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A3 Overviews for Communication in Development Projects – a Study from a Small Norwegian Company

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Abstract. The German Navy's current Mine Countermeasures (MCM) systems are reaching the end of design life, and new systems are to be developed. WTD 71, the German Navy's Research Institute, is to do this development and is investigating possibilities for unmanned systems. In this process, H. Henriksen AS has been chosen as the industrial partner to develop and manufacture the physical system. In this paper, we explore how the A3 Architecture Overview (A3AO) method can be used for communication in developing a new unmanned minesweeping system. Through interviews and observations in a small Norwegian company in the marine and naval industry, we found challenges related to system and project overviews. These were mostly caused by communication challenges and a lack of common understanding among stakeholders. We also identified a knowledge gap in the subject of minesweeping. To support the challenge of not having an overview of the system, we developed and tested A3AOs. Further, we altered the traditional A3AO to communicate the subject of minesweeping and an overview of the project. The industry resources appreciated the overviews and reported that they believed such methods would create value in projects.

Keywords. A3 Architecture Overview, A3AO, A3 Overview, Project Overview, Mine warfare, Minesweeping, Unmanned Systems, System Development.

Introduction

Domain. The legacy Mine Countermeasures (MCM) systems in the German Navy are aging and reaching the end of design life (Luck, 2023). The same goes for many other Navies in the Western world and NATO (Midtgaard & Nakjem, 2016), (Grotnik, 2023). This has given increased interest in and funding for the development and procurement of new MCM systems (van Vossen et al., 2019), (Naval News Staff, 2019). The ongoing war in Ukraine and the mining of the Black Sea also put more focus on the Navies' capacities related to Mine Warfare (MW). For new acquisitions, many countries are now aiming to have their next generation of MCM systems unmanned to reduce risk to personnel, as well as reduce operational costs and emissions (van Vossen et al., 2019).

As part of Germany's process of renewing its MCM capacity, its Navy's Research Institute (WTD 71) is assigned the task of exploring possibilities for developing a new unmanned minesweeping system. Through close cooperation with the Norwegian Navy's Research Institute (FFI), a small Norwegian company, H. Henriksen AS, has been chosen as an industrial partner for the development of the new system.

Mines, Mine Warfare, and Mine Countermeasures. Sea mines or naval mines, hereafter just called mines, are explosive devices placed in or under water to harm or sink an asset by triggering and detonating when the target object gets within their proximity. Figure 1 shows an overview of the most common types of naval mines. The use of mines in Naval Warfare is called Mine Warfare (MW) and is a very effective and efficient way of doing naval warfare. This is because mines have a relatively low cost and can be deployed without direct interaction with the enemy. Even though mines have sunk more American ships than submarines, ships, and planes combined (Edwards & Gallagher, 2014), the greatest effect of mines is the psychological effect that blocks the enemy from passing (Greer & Bartholomew, 1986). Mine Countermeasures (MCM) are the measures taken to tackle the mine threat. It can be divided into minehunting and minesweeping. Minehunting aims to search for mines to neutralize or avoid them. Minesweeping clears a mined area without prior detection of the mines to ensure safe passage.

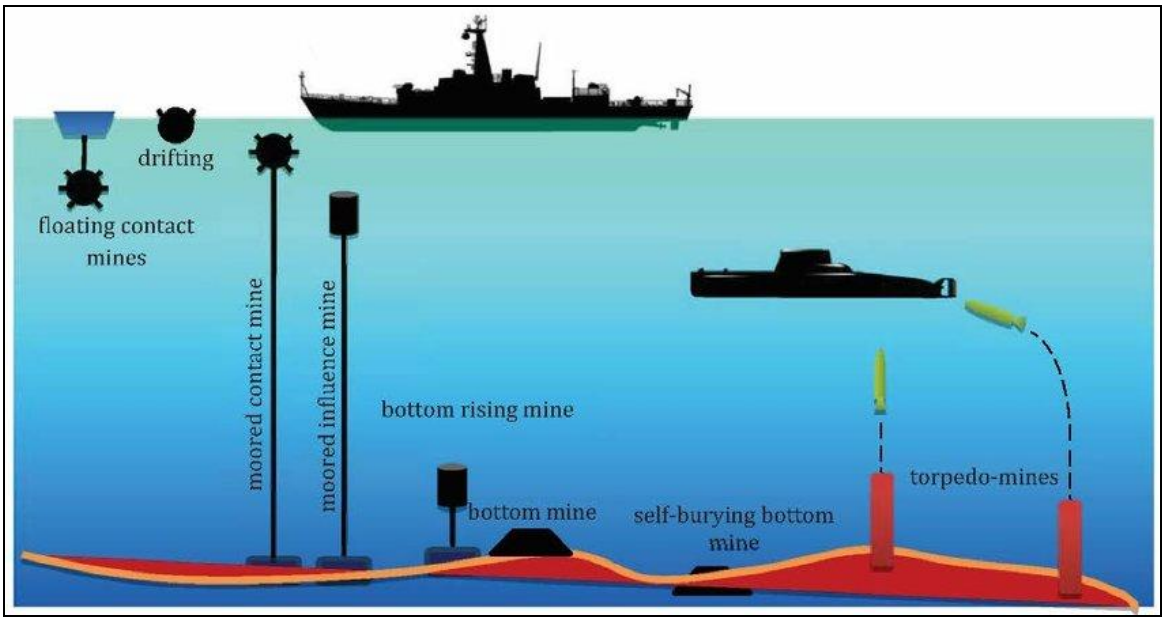

Figure 1. An overview of different Mines (Szturomski, 2015)

The Industry. H. Henriksen AS (hereafter just called Henriksen or the company) is a small family-owned mechanical workshop dating back to 1856. They started as a forge making canons and harpoons for the whaling industry in Tønsberg, Norway. Over the years, the company has evolved to become a preferred supplier and close business partner to many actors in the naval and marine industry world-wide. Currently, Henriksen employs about 70 people, of whom roughly 25 are in the Research and Development (R&D) department. The rest is spread out over various administrative positions, production, and logistics. Due to the company's relatively small size, the distances, both physical and non-physical, are not so long between the different departments nor between workers and management. As the company expands into the area of making unmanned systems, a whole new set of challenges emerges in its everyday work. This is mainly caused by the increased complexity, but also because the existence and use of such systems are still not that prevalent, and thereby, people may not have a common understanding of them.

