Benjamin Morris King

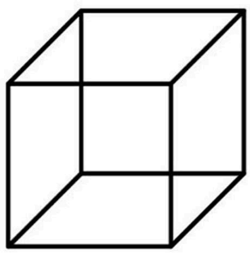
Postphenomenology and deep-water archaeology

A postphenomenological study on the relationship between archaeologists, technology, perception and praxis.

Master's thesis in Archaeology
Supervisor: Øyvind Ødegård
May 2020

Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Humanities
Department of Historical Studies



NTNU
Kunnskap for en bedre verden

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Abstract

Deep-water archaeology is highly technological, as it is reliant on marine technology such as robotics and imaging technologies to access cultural heritage that is below SCUBA diving depth in Norway. This leads to several theoretical questions concerning the implications and potential of technology on perception and praxis. The main aim of this thesis is to introduce postphenomenology to archaeology as a tool to discuss the implications and possibilities of technology. The focus is to explore deep-water archaeology in a postphenomenological perspective.

The research question for this thesis is as follows:

How can post-phenomenology help us in the understanding of how technology affects the archaeologist perceptions and praxis in deep-water archaeology?

From a postphenomenological perspective, the technologies have no "essence" one taken into praxis and can therefore not be separated from its use contexts- or in other cultural contexts. Technologies in the field of deep-water archaeology work as mediators that transforms the world in specific ways as a result of non-neutrality. With non-neutrality follows amplification/reduction structure, which transforms the world by amplifying some dimensions while reducing others. By doing this, we can bring into the human perceptual field what is unseen and unreachable by us with the use of technology.

I utilize a descriptive analysis to come with an explanation of how the technologies work within the framework of perception and amplification/reduction structure, and how it is forming the praxis in deep-water archaeology. Deep-water archaeologists use hermeneutical strategies to achieve desired visualizations, which is already a continuation of the inherent visual hermeneutical praxis in archaeology. By applying this theory, one can better understand how technology affects archaeologist's perception and praxis in deep-water archaeology. Postphenomenology forces us to consider what creates and constitutes our perception and praxis.

Foreword

Writing this thesis has been quite the learning experience for me as an archaeologist. There have been several setbacks and hard times towards the end of the thesis due to the coronavirus, and I would not have been finished in time if there was not for the support and constructive feedback from several people.

I would first like to give thanks to my supervisor Øyvind Ødegård. He has always been providing help and support from start to finish. I have learned so much as an archaeologist because you and will always be grateful for our exciting talks and your excellent feedback.

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Benjamin Morris King, Trondheim, 29.05.2020

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Chapter 1: Introduction

According to UNESCO (2001), there are approximately 3 million shipwrecks on the seabed worldwide. To be able to access cultural heritage underwater, marine archaeology is fundamentally dependent on technology (Ødegård, 2018, p.4). Marine and deep-water archaeology is, therefore, one of the most technologically advanced disciplines in archaeology and can, in many ways, be defined by its reliance on technology (Sperry, 2009). The practice of deep-water archaeological research is defined by a set of methods based on using technology to investigate and finding archeological material on the seabed deeper than the SCUBA equipped divers depth of 50 meters (Bingham Foley, Singh, Camilli, Delaporta, Eustice, & Sakellariou, 2010, p. 703). Most marine archaeologists in Norway do not dive deeper than 30 m.

This leads to several interesting questions relating to the relationship between theory and practice in deep-water archaeology. By looking back at processual, post-processual and contemporary archaeological theory, it has not only been concerned with the epistemological ways in which we interpret the material culture of the past, but has also been concerned with the relation between theory and practice and the implication of technologies used in archaeology.

