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Gigamapping for Creating a Context of Use

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Redesigning software to increase usability will not be solved by only changing the surface, i.e., the graphical user interface. A context of use, describing how software is intended to be used, by specific users, in a specific environment, is a prerequisite for achieving usability. This paper will explore the utilisation of gigamapping, from the field of systems oriented design, as a method to create a context of use. Surveys and semi-structured interviews verify that gigamapping can create a context of use and display complex information while maintaining connectedness and readability. In addition, semi-structured interviews verify that gigamapping provided additional value by discovering in-house challenges with interface management.

KEYWORDS: gigamapping, interface management, systems engineering, systems oriented design

RSD TOPIC(S): Cases & Practice, Learning & Education, Mapping & Modelling

Introduction

Interface management can be a small feat or a challenge depending on the system. Systems can be comprised of a certain number of sub-systems and supra-systems. This composition can drastically increase the number of system interfaces, creating a need for system interface management.

In this paper, a method from systems oriented design called gigamapping has been used to map out how engineers currently work in the Company. Gigamapping is a method of systems oriented design that focuses on visualising complex systems, thoughts, and designs. The gigamap sessions are done to understand the operational activities of project engineers. They are the foundation for creating a Context of Use (CoU) for an Interface Management Tool (IMT). The CoU presented in this paper resembles a combination of a concept of operations and a context of use. Through the CoU, IMT will be shown how and where to work in a project process that is transcribed from the Company. In addition, the CoU visualises project complexity and where the need for interface management is crucial.

Searches for “gigamapping and interface management” or “gigamapping and context of use” provide few results. This paper aims to expand the body of knowledge in systems engineering and systems oriented design by researching the capabilities of the gigamap to create CoU for IMT. This paper discusses relevant literature, the research methodology, the research design, and how gigamapping was performed. A total of five gigamap sessions were conducted before the CoU was made. Each session underwent verification from gigamap participants and consecutive feedback that inspired the layout and updating of the CoU. The survey results will be the foundations for discussion before we move to the conclusion, where the research question is answered before presenting suggestions for further work.

Background

The Company is an engineering and integration company. The Company's project deliveries span from systems to fishing vessels, wind turbines, and oil platforms. Recently, the Company had its product portfolio expanded, which meant that the Company's deliveries in projects became more complex than before. Although the complexity results from a more extensive product range that is interconnected, a more significant number of interfaces are now an integral part of the project. These types of interfaces are mechanical, electrical, and digital. These are interfaced between systems, mechanical attachments, and components and even include documents that will be distributed between different contractors to allow for successful project completion.

To better manage these system interfaces, the Company decided that an Interface Management Tool (IMT) owned by the company shall be upgraded. The purpose of the IMT is to allow for better management of system interfaces. The IMT is a product of its time, and it shows.

A significant challenge in systems integration is that the system rarely works as intended when everything is put together. If the system interfaces are not managed, the system's risk of not working increases (Shenhar & Dvir, 2007). As an engineering company and integrator, the Company is aware of the high risks in complex projects. These risks extend to the system not working if system interfaces are not managed. IMT is selected as the tool to mitigate the high risks to ensure that the system works when integrated.

The problem

The task of upgrading old software is not as simple as changing the visual representations. Underlying issues, systems architecture, and functionality that do not comply with the organisations, users' needs, and the current way of working must be investigated before an upgrade is done. When creating a tool or updating a software tool, a context of use is a prerequisite for usability. The context varies in relation to specific users, specific tasks, and the specific environment in which the users work.

Creating an activity description is not a complex task, but the output can be complex. The complexity is that activities may have additional dependencies, which must be documented. While it is possible to create a table or a document that presents the users' activities, it may not correctly represent the complexity of the interconnectedness of the activities. For this reason, a CoU will be created through Gigamapping for the IMT. This paper will explore the utilisation of gigamapping as a method to create a context of use with multiple views that intends to enhance the usability of the interface management tool.

In this paper, we will aim to answer the following questions:

- How can gigamapping be used to create a context of use?
- How will the gigamap provide value to the Company?

The research presented was conducted with an approach named Industry-as-laboratory. Industry-as-laboratory is an approach to what is done in practice rather than what is possible in principle with real projects in industry or domain (Potts, 1993). Research questions that need answers can be derived from industrial problems (Muller, 2013). These problems create an opportunity to utilise methods from systems engineering and put them into practice in the industry, thus allowing the authors to thoroughly test if a particular method was fitting to deal with the said problem.

Performing gigamapping

Gigamap sessions have been conducted to obtain the perspectives and the as-is experience of a group of engineers. The gigamap sessions gave a unique insight into how they worked. The immediate differences between the actual work and in-house procedures were minor but not as detailed. However, the time was insufficient to delve deep enough to discover discrepancies. The engineers involved in the gigamap and interview sessions had a varied range of experience in the Company. They work within different disciplines, but they often work together on projects. It is for the mentioned reasons that they were selected to participate. Their experience of collaborating and knowledge of project executions make their perspectives valuable. None of the participants in Table 1 had any previous knowledge of gigamapping.