Wehrtechnische Dienststelle - 71 (further referred to as WTD 71 or the customer) is the German Navy's Research Institute. Located in Eckernförde, on the German coast of the Baltic Sea, a group within WTD 71 is working on MCM systems. With its own unmanned surface vehicle (USV), it is also investigating possibilities for unmanned MCM operations.

A3 Architecture Overview (A3AO) is a systems engineering method created by Daniel Borches in 2010 (Borches, 2010a) to collect and communicate a system's architecture. Inspired by Toyota's A3 reports for LEAN (Roser, 2016b), the A3AO is made on a standard-sized A3 sheet (297 x 420 mm). Borches developed a template and guidelines for showing a complete system by modeling and

describing some different views like Functional overview, Physical overview, Design decisions, and Key system parameters (van de Laar, n.d.). The goal of the A3AO is to enable all stakeholders to have the same overview and understanding of a system throughout its whole life-cycle.

This paper uses the term "A3AO" for A3 Architecture Overviews, which describes a system's architecture in accordance with Borches' template and recommendations. When the A3AO method is altered to communicate other overviews than a system's architecture, it will further be referred to as an A3 Overview (A3O). It will also mention other specific types of A3 Overviews like, e.g. A3 Project Overview (A3PO).

The Problem. There are many challenges when starting a new development project. One of the main challenges is to ensure good communication between stakeholders, both internally in the company and externally. Borches supports this, as he found that the lack of system overview, ineffective knowledge sharing, finding the required system information, and communication across disciplines and departments are some of the major barriers that many industry partners and stakeholders have in common when evolving a system (Borches, 2010a). One important way to limit possible mistakes and delays is to ensure that the stakeholders have a good overview of, and a common understanding of, the subject and context, the system of interest, and the project itself. The need for this common understanding starts already at first contact with a potential customer. How the system is planned to work, what its intended purpose is, and how this is realized are described by its architecture. A lack of a common understanding of this architecture is often the root of costly and time-consuming project delays (Honour, 2004).

The increased interest in unmanned systems is evident in the market (van Vossen et al., 2019). Since many people and companies are not yet familiar with unmanned systems, this adds to the challenges of having a common understanding of the system's architecture.

Understanding and having an overview of the project and its execution is crucial to reaching goals such as customer satisfaction as well as meeting delivery dates and budgets. However, this can often be challenging if the different stakeholders do not have a common understanding of the project. Poor handovers or communication may cause a lack of this common understanding and information loss (Taleb et al., 2017).

Research Questions. The challenges described above then lead to the following Research Questions:

1. What are the challenges Henriksen is facing in system development today?
2. How can the A3AO method be adapted and used to support the challenges Henriksen is facing?
3. How are the A3 Overviews perceived by the industry?

The paper has so far introduced the domain, MCM, the industry, and the A3AO method. It has revealed some problems that have formed the research questions. Further, it will look into the background of the A3AO method and how it has been used in industry. The research conducted will be described before its results are presented and discussed. Lastly, the paper rounds off with a conclusion and gives recommendations for further research on the area.

Background

Architecture overview. Only a small part of the knowledge about a system's architecture is made explicit through different documents, diagrams, presentations, and system history. The rest remains tacit knowledge in people's minds (Borches, 2010a). The part of the architecture that is made explicit forms the architecture description. An architecture overview is a way of gathering tacit knowledge and architecture description and recording the essence of this in one place. Figure 2 shows how Borches and Bonnema see where the content and knowledge in an architecture overview come from, and Figure 3 shows the architecture overview in relation to the architecture description. Muller (2021), recommends using IEEE 1471 (IEEE, 2000) for guidance on creating an architecture overview. Borches (2010a) introduced and suggested the use of an A3-sized architectural overview, the A3 Architecture

Overview (A3AO). Some of the main benefits of this method over many other architecture overviews are the compact format and the extended use of models and figures instead of many pages of text.

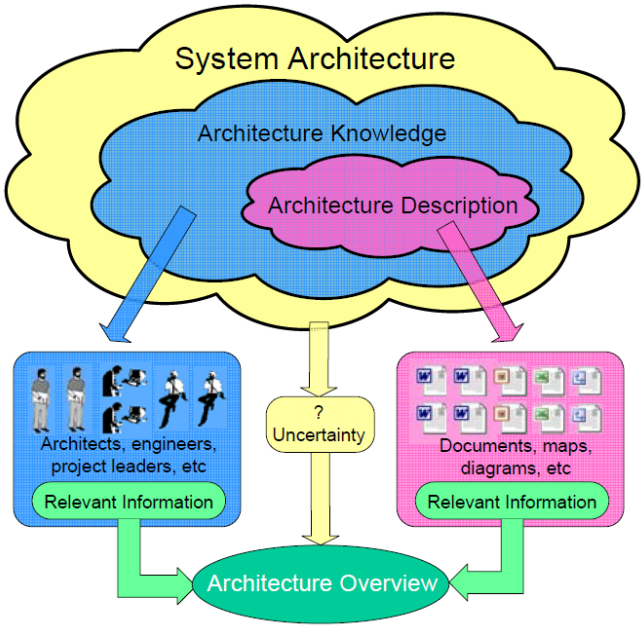

Figure 2. Creating the Architecture Overview (Borches & Bonnema, 2008)

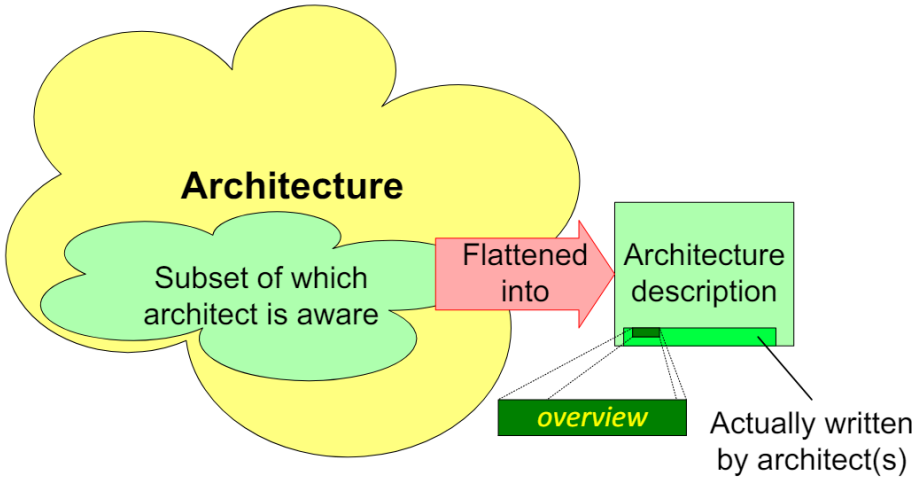

Figure 3. Architecture Overview as part of the architecture description (Muller, 2021)