Especially visualization technologies in archaeology has historically been an essential part of archaeological documentation and knowledge production. There have been studies in archaeological visualization since the 1960s. However, the most significant studies were conducted in the 1990s, and as Moser (2012) suggests, the more recent developments in archaeological visualization have maintained an "allegiance to core principle of scientific illustration developed in the sixteenth and seventeenth centuries " (Moser, 2012 p. 304). But what does this mean? In historical studies of antiquarian illustration during this period, the focus on the scientific image was used as a means to advance the scholarly pursuits at the start of antiquarian research in the sixteenth and seventeenth centuries, as these images served as archaeological data (Moser, 2012, p.304).

The focus in today's discussions when it comes to technology in archaeology is on how we can get "better" visualizations as a means to collect better data for archaeological research and knowledge production. This is especially the case for what I call the more technologically constituted archaeological fields such as deep-water archaeology. Many archaeologists have already been discussing the role of technology and scientific visualization in knowledge production in archaeology from a theoretical perspective (see example Lock, 2003; Jones & Levy, 2018; Perry, 2011). I will, in this thesis, "dive" into the discussions concerning the relationship and difference between science and technology in deep-water archaeology. I will do this through the lenses of what I consider an unknown philosophical movement in archaeology, and that is postphenomenology.

An important point to be made in this introduction is that the postphenomenological view on phenomenology greatly inspires me and my views on this topic. The reason why this is important to point out early on is that there are many interpretations, perspectives, and approaches to the understanding of phenomenology. The postphenomenological perspective on classical phenomenology separates itself from many of the points made in phenomenology when it comes to the question of technology and its implications on us as humans.

Postphenomenology is a philosophical movement in Science and Technology Studies (STS) and serves as a philosophy of technology that analyzes the phenomena of technology itself. Postphenomenology it is also heavily influenced by American pragmatism. The postphenomenological perspective on technology and science will serve as a good starting point in the discussion on the relationship between theory and practice, science and technology, and the role of technology in deep-water archaeology, as it is reliant on technologies.

This reliance on technology is a part of a more significant trend in our society and archaeological research. In many ways, the archaeological practice has always been dependent on some sort of technological instruments. The difference is that our contemporary technologies have become more "sophisticated", and new inventions as a result of technological development, are leading to new ways of seeing and doing archaeology. This is especially the case for deep-water archaeology.

Therefore, the main aim of this thesis is to introduce postphenomenology to archaeology and analyze the relationship between archaeology, technology, and perception. I believe that a postphenomenological perspective on this topic will give a new and refreshing insight into the relationship between archaeologists, technology, perception, and praxis. By using a deep-water archaeological investigation of a shipwreck in Trondheimfjorden as a case study, I will analyze the use of technologies and its consequence on perception.

1.1. Research status

Deep-water archaeology is closely associated with the history and development of marine technology (Broadwater, 2002). Technologies such as SCUBA equipment like the Aqualung developed in the 1940s by Jacques-Yves Cousteau and Emil Gagnan allowed divers more mobility for excavating underwater. After the breakthrough of the SCUBA technology throughout the 1950s to the 1970s, underwater archaeology went through rapid developments in the use of technological instruments and new methods for excavating and surveying archaeological remains (Bass, 2011).

During the 1960s, there was an increase in the use of technological instruments, which allowed archaeologists to document underwater heritage through the use of imaging technologies such as side-scan sonars (SSS) and magnetometers for the location of sunken and buried ships (Bass, 2011; Broadwater, 2002). Nevertheless, what defines deep-water archaeology is the use of technologies that give us access to remote places that is not accessible with the use of SCUBA-equipment.

What furthered the development of underwater/ deep-water archaeology as a scientific field was the remote operating vehicle (ROV). This also includes the sensors that the ROV and equip itself with and other acoustical sensors (often called payload sensors), and recently the use of autonomous underwater vehicles (AUV) is being developed and utilized as a tool for surveying and locating underwater heritage. The first ROV was probably built by Dimitri Rebikoff, an oceanographer and engineer in 1953 (Wernli, 2018).

