model and the Waterfall model.

The Agile model is an iterative and incremental method to design and build activities for engineering, and new products. The projects are often highly flexible and designed in an interactive manner; the most common example is agile software development. Designing in an agile manner requires capable individuals and close collaboration with supplier and customer. In industries where technology is changing and improving fast and where time to market is short; the agile model is a necessity.

When to use the agile model:

- In developments where new changes frequently has to be implemented.
- In projects where the planning time is limited.
- In industries where the products and techniques used are constantly changed and improved.

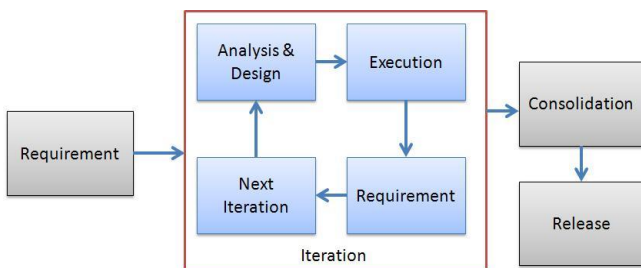


Figure 3-Agile model workflow

The V-model is a graphical model of a system lifecycle that have been used since 1980 in many different industries. The left side of the "V" represents the requirements, and the creation of the system, whilst the right side of the V

represents the validation and how the parts are incorporated. The V model is used in industries where it is important to break down the requirements to subsystem To later on build it up on the right side on a verifying and iterative way. There is always a correspondence between the right and left side of the V.

When to use the V-model:

- The V-model should be used for projects where requirements are clearly defined and fixed.
- The V-model should be chosen when sufficient technical resources are available with needed technical expertise.
- In projects with high confidence of customer, since, no prototypes are produced, there is a very high risk involved in meeting customer expectations.

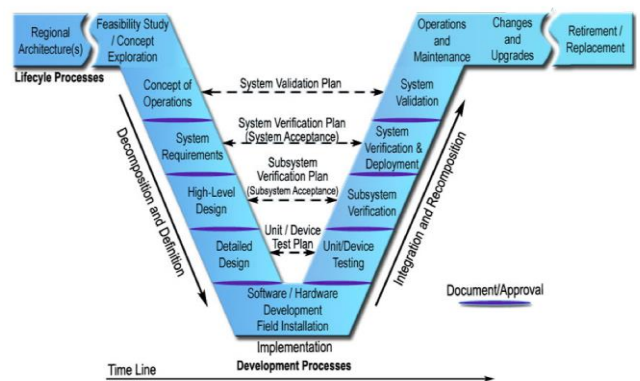


Figure 4- V-model workflow

The waterfall model, also referred to as a linear-sequential life cycle model, is a sequential design process in which progress is seen as flowing downwards like a waterfall. Waterfall model main characteristic is that the project relies on a strict plan, often defined by the company or organization's leadership, extensive documentation and has a clear working through project time. The phases are Requirement, Design, implementation, Verification and Maintenance.

In all of the interviewed companies there were in some extent avoiding the waterfall model, since the developing phases do not overlap. The waterfall model makes changes very hard and in some cases impossible.

When to use the waterfall model:

- Requirements are very well known, clear and fixed.
- Product definition is stable.
- Technology is understood.
- There are no ambiguous requirements.
- Ample resources with required expertise are available freely.
- The project is short.

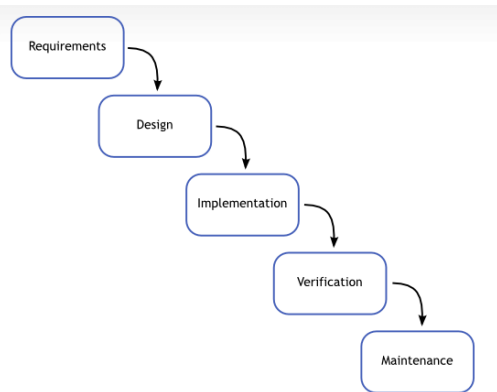


Figure 5-Waterfall model workflow