How A3AO has been used in the industry. In 2010, Daniel Borches published his PhD thesis, in which he introduced the A3 Architecture Overview (A3AO) method (Borches, 2010a). Since then, extensive research has been done on this method, mostly in Dutch and Norwegian companies through universities (Frieswijk, 2018), (Muller & Falk, 2018) but also in other parts of the world, e.g. (Liao, 2021). The traditional A3AO method was originally intended for reverse architecting and has been used in research to validate this, e.g. (Wiulsrød et al., 2012), (Boge & Falk, 2019), and (Haugland & Engen, 2021). However, some have used it for slightly different purposes. Boge and Falk (2019) used the A3AO as a project management support tool. Kooistra, Bonnema, and Skowronek (2012) used it for the description of Systems of Systems (SoS), which is similar to what Pesselse, Hofman, Simons, and Muller (2019) did when placing the System-of-interest (SoI) in its context in the Level 0 A3AO. ‘t Hooft, van Omme, de Kroon, and Bonnema (2020) have also altered the A3AO to communicate how to apply Systems Engineering (SE).

The A3AOs have mainly been designed for printing on (A3-sized) paper, but suggestions and research have been made to develop them as interactive artifacts for digital use (Brussel & Bonnema, 2015), (Liao, 2021), (Johanssen & Zhao, 2019).

Project Overview and Communication in Projects. In Project Management Body of Knowledge (PMBOK), the Project Management Institute (PMI) defines a project as "*a temporary endeavor undertaken to create a unique product, service, or result*." (Project Management Institute, 2017). The Systems Engineering Handbook supports the PMBOK definition but also mentions resources and requirements; "*... an endeavor with defined start and finish criteria undertaken to create a product or service in accordance with specified resources and requirements*" (Walden et al., 2015). Elsewhere, PMI says that a project is "*a series of structured tasks, activities, and deliverables that are carefully executed to achieve a desired outcome*.", and that project management is "*the practice of using knowledge, skills, tools, and techniques to complete a series of tasks to deliver value and achieve a desired outcome*" (Project Management Institute, 2024). Regardless of definitions, two key criteria for successful project management are having a good overview and being able to communicate well with stakeholders (Boge & Falk, 2019). There are many tools for project management that allow the Project Manager (PM) to have a good overview of timelines, budgets, hours spent, etc. (Aston, 2024), (Smith & Williams, 2024). Getting a more holistic overview of the project often requires the user to find key information in many different locations and from other sources. This can often be, e.g., the Project Charter, which, at a high level, "*ensures a common understanding by the stakeholders of the key deliverables, milestones, and the roles and responsibilities of everyone involved in the project*" (Project Management Institute, 2017). Having a good tool that gives an overview supports communication with other stakeholders. In the construction industry, PMs spend about 90% of their time communicating with project participants (Taleb et al., 2017). It is reasonable to believe that PMs spend most of their time communicating with others in other industries as well. Given this, it is no wonder that research shows that 55% of PMs identify communication as the most critical factor for project success (Project Management Institute, 2013).

Muller presents a Project Overview Canvas (occasionally also referred to as A4 Project Overview (A4PO)), shown in Figure 4 (Muller, 2023). This was developed from a method used in a Deutch company (ASML) under the name "*Bollenplaat*", where project overview information was shown on one A4 sheet of paper. The intention was to make the author of the Project Overview, i.e., typically the Project manager, condense the high-level information of a project into an overview that fits on an A4 sheet of paper. This is a good exercise to get an overview of a project, and it forces the author of the A4PO to think carefully about what information is most relevant to the user or reader. As mentioned, Boge and Falk tested using the traditional A3AO as a project management tool, but that was mainly to ensure that stakeholders in the project context had a common understanding of the System of Interest (Boge & Falk, 2019).

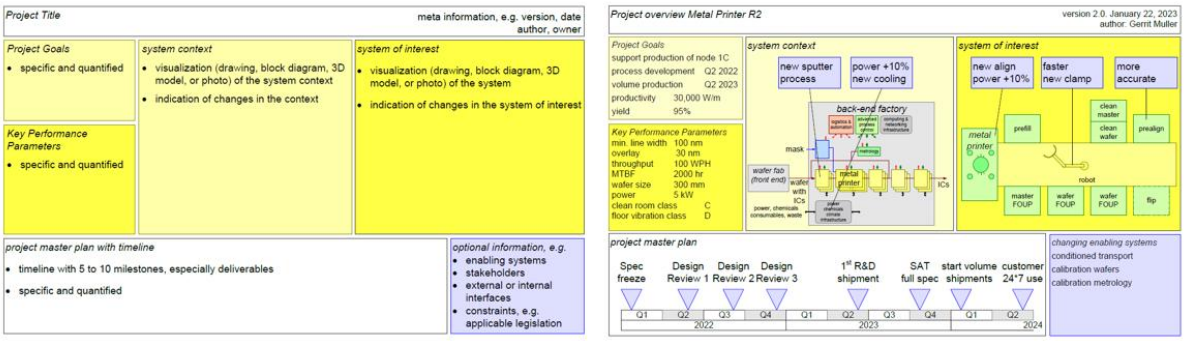

Figure 4. The A4 Project Canvas presented in the SEMA6202 course at USN in autumn 2023 (Muller, 2023) forms the basis for parts of the new A3 Project Overview. The left-hand side shows the A4PO template, and on the right is an example.

Research Method

Research Method. The research was conducted as a combination of stakeholder interviews and observations made by the first author in the everyday work as part of the development team, so-called action research (Baskerville, 1999), (Avison et al., 1999). The research was done using an Industry-as-Laboratory approach (Potts, 1993). Since the first author was a fully contributing part of the design and development team, he was able to get close to the relevant stakeholders.