One of the first deep-water archaeological projects, conducted with an ROV, was the Skerki Bank Project located in the Tyrrhenian Sea (Ballard, McCann, Whitcomb, Mindell, Oleson & Giangrande, 2000). During this 9 year project from 1988 to 1987, one of the first scientific use of robotics and a defining moment for deep-water archaeology was the Jason project that was conducted in 1989 (Adams, 2007; Ballard et al., 2000; Bingham et al., 2010, p.704). The purpose of the Jason project was to use a newly developed ROV named *JASON* to map and sample a site called *ISIS* (Ballard et al., 2000, p.1596). The ROV was used for an archaeological investigation, and the JASON ROV allowed the archaeologist to date the ISIS site to a late Roman wreck site on a depth of 800m (Bingham et al., 2010). Discoveries of other types of scattered material suggested that there may be significant numbers of shipwreck lying in the deep waters (Adams, 2007).

In Norway at the Norwegian University of Science and Technology, located in Trondheim, there has been a close collaboration between the archaeological department and the marine technological department. There have been conducted several deep-water archaeological surveys and investigations in interdisciplinary cooperation between archaeologists and marine engineers. As a result of technological development, we have seen an increase in new discoveries. This generates new opportunities, new ways of communicating, and new things to explain (Nilssen, Hepsø, Nattkemper & Johnsen, 2016). An example of this trend was the Ormen Lange project (Bryn, Jasinski & Søreide, 2007; Jasinski & Søreide, 2016). During this project, a deep-water archaeological survey and excavation of a shipwreck outside Nyhamna in Møre and Romsdal were carried out with the help of advanced underwater technological instruments. This kind of archaeological excavation at a depth of 165 – 175 meters had never been done before (Bryn et al., 2007; Jasinski & Søreide, 2016). This project demonstrated that we are now able to excavate a shipwreck in deep waters with complete dependency on technological tools and instruments.

Because of the rapid development of marine technology, the focus of the deep-water archeological field has been on applying this technology for archaeological surveying and documentation. While this has been a necessary part of deep-water archaeology, the focus on method has, in my opinion, overshadowed the need to take "a step back" and consider the ways in which technology affects archaeology as a field and its implications on archaeological epistemology, archaeologist's perception and practice.

1.2. Research question and thesis outline

The primary and only research question is as follows:

How can post-phenomenology help us in the understanding of how technology affects the archaeologist perceptions and praxis in deep-water archaeology?

The main goal is to introduce postphenomenology to archaeological theory concerning the questions on technology and its use in archaeological research and practice. This thesis focuses on deep-water archaeology and the use of technology as a basis for the postphenomenological study. My research can be seen as a part of the broader discussion in archaeology and the use of technology as a means for knowledge-gathering and production. Praxis, in this case, means the human ability to make theoretically informed action to knowingly and creatively make a change in the world. Practice is not the same as praxis, as practice simply means action in the world (McGuire, O`Donovan & Wurst, 2005, p. 356).

How does one apply postphenomenology theory? Postphenomenological research on technologies has some common characteristics that made me choose postphenomenology as a theory to answer my research question. Robert Rosenberger and Peter-Paul Verbeek lay these characteristics of postphenomenological studies as follows: firstly, postphenomenological studies focus on "*understanding the roles that technologies play in the relations between human and world, and on analyzing the implications of these roles*" (Rosenberger & Verbeek, 2015, p.31). Secondly, this means that the focus for a postphenomenological study is on human-technology relations that includes "*empirical work as a basis for philosophical reflection*" (Rosenberger & Verbeek, p.31). These empirical studies focus on a descriptive analysis from self-conducted studies or from a first-person perspective of specific technologies and its various dimensions and impact on human practices and experiences (Rosenberger & Verbeek, p.31). Thirdly, one should "*investigate how, on the relations that arise around a technology, a specific "world" is constituted, as well as a specific subject*" (Rosenberger & Verbeek, 2005, p.31). The specific "world" and "subject" in this case means deep-water archaeology. On the basis on these three characteristics as just described, "postphenomenological studies typically make a conceptual analysis of the implications of technologies (Rosenberger & Verbeek, 2005, p.31). This can include a specific dimension in the human-world relation that can be everything from epistemological to political implications.