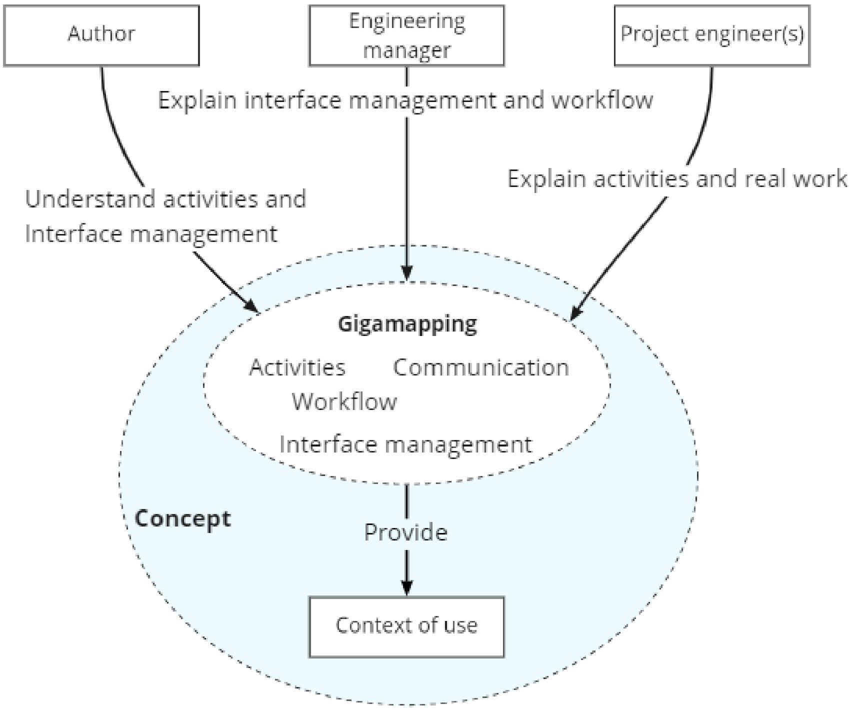

Figure 1. Interview and gigamap process.

Table 1. Gigamap participants.

Number	**Role in Company**	**Experience in Company**	**Gigamap or Interview**
GM 1	Senior Electrical Engineer	5 years	Gigamap
GM 2	Senior Electrical Engineer	10 + years	Gigamap and interview
GM 3	Senior Software Engineer	10 + years	Gigamap
GM 4	Engineering manager	5 years	Gigamap and interview
GM 5	Lead Principal Engineer	7 years	Gigamap
SSI-1	Lead Principal Electrical Engineer	5 years	Interview

Before starting the gigamap sessions, the participants were introduced to the term relations. These relations were thought to help structure the creation of the gigamap and are used between activities and items included on the gigamap. Each relation was assigned its colour and was pre-defined before the sessions started. The participants were informed of the colours and what each colour meant. The relations are retrieved from Birger Sevaldson's Library of Systemic relations (Sevaldson, Library of systemic relations, 2012).

Causal relations: Relations where an input affects the output. To mark these causal events, the colour red is used to show that.

Pre-dependent relations: A pre-dependent relation is where an activity has prerequisites before it can be started and is dependent on one or several other activities to be completed. This is shown between almost all activities in the gigamap and is visualised as the colour green. An example of this is that the panel builder needs system information from the package-responsible engineer before fabrication can begin. This requires product specification as a prerequisite before the panel builder can produce the item.

Institutional relations: An institutional relation is the exchange of information that happens between departments, disciplines, roles, and companies. These relations indicate that the activity relies on communicating outwards and are shown as the colour blue. An example is when the client and class shall approve a system specification. Therefore, this information is related to another institution and is classified as an institutional relation.

The colour of the relations is not pre-determined by anyone but inspired by Sevaldson's library of systemic relations.

Gigamapping

A total of five gigamap sessions were performed. The five gigamap sessions will be referred to as *exploratory gigamaps.* They are named so because they facilitate exploring the gigamap participants' operational activities.

Three sessions were conducted with markers, giant sheets of paper, and post-it notes in a physical meeting room. Two sessions were conducted via Teams-meetings, where a tool called Miro was used instead of paper and markers. Miro is a tool available online through browsers and acts as an ample space where modelling can be done. Miro is a potentially low-threshold commercial product. Each method, digital or physical, has advantages and disadvantages in relation to the other. Physical gigamapping gives additional information through the ambience and cues in the room. Digital gigamapping allows for easier editing and managing of mapped information. All figures of exploratory gigamaps and CoU presented in this paper are made in Miro.

The exploratory gigamap sessions were conducted with two package electrical responsible engineers (GM 1 and GM 2), one software engineer (GM 3), and one engineering manager (GM 4). To start the exploratory gigamap, a vessel propulsion pod was chosen as a system of interest. The pod is a complex piece of machinery that enables vessel propulsion from electric power to mechanical power. The pod is interfaced to the electrical sub-system, and the electrical sub-system is interfaced to the automation sub-system. Next, two disciplines were selected and marked with Z-points. Electric (EL) and Software (SW). The reason for zooming in on EL and SW is that both disciplines' sub-systems are interfaced with each other, and the gain of a better understanding of how two different fields work may yield more information relevant to deriving a CoU (Figure 2).

After zooming in on the disciplines, the gigamapping session began with the rest of the participants mapping their activities. Following activities, information exchange became the topic of interest. This is where the participants provided a list of seven mediums used commonly in projects, including how system interfaces were managed. FTP servers, Teams, Servers, SharePoint, Skype, ProArc, and Email. Each system and sub-system have its own system interfaces that need to be managed. Maintaining different system interfaces between seven other mediums throughout multiple disciplines is a challenge and not efficient. The number of mediums for informational exchange was marked with a “P” for a problem. The purpose of the marking was to acknowledge that there was a problem but also to indicate that there are no current plans to solve said problem.