The research process involves several steps. Figure 5 shows how this research was conducted. Since the data collection methods were observation and interview, the results were analyzed and interpreted to find common ground and similarities in the different stakeholders' answers. The following describes the different steps of the research. Subsequently, the results are presented.

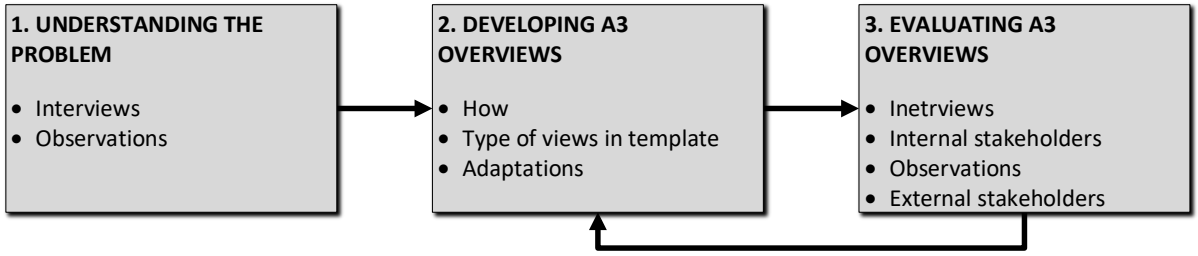

Figure 5. Step-by-step process of the research.

Understanding the Problem. Communication between stakeholders in a development project is important to ensure that the designed system fulfills its purpose. The first author has been working for more than ten years as a project engineer on multidisciplinary projects in the marine and offshore industry. During these years, the first author has seen many examples of costly delays and other errors due to misunderstandings between stakeholders. To gain more in-depth understanding of the problem, we performed two series of interviews with company resources. Firstly, we conducted interviews with stakeholders in the company to map any possible knowledge gaps amongst the stakeholders in the R&D department or pain points in their daily work. Secondly, we performed an additional interview to map where the interviewees turned to get an overview of the System of Interest.

Developing A3 Overviews. The A3 Overviews were made in MS Visio with Borches' A3AO Cookbook template (Borches, 2010b) as a basis and inspiration. It was quite early clear that the template had to be customized a bit to fit the project and the purpose. Several sets of A3Os were fabricated, both more traditional A3AOs and an A3O communicating the concept of minesweeping. The first author also developed an A3 Overview for projects, i.e., A3 Project Overview (A3PO). This was based mainly on Borches' A3AO (Borches, 2010b) and Muller's A4PO (Muller, 2023). The idea was to create a template that could be used by the Project Manager (PM) and the early project development team. The goal was to create a project overview that condenses the project information and the Project Charter, similar to how Muller shows the architecture overview relative to the system architecture and the architecture description in Figure 3.

Evaluating A3 Overviews. To evaluate the A3Os, we conducted interviews with several internal stakeholders. These stakeholders were typically other engineers in the company's R&D department, but also others, e.g., members of the management group. Throughout the period of this research, the first author also had the opportunity to talk to other external stakeholders. These stakeholders were not interviewed; they were only discussed with or interacted with. Observations were made on what difficulties and challenges exist when talking to stakeholders with another background or understanding of a topic. These external stakeholders were representatives from the customer, a patent lawyer, and an illustrator, to mention a few.

Data collection. In total, 25 different employees in Henriksen were interviewed in four separate interviews. 28 candidates were presented with artifacts or asked to answer the questions, but 3 of the candidates did not have time for the planned interviews. Nevertheless, the 25 employees who were interviewed constitute about 35 % of all the company's employees. The interviewee group covered about 75% of all resources in the R&D department. Resources from the production and warehouse are not considered the primary target group for such artifacts, i.e., the A3Os, and were not interviewed. Taking this into consideration, more than 70% of all relevant internal stakeholders were interviewed in one or more of the four interviews. The interviewees were divided into four groups: Project managers/Line managers, Project engineers, administrative management, and Others. Project managers/Line managers typically include resources such as the R&D manager and project manager. Project engineers are engineers in the R&D department. Administrative management includes resources such as the CEO, CFO, Business Developer, etc. The last group, i.e., Others, includes resources such as the PR and marketing resource. Resources in this category were not considered the main target group for all A3Os and were only interviewed on their perception of the A3O that explains minesweeping as a subject. Table 1 shows how the different interviewees are grouped and how many were interviewed in the different interviews. The "Initial Stakeholder Interview" and the "Source of System Overview" were conducted to give an understanding of the problem, while the "A3 Subject Overview" and the "A3 Project Overview" were conducted to collect feedback on the A3Os to develop them further. General observations and informal interviews/talks were also made to obtain feedback on all A3Os, including the A3 Architectural Overview. Throughout the whole project, observations were made when the first author interacted with both internal and external stakeholders or observed different stakeholders interacting with each other. These observations were captured in small notes.

Since all interviewees have Norwegian as their native tongue or everyday language, the questionnaires and interviews were conducted in Norwegian to avoid language barriers. The answers were compared to find similarities and commonalities.

Group	No. of interviewees	Interviews			
		Initial Stakeholder Interview	A3 Subject Overview	Source of System Overview	A3 Project Overview
Project manager/ Line manager	3	2	2	2	3
Project engineer	14	11	8	12	1
Administrative management	7 (1 did not answer)	1	1	1	5
Other	4 (2 did not answer)		2		
SUM:	28 (3 did not answer)	14	13	15	9

Table 1. The table shows the different groups of interviewees, how many were interviewed in each interview, and the total number of interviewees.

Adapting and Updating A3 Overviews. After the interviews, the A3Os were updated to incorporate feedback from the interviewees. There will always be a high degree of personal preference when it comes to appearance and set-up, and some are often in direct conflict with what others like. Hence, no changes were made based on the feedback from one interviewee alone. In cases where one interviewee mentioned a suggestion for a direct change, this statement was presented to other stakeholders to probe it. If the feedback turned out to be a consensus, the change was implemented.

Result

Understanding the Problem. The initial interview showed that many of the stakeholders pointed out the lack of overview of both the system and the project as an issue when starting new projects. They felt that this held them back in their work. Their solution was mainly to either talk to people or read a lot of different documents, but many also felt that they didn't have time for this. Most interviewees

preferred to have been briefed about the system and project in a kick-off meeting. Several interviewees also mentioned the project's lack of clearly defined roles as challenging.