For this thesis, I am focusing on the epistemological implications of technologies in deep-water archaeology. An essential aspect of postphenomenological studies is its focus on case studies of concrete human-technology relations to technologies. By applying postphenomenology, I will demonstrate the value and insights that postphenomenology can have for archaeological theory and deep-water archaeology. There will be no inclusion of political implications in this thesis.

In chapter 2, I am going to elaborate and explain postphenomenology and its philosophical discussion and its use of phenomenological concepts that Don Ihde incorporates in postphenomenology. Chapter 3 is the chapter where I do an archaeological investigation and will focus on the different optical and acoustic imaging technologies applied during the archaeological expedition. The case-study can, in a way, be seen as a separate part of the thesis, as the case-study will not have any postphenomenological discussions or analysis. The postphenomenological analysis and discussion are in chapters 4 and 5, respectively. In chapter 4, I will discuss the results from the case study and analyze it using postphenomenological theory to bring to light its use of technology and its implication on knowledge-gathering, production, and perception. I will then take the analysis and results in a broader discussion concerning the questions on technology in archaeology. My conclusion to this thesis will be in chapter 6.

Chapter 2: Postphenomenology as deep-water archaeological theory

In this chapter, I will first give a short account of some central phenomenological themes and thought of Edmund Husserl, Martin Heidegger, and Maurice Merleau-Ponty. After this, I will then explain the central themes in postphenomenology relevant for this thesis and how it incorporates the themes from phenomenology. Postphenomenology is also heavily influenced by another philosophical movement called pragmatism. Because of the scope of this thesis, I will mostly focus on phenomenology. This will lay the groundwork for understanding my analysis and discussion later on, as it shows how postphenomenology can help us archaeologists to understand how the world, or archaeological material, in this case in deep-water archaeology, shows itself through technology.

2.1. The "Post" in Postphenomenology and archaeology

While it may seem like a cliché to have the word "post" in front of phenomenology, there are good reasons for doing so. Postphenomenology wants to make an apparent deviation from the more classical phenomenological thought on technology. Don Ihde, the American philosopher behind postphenomenology, has a conception of phenomenology that approaches the relation between beings and their world in terms of experience through technologies (Verbeek, 2005, p.122). What is essential to know about postphenomenology is that it takes ideas from both phenomenology and American Pragmatism. This is another reason why Don Ihde`s philosophy is called postphenomenology, as it incorporates philosophical concepts and ideas from mostly classical phenomenologists such as Edmund Husserl, Martin Heidegger, Maurice Merleau-Ponty, and ideas from the pragmatist John Dewey.

Even if postphenomenology was developed during the post-processual archaeological period, the ideas and concepts fit into the new contemporary theoretical discussions in the archaeological discipline, where a turn towards things and the challenging of the Cartesian notion of subject/object dichotomy have led to an anthropocentric tendency (Olsen, 2010, p. 29).

While there are a few that have utilized or discussed postphenomenology in archaeology, I would still claim postphenomenology is mostly an unknown theory in archaeology (see example Chakrabarty, 2019; Crystal, 2018; Domanska, 2006). As pointed out in the introduction, there have been many discussions on the role of technology in archaeology. Many of them have the same themes, perspectives, and questions that postphenomenology discusses and seeks to answer.

2.2. Postphenomenology and technological intentionality

According to Ihde, before the origins of phenomenology, technology was not of much interest to philosophy as it may have been assumed that technology is *applied science,* only belonging to the natural sciences in which one applies existing scientific knowledge to develop technology or other inventions in order to understand the natural world. This harbors a "latent ontological judgment," according to Ihde (Ihde, 1979, p. xvii). The "idealistic" or "platonistic" view on science and technology has led to a theory-practice, or in other words, a mind-body distinction (Ihde, 1979, p. xix). What this means is that one, according to Ihde (1979), presumed that:"T*heory, as a set of concepts in some system of relations, is usually thought of as the product of mind, while practice often is associated with a product of body*" (p. xix).