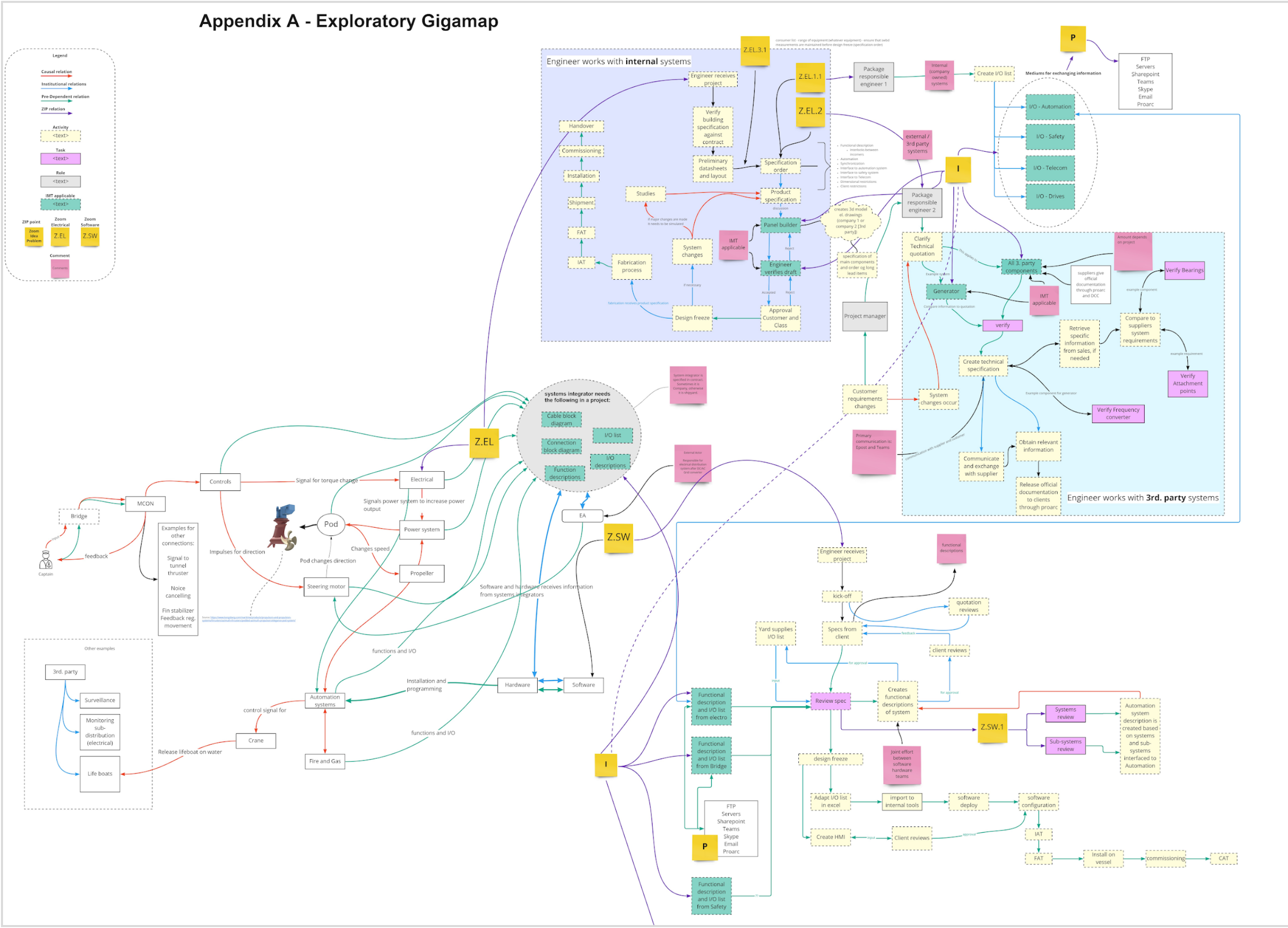

Figure 2. Raw input from the exploratory gigamap sessions.

The Input/Output list (I/O list) activity in Figure 3 does not contain interfaces directly. The I/O list, used as a concrete example, includes information on signals that shall be transmitted between systems and sub-systems. These signals need to be connected – interfaced – to a respective receiver or transmitter of signals. Gigamap participants stated that managing this information was a challenge. To make these challenging items stand out, a decision was made to colour them green and refer to them as “artefacts.” The artefacts indicate where interface management was found to be needed (Figure 3).

The final gigamap session was performed with a Lead Principal Engineer (GM5[1]). This session was not about expanding the gigamap but distilling it. The distillation process was initiated because GM5 was overwhelmed by the information on the gigamap. GM5 suggested removing everything except for the artefacts. This shifted the focus away from activities and to managing the artefacts, confirming the challenge of the Company having too many mediums for information exchange. Additionally, GM5 added multiple new artefacts that were not included earlier, expanding the scope of IMT.

It was also noted that for IMT to work on a project, it needed to be governed by a project plan and supported by a quality assurance- and risk plan. It was based on the experience from GM5 that a supporting and governing framework would be critical for this to be functional in a project. The result of this process shows how IMT is a possible solution to manage the artefacts shown in Figure 4.

[1] GM5 is Lead Principal Engineer. Gigamap Participant no. 5, see Table 1 – Gigamap participants.