Another clear finding was the lack of knowledge and understanding of minesweeping as a subject. Some interviewees had gained knowledge about the subject through working with it for some time, but everyone reported not having this knowledge before they started working with it.

The interviewee in the "Initial Stakeholder Interview", who was classified as administrative/upper management, reported, among other things, that managing customer expectations and the handover to the project team were challenging at the beginning of projects.

In the interview "Source of System Overview", we asked the resources where they turned to get an overview of the System of Interest. As shown in Figure 6, the results showed that one-third of the interviewees turned to the Project Manager to get an overview of the system. Other main sources were a document management system, 3D models, and a system description document (System/Segment Design Description (SSDD)). The latter document aims to describe the system but often has well over 100 pages and, therefore, takes time to go through.

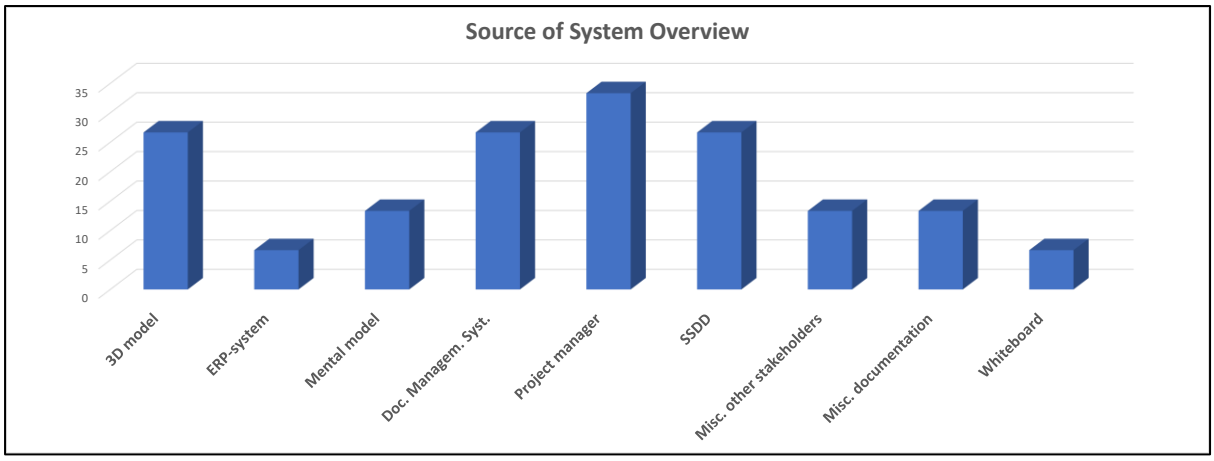

Figure 6. The interview "Source of System Overview" showed that the interviewees had different sources to get an overview of the System of Interest.

The insights gained from interviews and observations led to the understanding that not only the system and its architecture should be captured for communication. The company and all stakeholders would also benefit from the creation of an overview of the whole subject of minesweeping, as well as an overview of the project.

Developing A3 Overviews. The interview "Source of System Overview" and other observations showed that there was room for a better method to collect and communicate an overview of a system's architecture. To test a suitable method, two A3AOs were made for two different systems for Unmanned Surface Vehicles (USV). The A3AO shown on the right-hand side of Figure 7 was made for the WTD 71 project. The one on the left shows another USV system. Both are based on Borches' method but tailored to the project and made with one side only.

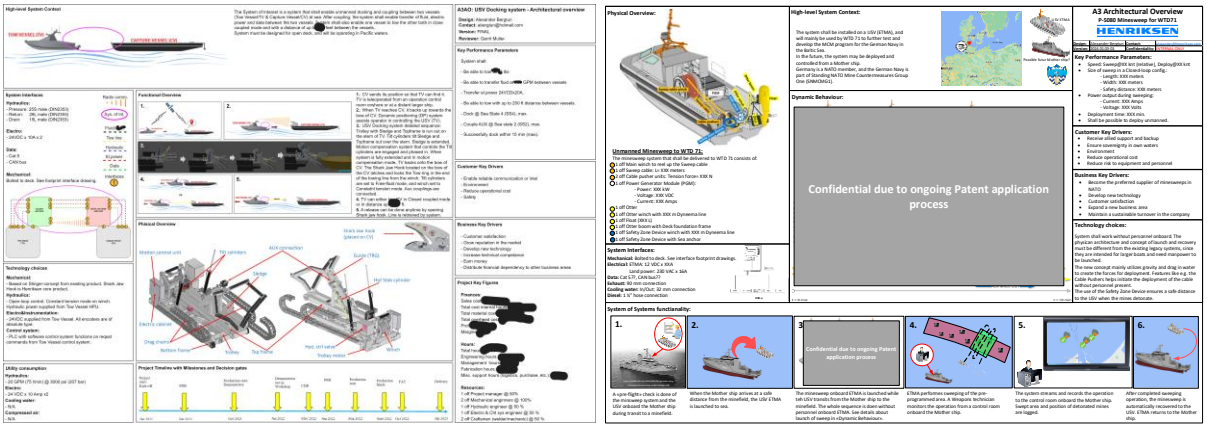

Figure 7. Two traditional A3AOs were tested out for communicating the architectural overview of two different development projects for systems on Unmanned Surface Vehicles (USV).[1]

The initial interview showed that many stakeholders struggled with the understanding of minesweeping as a topic. Hence, an A3 Overview for explaining minesweeping as a subject was made by altering and tailoring Borches' A3AO template. The "Summary" side was used to communicate the less technical aspects of minesweeping, such as introduction and background, key drivers, risk, and definitions. The "Overview" side described the different minesweeping methods and the concept of their function in operation. The "Overview" side also displayed the Concept of Operations (ConOps) of a minesweeping operation, explained in a sequence of a fictive example, as shown in Figure 8.