This way of dividing the mind-body is in direct opposition to the phenomenological thought of Being and being-in-the-world. The "idealistic" approach has held a "*presumed primacy of "theory" over "practice", of "mind" over "body""* (Ihde, 1979, p. xxii), which has led to the view that only science creates technology and not the other way around. Phenomenology can be considered as a praxis philosophy from a Heideggerian approach (Ihde, 1979), as he saw the relations between human beings and tools as the center stage of the relationship between beings and their world (Verbeek, 2005).

The intentionality of technologies mediates the relation between humans and the world, which codetermine how subjectivity and objectivity are constituted. While Don Ihde also shares this view, but in Ihde`s sense, technological intentionality also co-shapes this contact and, in many ways, determines how humans can be present in their world and how the world gets presented to them (Verbeek, 2005, p. 116). Intentionality is probably the most important concept in phenomenology. It was first introduced by Edmund Husserl and later adapted and further developed by his student Martin Heidegger as Being-in-the-world. With this in mind, phenomenology attempts to overcome the tension between idealism and realism, or in other words, subjectivism and objectivism, respectively. Idealism means primacy to consciousness, while realism assigns primacy to reality, meaning that all knowledge we have about reality is a mirror to the world (Verbeek, 2005).

To solve this issue on this dualistic divide, Husserl introduced the term "intentionality" as a way of asking himself what is given to human beings when they are addressing themselves to the world (Verbeek, 2005, p.109). To make sense of this, Husserl had to "put things between brackets", which is called *epocè* or a phenomenological reduction (also called bracketing) (Verbeek, 2005, p.109). To be able to achieve this bracketing, he had to:

> *"suspend the "natural" attitude in which human beings assumes that what is given to them corresponds to a world outside them, or to an order fully articulated by reason. All presuppositions with respect to what is given must be put between brackets"* (Verbeek, 2005, p.109).

This is a direct break from the Cartesian idea res-cogitans and res-extensa thought, also known as Cartesian dualism, that has been a part of modern western epistemology. From my understanding, bracketing means that the world "outside" can no longer be characterized or longer be taken for granted. One must put aside what is believed to be the "essence" of the phenomena being studied. What is left is then appearances, or "phenomena" (hence the word *phenomenology*). Intentionality for Husserl means that human consciousness is always directed towards a phenomenon, as *consciousness-of-something*. Consciousness never exists as something that is isolated or divided from the world. By using this, we achieve the necessary phenomenological reduction or bracketing (Verbeek, 2005, p.109). This is known as *transcendental phenomenology,* as Husserl "*sought to discover the ultimate foundation of our beliefs of the world and our existence through an understanding of the framework of our own consciousness.*" (Yee, 2019, p.1).

Intentionality in the existential tradition of Martin Heidegger and Merleau-Ponty is an important concept that tries to understand the relations between beings and their world differently from Husserl. It does not separate them into the subject/object dichotomy, as human and their world beings cannot be understood in isolation (Verbeek, 2005). The understanding of intentionality between Edmund Husserl and his student Martin Heidegger is a little different, but Heidegger agrees with Husserl in that intentionality is a "*defining characteristic of all lived experiences*" (Moran, 2002, p. 232). While Husserl saw intentionality as a structure of consciousness, Heidegger engaged in the paraxial and existential nature of intentionality, as he emphasized the practical bodily encounters with things in the world, claiming that Husserl remained too Cartesian (Moran, 2002, p.13).