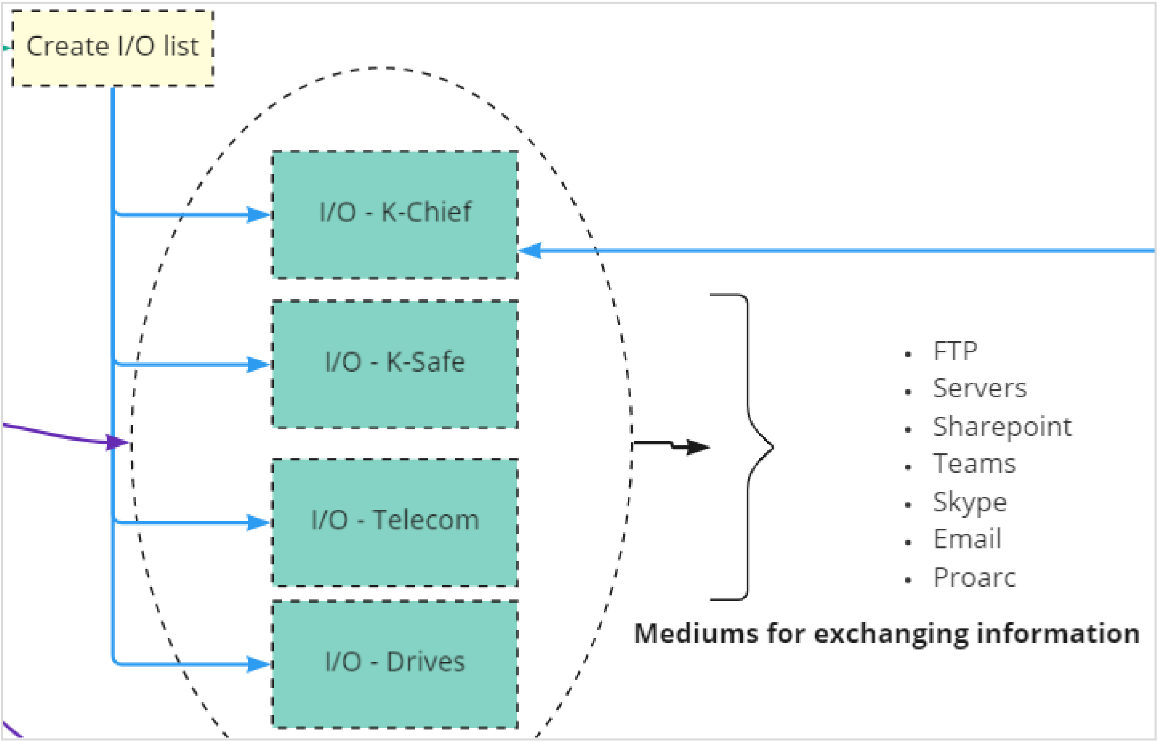

Figure 3. I/O list and artefacts.

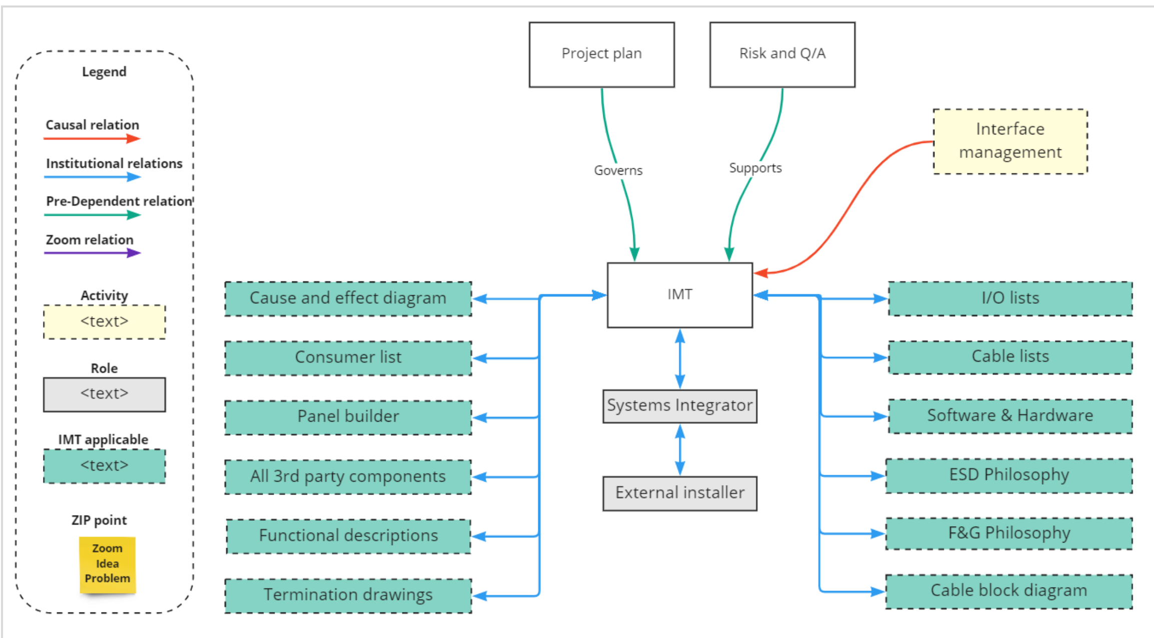

Figure 4. Distilled gigamap, showing only one activity and multiple interfaces.

Creating the context of use

Feedback. During the creation of the gigamap, there were consecutive verifications throughout the process. This has been conducted by inviting employees that did not attend the gigamap session. The purpose was to verify what had been created and provide feedback for the first draft:

- "Chaotic at first, but there is a pattern."
- "When I study this, I recognize many working processes."
- "This makes no sense; it needs to be more linear."
- "How is IMT connected to this?"

Based on the feedback, it was fair to assume that the first draft was considered unreadable to most, which led to the revisualisation seen in Figure 5. To portray where interface management occurs in a project, a decision was made to visualise the project in a manner many can relate to—a linear "swim lane" shown in Figure 5. The swim lane shows the connectedness of project activities, their relations, and where interface management is considered critical by gigamap participants.