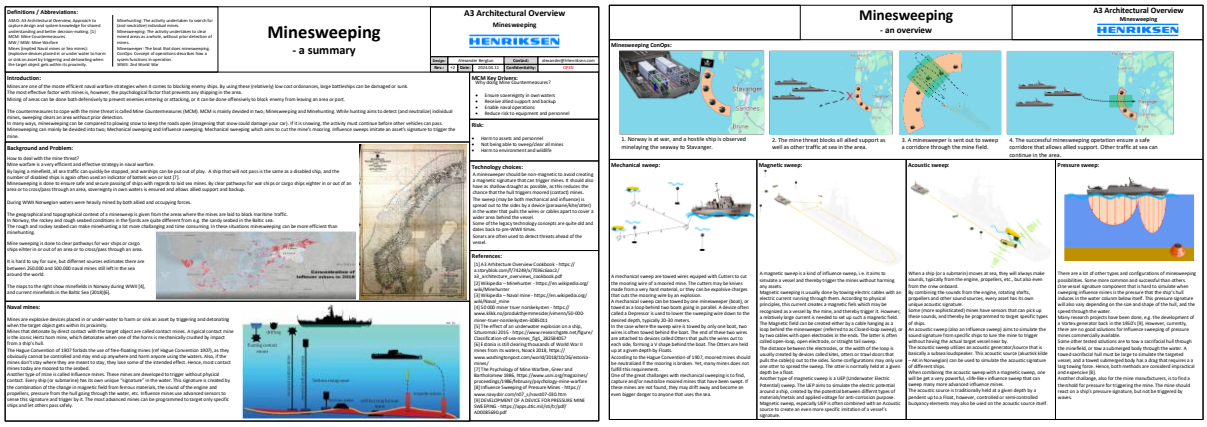

Figure 8. The A3AO method was altered and tailored to test whether it could capture and communicate a subject or a concept rather than a system's architecture.

Many of the interviewees reported the lack of a project overview as challenging, so the A3 Project Overview was developed. The views and their location on the sheet were inspired by both Borches' A3AO (Borches, 2010a) and Muller's A4 Project Canvas (Muller, 2023). Based on insights from the initial interview, other views, such as organization charts and Work Breakdown Structures, were implemented. The first author also suggested some views based on his experience with larger and more complex projects. To make it more readable, the different views were grouped and color-coded, as shown in Figure 9.

[1] The content in the A3AOs in the figure shows examples of concepts, not necessarily reality in the projects.

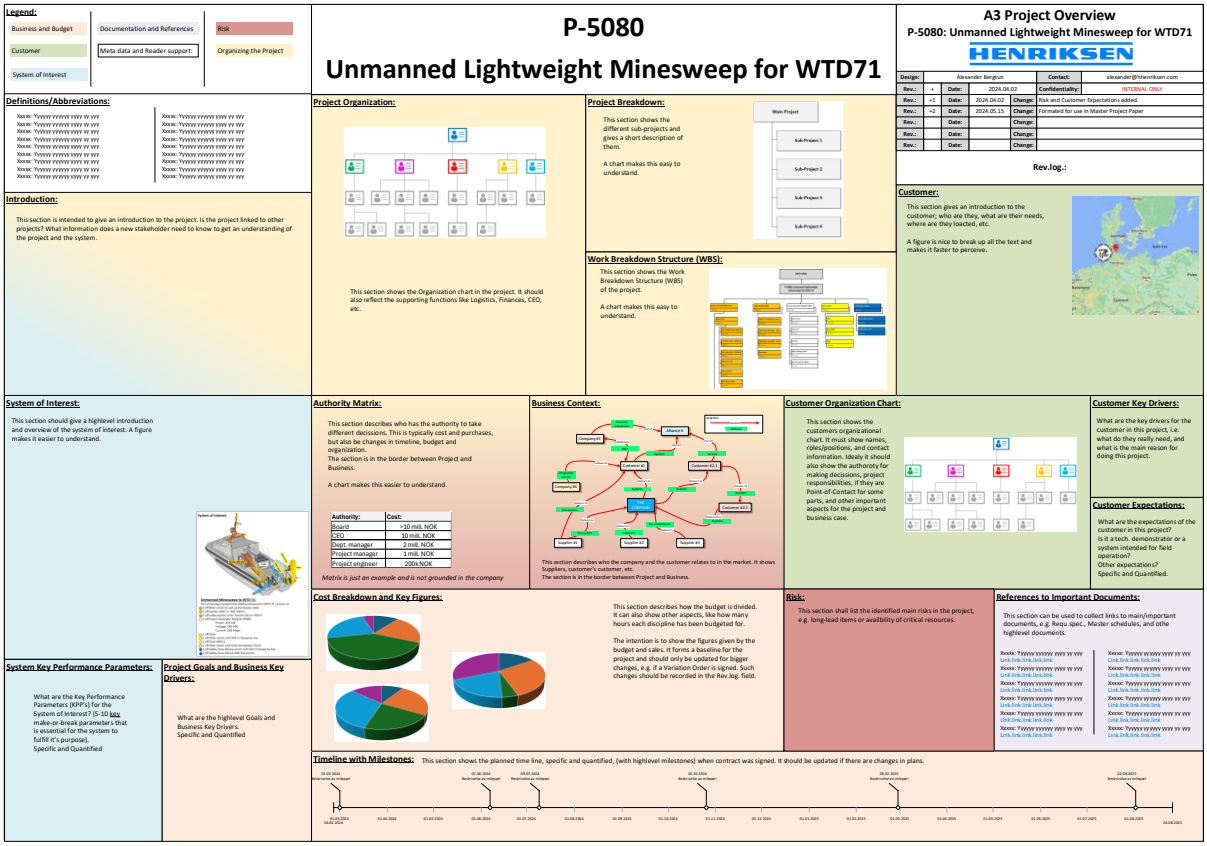

Figure 9. The A3AO method was altered to capture and communicate a baseline overview of a project.

Evaluating A3 Overviews. The first author fabricated a lot of different overviews and detailed figures in the project. Some of these figures were used when fabricating the different A3 Overviews. The figures and some of the A3Os were also used in interaction with external stakeholders and resources. As an example, the A3AO on the right-hand side of Figure 7 was used in communication with, amongst others, the customer, a patent lawyer for communicating the system in a patent application process, and an illustrator who makes marketing material. Some figures were also used as part of a presentation held by the company at an international defense exhibition in Tallinn, Estonia. In general, observations and direct feedback show that such material is well-received in the industry and is of good help when communicating across projects and businesses. The following presents some of the findings for the different A3Os that were fabricated and tested.