In Martin Heidegger`s "*Being and Time"* (2010) (originally published in 1927)*,* he broadens the term intentionality to be about Being-in-the-World. Dasein is the primary term that BT is analyzing. Dasein means "being there" or "being-in" (Moran, 2002). While Descartes thought of Being, Heidegger thought of Being as Being-in or Being-there. What Heidegger means is that one cannot separate or understand human beings as divided from their world, but as Being-in-the-world. Being-in-the-world means that we have a correlation with the world as the external world is not something that is separated from us. With the conception of Being-in-the-world, Heidegger seeks to give an account of our basic contact with things in the environment: *present-at-hand* and *ready-to-hand* (Ihde, 1990; Moran, 2002, p.233). Present-at-hand refers to the relation in which entities appear as "just there" in order for us to theorize about their particular qualities. Ready-to-hand refers to forms of active engagement with entities in the environment where we are using them without theorizing about them (Morian, 2002).

The postphenomenological perspective explores this intentionality through human-technology-world relations (Ihde, 1979, 1990, 1991). This is called *technological intentionality,* which means that technologies provide a framework for human actions and has a certain influence on those actions, a particular *technological trajectory* (Ihde, 1991, p.123)*.* Technologies do, in a sense, "want" humans to do things in a specific matter as technologies have a certain "intention" to promote among its users (Verbeek, 2001, p.136). I want to point out that this is not some "technological determinism" but sees technologies as playing a role of their own in human-technology-world relations.

Different scientific practices, with different "technological intentionality's", direct technological instruments to specific aspects of reality or phenomena that are "out of reach". In the case of deep-water archaeology, it brings phenomena such as shipwrecks and other underwater cultural heritage into contact with archaeologists and their world. This is called "technologically mediated intentionality" and refers to the relations between archaeologist and the deep-water archaeological "world" that are mediated through imaging technologies (Verbeek 2005, 2008). Mediation, in a more Latourian and symmetrical archaeological perspective, refers to the "*multiple way's humans and non-humans swap properties in the process of moving towards a goal*" (Witmore, 2007, p. 552), and is similar to the postphenomenological notion of mediation. In phenomenology, this becomes "human beings" and "world". One cannot perceive humans or the world apart from each other; they can only be perceived in their mutual relationship (Verbeek, 2001).

The humans and their world are constituted in the being-in-the-world in this way and in the mediated experience through technological artifacts. Instead of a human-world relation, postphenomenology places the technology in a mediational position (Ihde, 1979, p.18):

(1) Human—Technology—World

The position of technology in the diagram should be understood as a mediator of experience and not as something that stands in between humans and the world. Also, this diagram:

> "*deals with subjects and objects, not as pregiven entities that assume relations with each other, but as entities that are constituted in their mutual relation. Thus, postphenomenology does not draw a line between two poles, but rather lets the poles emerge from the line that constitutes them*" (Verbekk, 2005, p.163).

With this as a focal point for Ihde`s concept of technological intentionality, our attention is directed towards the various ways in which technologies are present in the role of human-world relations. When technology is involved in technological intentionality, it mediates the intentional relationship that constitutes human and world (Verbeek, 2005). However, Ihde still claims that "no instrument can eliminate whole body, primary experience" (Ihde, 2009, p. 467).

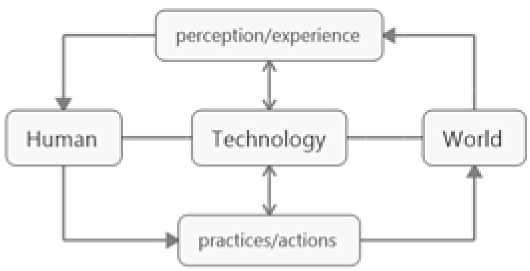


Figure 1: A diagram illustrating how postphenomenology sees human-technology-world-relations play out. Inspired by an illustration in "Animation: Explaining Technological Mediation" https://www.youtube.com.