This was done by comparing the information provided by the gigamap participants with the in-house company processes of project execution. To clarify Figure 5, markers for project milestones were added as grey arrows. These arrows are added to show wherein a project activity occurs.

Annotations illustrate the interface management. Annotations are green numbered dots related to their own table that shows artefacts in Figure 5. The table lists general IMT artefacts required in a project and can be seen clustered between "Scope" and "Design Freeze" to simplify the complexity while retaining the readability in Figure 5.

Feedback for the swim lanes:

- "This makes sense."
- "It is clear where we need more communication in the project."
- "The work process is not completely like that; some items are missing."
- "This illustrates why interface management is important."

The swim lane does not cover how the interface management tool will be used in a project. It neither shows how it is related between actors and other activities, and the annotations do not show how system interfaces are connected. This gives cause for a different view that focuses on the system interfaces and their actors. Figure 6 is made to illustrate that view. It shows how interfaces are related to relations and functions in IMT to track system interfaces in the project.

With gigamapping, different views can be presented to display various problems. ZIP-analysis provides strength in this case to enhance different views. We need to 'Zoom' in to understand better how IMT works.

Figure 6 displays multiple views and uses. The top right shows the capabilities of IMT in terms of the project manager's role. The bottom part of Figure 6 shows how the engineering manager speaks with a client and conveys the information to the project team – the same information is stored in minutes of meetings and tied to action lists linked with users. The users can see their actions in the action list and perform the specified tasks.

While it is possible to visualise an entire project in a gigamap, The visualisation in Figure 6 is limited to a specific set of artefacts and processes that are dependent on each other in a project. These artefacts and processes are framed in the middle of Figure 6.

The Company needs the IMT to support multiple projects – something that is visualised in Figure 7. ProArc[2] is added in Figure 7 to illustrate that final system interfaces are sent to clients, yards, and through a formal document management system. The purpose is to visualise the relations between the actors, IMT and ProArc.

[2] ProArc is a document management system used within the Company.

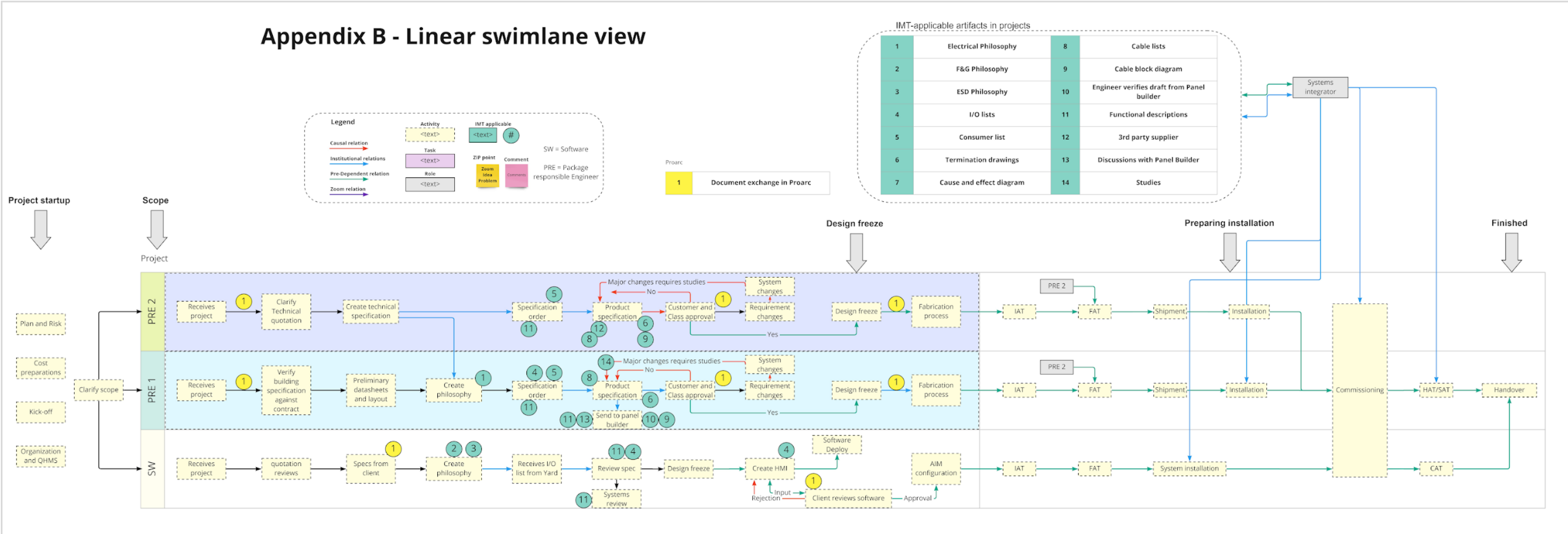

Figure 5. Illustration of where IMT can be used in a project – shown by the green annotations. The green annotations are related to the table with green numbers.