The A3AO was presented to several internal and external stakeholders and was well received by those to whom it was presented. Henriksen's Quality manager, amongst others, really liked the A3AO format. He suggested that an A3AO should be made for all projects in the company. The A3AO for the WTD 71 project was also presented to the customer. They were mainly very satisfied with the format, but had some comments related to the actual contents.

The A3 Overview for minesweeping as a subject, shown in Figure 8, was tested on 13 internal stakeholders, spanning from the Project manager in one of the MCM projects to a logistics worker who worked with Quality Control of received goods. Most of the interviewees worked on MCM projects on a daily basis, but there were also some who had never worked on any of these projects at all. Regardless of the background and prerequisite knowledge on the subject, more than 90% answered that the A3O gave them a better understanding of minesweeping as a subject or a concept. Most interviewees reported having spent 10-15 minutes going through the A3Os, and everyone answered that they thought they would have come up to speed faster in their work if they had had the A3O at the beginning of their work. None of the interviewees felt that any information was missing or that any views were excessive.

The Chief Financial Officer (CFO) was very happy to get the A3O and answered that it was valuable insight to her as an employee in Henriksen, even though she did not have a technical background or work on an MCM project.

All interviewees liked the A3PO with its setup and viewpoints. However, there was a consistent difference between how the upper management saw the use of the A3PO relative to how the PMs saw it. PMs were not that interested in the "Business Context" view that aims to reflect the company's position and relations in the market. The upper management, on the other hand, reported this as a nice viewpoint and even suggested more business and strategic viewpoints, such as e.g., SWOT analysis (Gürel, 2017). "Risk" (project risk), "Revision log" (intended to track larger changes in the project or contract), and "Customer Expectations" were viewpoints that the first author forgot about in the first revision of the A3PO. A few interviewees pointed these out, and they were later implemented.

The advantage that was reported to be the largest of the A3PO in a project was using it for project development, handovers, and as a benchmark for debriefing and evaluation at the end of a project. None of the interviewees thought that a second page (backside) of the A3PO with a more dynamic status overview of the project was a good idea, since this dynamically updated information is available elsewhere.

Discussion

RQ1 – What are the Challenges Henriksen is Facing in System Development Today? Interviews and observations showed that getting an overview of both the system and the project poses a challenge at the beginning of development projects. This is partly caused by poor communication amongst stakeholders and a lack of common understanding of the system and project. Handovers from sales and project developers to PM, and further from PM to the project team, are identified as sources of loss of information and knowledge about the system, project, and customer needs and expectations. This is also in accordance with Boge and Falk's findings that handovers and interfaces between departments are challenging (Boge & Falk, 2019). Finding tools and methods for supporting and improving communication should help create a better flow of information and reduce possible misunderstandings that, again, will cause costly and time-consuming delays. In Henriksen's project for delivering an unmanned lightweight minesweeping system for WTD 71, one challenge was also that many engineers in the development team did not know much about minesweeping as a subject. This is no wonder since mines, mine warfare, and MCM are subjects that are not considered general knowledge among people who have not been involved in this through the Navy.

RQ2 – How can the A3AO method be adapted and used to support the challenges Henriksen is facing? Getting an overview and a common understanding of the system's architecture was identified as a challenge. Research in other companies and projects across the industry, e.g. (Boge & Falk, 2019), (Pesselse et al., 2019), shows that the A3AO method is suitable for dealing with such challenges. Hence, an A3AO was fabricated and tested to support communication between stakeholders. The main reason for choosing the A3AO method as a basis for suggesting a tool or method for the different revealed challenges was that the A3 format is so compact and easy for anyone to handle. The reported time required for going through an overview document on an A3 page is a lot less than the time a stakeholder currently spends on getting an overview, since many reported that they had to go through other documentation and ask questions to get the overview.

The interviews showed that many of the interviewees had a knowledge gap related to minesweeping. Knowledge of the subject and the system's context is crucial when designing a system. Others in the company would also benefit from having such knowledge. Since the A3AO method has been found to work well for communicating system architecture, the first author wanted to test whether the same method could support communication of other aspects. Hence, the A3AO was changed and adapted to communicate a concept or a subject instead of architecture.

Lastly, the A3PO was developed to assist sales, project developers, and PMs in collecting and structuring information early in the process and later assist with handovers and knowledge sharing. The A3PO was intended to be on one page only and capture and communicate the overview of a project as a more static baseline for the project. After the A3PO is fully populated, new revisions should only be made for bigger updates in the project, e.g., if a larger milestone is moved or a variation order is signed. If the sales and/or project developers start to populate the template already at the first contact with the customer, it is estimated that it would be 70-80% populated by the time a sales order is signed. Then, the PM can take over the ownership of the document and finish the last 20-30% at the beginning of the project. The A3PO could, in that way, serve several purposes:

- help sales and project developers get an overview in the very early phases of the process,
- collect key information about the customer and the project,
- support the handover process from sales to the PM,
- enable better communication between the PM and the project team,
- and work as a simple reminder and overview for the project team throughout the project.

RQ3 - How are the A3 Overviews Perceived by the Industry? The A3AO method was tested out in its more traditional form. Although tailored, it mostly followed Borches' suggestions. A3AOs for two different systems were presented to several stakeholders, both internally and externally. Direct feedback was received, but the first author also made observations on how the different stakeholders reacted. In general, the A3AO clearly triggered most stakeholders' interest when it was presented. None of the stakeholders were familiar with the A3AO method, but reported liking it and seeing its use in projects. We chose to use more detailed and elaborate models and figures in the A3AOs. This is believed to cause some of the "wow factor" that was observed when presenting the A3AOs and the figures. One stakeholder claimed that he actually preferred simpler figures and boxes, but the rest clearly appreciated the more life-like and elaborate figures. Haugland and Engen's (2021) findings support that industry resources mainly prefer more elaborate figures. Using simpler figures could greatly reduce the time spent creating the A3AOs. However, judging from observations of the different stakeholders' responses, it is believed that the audience in the industry would not receive simpler figures as well as the more elaborate ones. This helps justify the time spent making them.

Most interviewees reported spending 10-15 minutes going through the A3Os, so it can be estimated that they would spend the same time on the A3AOs. To get an overview, this would have saved time compared to the current way of getting an overview, i.e., reading documentation and asking questions. Some stakeholders may prefer more details. This is consistent with the findings from (Haugland & Engen, 2021), which show that different stakeholders would prefer different levels of detail. However, to get an initial overview of the system, the A3AO is found to be a good method.