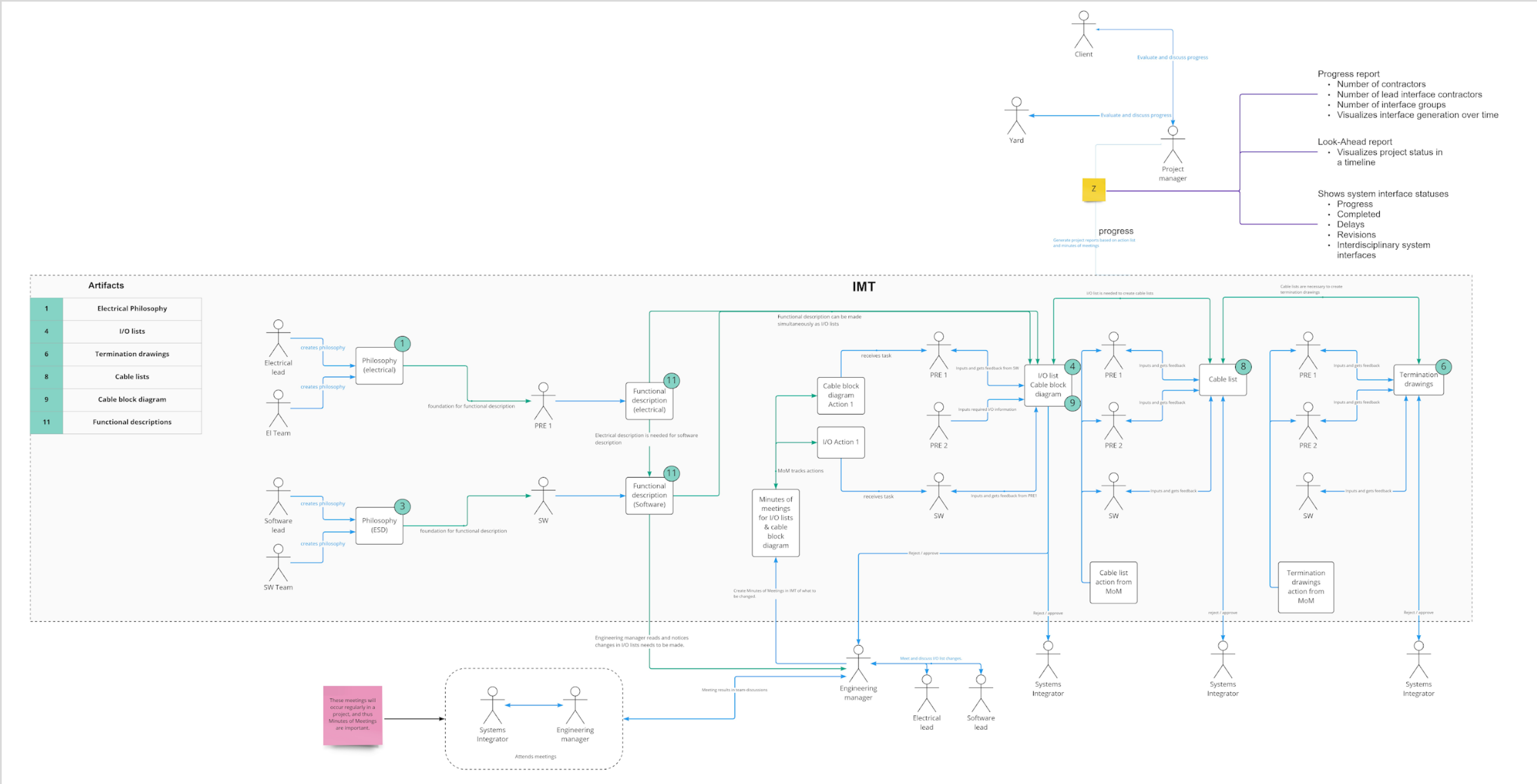

Figure 6. Illustration of how IMT is used in a project, its actors, and its capabilities.

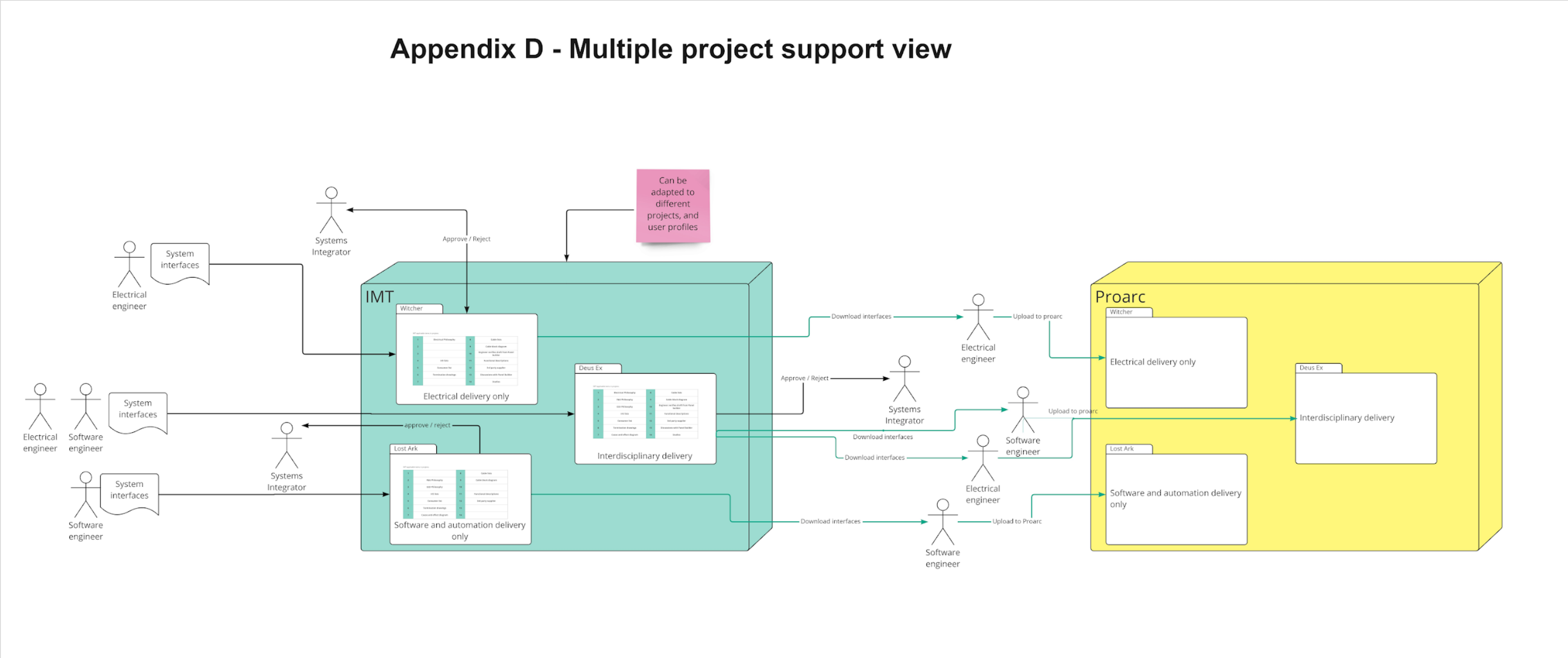

Figure 7. Support of multiple projects in IMT.

Positive and negative feedback. Regarding the survey, two options can be assumed. One: They did not have time in their schedule to participate. Two: The gigamap was too overwhelming, and they did not gain interest and opted out of the survey. Out of the twenty who received an invitation to answer the survey, ten participated. Eight responded to the statements, and nine responded with feedback comments. This means that not all who responded to statements have left feedback and vice versa.

The survey's positive feedback indicates that the CoU helps visualise the picture of interfacing parties and shows project complexity. Others have commented that this makes it possible to improve the Company delivery process as it presents complex dependencies between interfaces and parties.

The negative feedback indicates that the CoU is overwhelming at first. Navigation is a repeating factor that the participants are requesting – meaning that the structure of the CoU is not as straightforward as it should be. The users are not guided from a start to an endpoint. There should have been sub-maps with options for expanding to simplify the CoU into different levels. Lastly, one of the comments says that if one does not possess background knowledge and experience in complex integrated projects, the CoU is challenging to read and understand.

The CoU has received mixed reviews from the survey. It is agreeable that gigamapping has value, presents complex information, has readability, and clarifies where interface management is needed. However – the CoU remains somewhat unclear.

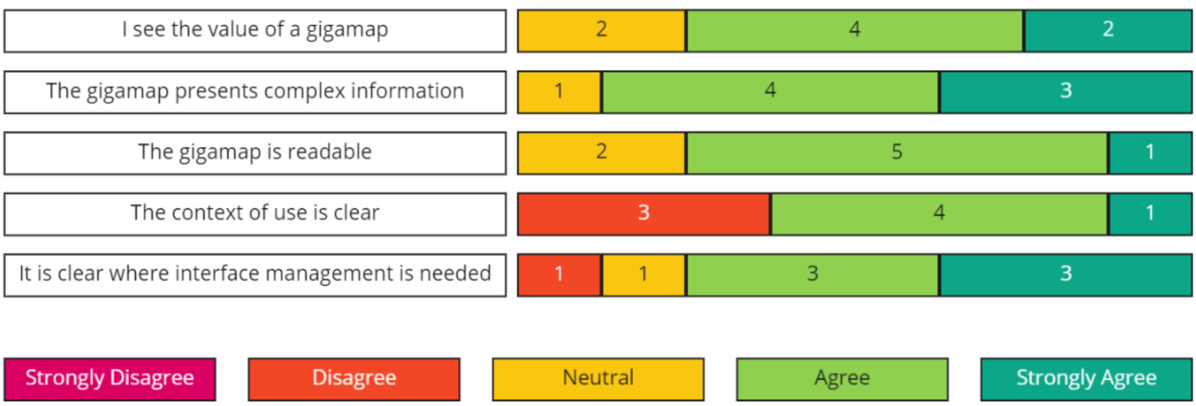

Figure 8. Results from the survey for the gigamap and context of use.

Semi-structured interviews were conducted with SSI-1[3], GM 2[4], and GM 4[5]. SSI-1 was not a participant in the gigamap sessions. However, SSI-1 recognised elements from the CoU and would have liked to add an organisational chart in addition to the context of use. The organisational chart would have been able to visualise better with whom to collaborate.

SSI-1 stated that the CoU would be beneficial to defining an interface register and that a register would lower the threshold of project input and collaboration between disciplines. SSI-1 did not have prior knowledge of the existence of IMT and stated that a tool for interface management could clarify the work process. SSI-1 expressed that the CoU was too unclear to understand but added that the lack of ownership could be a factor.

GM 2 has a different point of view than the other interviewees. GM 2 sees a potential value but felt the gigamap session was just an interview. GM 2 perceives the CoU as abstract but easier to understand when the author guides GM 2 through it. When asked if IMT could manage information exchange in a project, the answer was both yes and no, with the largest drawback being the absence of information or attention to revision management.

GM 4 states that the gigamap is a beneficial tool to visualise complicated and complex thoughts and ideas and its ability to document relations. While the first draft of the gigamap was overwhelming, GM 4 said it was helpful since it was easier to see what was missing and what was superfluous.

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[3] SSI-1 - Lead Principal Electrical Engineer, see Table 1 – Gigamap participants.

[4] GM 2 - Senior Electrical Engineer, see Table 1 – Gigamap participants.

[5] GM 4: Engineering manager, see Table 1 – Gigamap participants.