The A3AO is intended to capture and communicate the system's architecture to stakeholders (Borches, 2010a). In larger companies where there is a department that develops the architecture and a different department that does the (detailed) design, the A3AOs are found to be of good help during handovers and when communicating across teams (Haugland & Engen, 2021). In Henriksen, the same team that is to do the detailed design and therefore needs the A3AO is also the same people who are to develop the architecture that should be communicated in the A3AO. Nevertheless, it is believed to give value both in the form of creating a common understanding within the design team and when communicating with stakeholders outside of the team.

Most people know little about mines, mine warfare, and MCM. The initial interview confirms this, as every interviewee reported having very limited or no knowledge about this subject before starting the project. The fact that none of the interviewees missed any information on the A3O may also be caused by not knowing what *could* be missing. Considering the cost-benefit aspect for the A3O on minesweeping as a subject, the alternative would be that each other resource would spend a lot of time reading up on the same subject.

The A3 Project Overview (A3PO) may have generated the most feedback and discussions. The A3PO is supposed to support the processes very early in the project and project development for system suppliers in the industry, and enable an overview that could help communication among stakeholders.

Handovers are always troublesome and a large source of information loss. The A3PO enables the sales and project developers to capture and record information about the customer, delivery (in most cases, the System of Interest), timelines, domain-specific language and expressions (to be captured in "Abbreviations/Definitions"), etc. This will support the handover and communication process and allow all stakeholders to have a common understanding from the beginning of a project. Some interviewees suggested that some information may be prefilled in the template since some things are often recurring in almost all projects. In projects where this information is not relevant, it can be removed.

Some in the upper management saw the use of the A3PO method, with a few modifications, also in more business-related contexts. These conflicting opinions from how the upper management and the PMs saw the need for more business-related views make it hard to satisfy all stakeholders' needs in one document. The difference in how upper management and PMs see possibilities and the use of different methods is also in accordance with findings in (Boge & Falk, 2019). Since this method is mainly developed for recording and communicating an overview of a project, the first author believes that the focus should be on the views that support the needs of the Project managers. Most of these views are also the most relevant for sales and project developers. The biggest argument for not including the "Business Context" view in the A3PO is that this may change throughout the project, especially with regard to the different suppliers and their deliveries. This view will, on the other hand, be of good help to the sales and project developers when mapping out the various relations in the market in larger, more complex projects. Observations, as well as interviews with the upper management, highlight the importance of enabling the PM to have an understanding of how the different actors in the market relate to each other. The latter is also supported by PMI research (Project Management Institute, 2017). In larger and more complex projects, this understanding and overview are not always easy to figure out at first glance. This is the reason why the "Business Context" view is kept in the A3PO despite some of the interviewees feeling that it was excessive information.

To satisfy the upper management's need for more business-related views, it would perhaps be better to develop an A3 Overview dedicated to business instead. However, also other methods exist for this, such as Osterwalder's Business Model Canvas (Strategyzer AG, 2024).

One of the interviewees questioned the format of the A3PO. He felt that it contained too much information, colors, and figures on one page and suggested that it could be advantageously changed to an A4-sized document with more pages. Within the area of business modeling, what he reports is known as "Cognitive Murder" (Garner, 2015). Boge and Falk's Client, who was unfamiliar with the A3AO method, also reported that their A3AO contained too much text and information to understand (Boge & Falk, 2019). It can be argued that the information and figures will drown in each other in such a format as the A3AO (and A3PO); however, getting the key information in a limited area is the point of using the A3AO method.

Limitations of the Work. Measuring the actual effect of the A3O for minesweeping is hard for two specific reasons. Firstly, those who work on the MCM projects are considered to inevitably learn about the subject over time through their work. The reference group amongst the interviewees was meant to compensate for this. However, secondly, since Henriksen is moving deeper into the business of developing minesweeping systems, the Chief Technology Officer (CTO) held a good and thorough presentation about minesweeping as a subject for all employees in the R&D department. Since this was done after the initial interview that showed the knowledge gap on minesweeping and before the A3O was presented, it is hard to measure what they learned from the A3O. Nevertheless, all interviewees except one reported having gained a better understanding of minesweeping after going through the A3O.

None of these methods has been validated by using them fully in a real-life project, and therefore, the actual effect they would have had on the project's overall efficiency or outcome is not measured. However, interviews with actual potential users show that they are positive about such methods and believe

they could bring value to the project. Many interviewees also see other potential areas where an A3 Overview could give value; but, as some of the interviewees also said, it is important to integrate the A3 Overviews into the QA system to benefit their full potential.

Conclusion

There are many challenges when developing new systems. Developing unmanned systems poses even further challenges since the existence and use of such systems are still not that prevalent, and thereby, people may not have a common understanding of them. By modeling and communicating the system's architecture, many costly and time-consuming misunderstandings can be avoided. The Systems Engineering (SE) method A3 Architectural Overview (A3AO) was tested to model and communicate the architecture of two unmanned systems. It was well received by the company, as well as by the customer and other actors in the industry, and was found to be suitable for the purpose.

The A3AO method was also altered and tailored to be used to communicate the subject of minesweeping. The purpose was to enable the design team to better understand a subject that is less widely known among people. Although gathering such information is time-consuming, it is of great value and high importance to the design team to know about the System of Interest's overall context, concept, and functionality as a subject. Hence, it is better to have one engineer find and record all the information and fabricate the A3 Overview (A3O) than if the whole team spends time on it. More than 90% of the interviewees reported that the A3O gave them a better understanding of minesweeping as a subject.

Interviews revealed that the lack of a project overview causes uncertainty at the beginning of projects. Hence, the A3AO method was used as a basis for a new format, the A3 Project Overview (A3PO). The A3PO enables sales, project developers, and project managers (PM) to record and get an overview of the project in the early phases. This method is further believed to be suitable for supporting handovers from sales to PMs and further from the PM to the project team.

Recommended future research

The A3 Project Overview (A3PO) was not tested in an actual project, and its full value could, therefore, not be measured or validated. However, interviews with several potential users showed that they saw a potential for enabling increased overview in the early project phase and improving communication in handovers. To research the A3PO's potential, trying to measure and validate its value in projects in the industry is recommended.

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Biography

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