When asked about the CoU, GM 4 said that the flow of information and dependencies between disciplines to be used in IMT is beneficial. However, if information sharing is not mapped or charted, consequences will occur since it is difficult to find the owner of the information later. Because of the importance of clarifying early in a project who needs what, gigamapping and the CoU can display that. However, it does not show a timeline, which is a drawback.

Discussion of results

The initial problem statement for this paper was to investigate gigamapping as a method for creating a CoU. However, another problem was discovered during the gigamap sessions. The Company has challenges in exchanging information internally in projects. This information is often related to system interfaces. The reason for challenges in informational exchange is two-fold. One: Interface management occurs between departments and disciplines. Two: There are seven different mediums of exchanging system interfaces. A solution to replace the seven different mediums was never discussed because the focus was on the central problem – creating the CoU for IMT so that the Company can better manage system interfaces that occur between multiple departments and disciplines.

Two gigamap sessions were performed digitally during the research, while the rest was done physically. Both had their advantages and disadvantages. The advantage of digital gigamapping is that it is easier to edit and correct. On the other hand, since digital sessions do not require physical space, it became more challenging to pick up on social cues and the ambience. Physical gigamap sessions provide the opposite. Easier to feel the ambience and pick up social cues, but errors made in the gigamap are more challenging to manage and edit afterwards.

Other methods to obtain project activities could have been using tables to map down the activities. Another method to redesign IMT could be the use of the ten-sketch method from the SEHD-6202 Course, Human Factors Design, that is held at the University of South-Eastern Norway. The disadvantage of using tables is that it would become like an interview, one-sided, and with the most significant limitation, not being able to ask the right questions. Additionally, the tables could not be as interesting to study as the gigamap or CoU. Also, tables would not encourage the same level of discussion and interactivity as gigamapping. This makes gigamapping preferable to interviews since many of the relevant issues that are brought up are included in the gigamap. The ten-sketch method would mean that the graphical user interface of IMT would be sketched ten times as a reiterating process. The ten-sketch method would be a more straightforward approach to a potentially more profound problem in IMT.

The CoU presented results from gigamapping as an activity and method. Gigamapping can act as a facilitating activity that sets a foundation for a product that can be created later. However, time is a limitation, and adding all the functions of IMT in the gigamap and CoU was not prioritised. Instead, the time was spent collecting qualitative data through workshops and reiterating the CoU to make it more presentable. Even after all the reiterations, the overall gigamap was still perceived to be overwhelming, but it represents a small picture of reality.

The gigamapping sessions encouraged some discussion, but not with all participants. At some times, it became staccato, like a structured interview. While it is reasonable to argue that gigamapping is a low threshold activity in terms of tool requirement, the same cannot be said for experience. What was beneficial was that the gigamap participants could show connections and relations to what they explained throughout the gigamap session.

Complex systems are overwhelming, and models and visualisations are nothing but simplified depictions of reality. While the output was expected to be complex, viewers requested additional assistance in navigating the gigamap. Making a film with voice narration is an alternative to presenting the gigamap and CoU to the survey participants. The film and narrator could take the viewer through the essence of the contents. This could make the gigamap and CoU easier to understand. However, the time left was insufficient to create a solution like a film with narration.

Conclusion

This paper aimed to answer the research questions: How can gigamapping be used to create a context of use? How will gigamapping provide value to the Company?

Gigamapping as a method was selected to perform activity descriptions so that a CoU for IMT could be created. The CoU is a prerequisite for achieving usability, according to ISO 9241-11. Through gigamap sessions, participants were invited to visualise how they work on projects and display relations between activities. The gigamap was able to show complex information through the interconnectedness of the activities and their dependencies, verified by the surveys and the semi-structured interviews.

The gigamapping had already provided value to the Company after five gigamap sessions by discovering that the Company has challenges with information exchange because multiple exchange mediums are used in projects. Another challenge that was discovered is that the Company also has challenges with managing system interfaces, not only because of multiple mediums for informational exchange but also because system interfaces are managed at different departments and between different disciplines, cross-disciplinary, verified through consecutive feedback from gigamap participants. The cross-disciplinary interface management was made more apparent after the distillation process. The distillation was done to remove cluttered information and retain what was significant. The artefacts were considered significant during the distillation process and not the cross-disciplinary interface management.

The survey confirms that the gigamap presents complex information, somewhat easy to read, albeit the data can be overwhelming if not structured. The question regarding its utility in creating a CoU remains unclear. The viewer can understand the CoU, and when the author guides the readers, they can see the CoU as a tool. However, gigamapping does not seem to be a preferred method to present a CoU unless guided by the author.

The research shows that gigamapping performs well for creating activity descriptions as a Systems Engineering method. Digital and physical gigamap sessions have advantages and disadvantages. Physical gigamapping gives additional information through the ambience and cues in the room. Digital gigamapping gives for easier managing and editing of mapped information. In addition, Gigamapping has shown itself as beneficial when it comes to discovering challenges because of the different perspectives of the participants, and it helps display relations and visualise them in the topic of interest.

Further work

The author recommends more research in integrating gigamapping as a tool within the field of human factors design.

In order to make potential users of a gigamap more comfortable exploring the content in the gigamap, investigate how to improve navigation within the gigamap and/or how to provide a more explicit description of a gigamap.

Within the domain of this paper, software development, additional areas where gigamapping can be explored are

- Gigamapping for maintenance of software and systems
- Gigamapping for stakeholder analysis
- Gigamapping and analysing user requirements for systems development
- Gigamapping and coordinating system integration with other systems or software
- Repeatability for gigamapping

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