The human-technology-world diagram suggests that the use of technological artifacts "embody" human experience. The line between the positions in the diagram shows the correlation between different positions and how human-world relations are mediated by an instrument (or technology). In the Human—Technology—World relation, as shown in figure 1, the experience is not that of the technology itself, but of the phenomena. We can say that technology is the means of the experience in deep-water archaeology and in other remote sensing archeology (Ihde, 1979). Just like Heidegger pointed out in his tool analysis of the hammer, there is a "withdrawal" or a "concealing" transformation of the world through technological mediation (Ihde, 1979, 1990). The technologies as focal points for experience of phenomena "disappear" in the contextual praxis in which the technologies are used. In this mediational relation, as shown in figure 1, the instrument extends the bodily perceptual limit and becomes integrated into our "self-experience" (Ihde, 1979, p. 19). This is taken from Merleau-Ponty in his book "*Phenomenology of Perception"* (1962) (originally published in 1945). In this book, he explores the spatiality of one`s body and motility through an artifact, such as a blind man`s stick, which becomes a perceptual extension, extending the scope and active radius of touch that is mediated through an artifact, a technology. (Merleau-Ponty, 1962, p.143: Ihde, 1990, p.40). There are, of course, several ways in which the human-technology-world relations materializes itself, creating different ways in which we are using technologies to relate and perceive the world around us.

2.3. Perception and mediated perception

Perception is a central theme in postphenomenology, as Ihde`s conception of phenomenology occupies itself with human experience and the structure of experience (Ihde, 1990). Ihde calls his analysis of human experience as relativistic (Ihde, 1990, p.23). This relativistic assumption is not to be confused with epistemological relativism as Ihde states:

> "*A phenomenological account … always takes as its primitive the relationality of the human experiencer to the field of experience. In this sense, it is rigorously relativist. The relationality of human-world relationships is claimed by phenomenologists to be an ontological feature of all knowledge, all experience*" (Ihde, 1990, p.25).

For Ihde, this plays a crucial role in phenomenology as experience is the place in which the mutual relation between human being and their world can be localized (Verbeek, 2001, p.123). Ihde explores this and analyses human experience in terms of perception, as he considers perception to be the key to understanding the relation between humans and their world (Ihde, 1998, p.33; Verbeek, 2001, p.123). In perception, human beings and their world are not separated, as in experience. People are as much "in" the world" as the world is "in" them (Verbeek, 2001, p.123).

What differentiates postphenomenology from the classical phenomenology is how Ihde distinguishes perception into two dimensions. He calls these dimensions micro-perception and macro-perception (Ihde, 1990). Micro-perception always implicates the body-in-action, meaning that the body is correlated with a world that is open to action (Ihde, 1990, p. 39). Micro-perception is the sensory perception and bodily dimension (Verbeek, 2001, p. 124), which means actual seeing, hearing, and other bodily experiences (Ihde, 1990, p.29; Ihde, 1993, p.74). Macro-perception is the interpretive dimension (or hermeneutical dimension) of perception, that exists in a cultural context in which micro-perception exists and yield diversity in the understanding of perception. The macro-perception "informs or orients bodily perception itself" (Ihde, 1990, p. 29, 40; Ihde, 1993, p.74; Verbeek, 2001; Hasse, 2008). This epistemology on perception is quite useful when it comes the question on the relationship between deep-water archaeology as a social and cultural practice and the archaeologist practicing this discipline (Hasse, 2008, p. 45). These dimensions of perception take into account the positionality and context of archaeologists.

In terms of mediation, Ihde modifies his views on mediation by using Heidegger and Merleau-Ponty views on human beings and artifacts. In short, Ihde uses Heidegger tools analysis where the artifact "withdraws" human beings from their experiences while Merleau-Ponty analyzes how the bodily senses can be extended through artifacts (Ihde, 1990, p. 31-34, 38-41). Ihde uses these analyses to describe perception in terms of mediation as the intentional relation between human beings and the world that is extended through artifacts (Ihde, 1979; Ihde, 1990; Verbeek, 2001, p.126). There is therefore mediated, and unmediated perception as shown in this diagram:

Unmediated perception: I-world
Mediated perception: I-Technology-World

Unmediated perception means perception that is unmediated by artifacts. Unmediated perception takes place without the intervention of technology or artifact on the micro perceptual level (Verbeek, 2001). Mediated perception though technology perception means mediated by technology. Mediated perception is what defines deep-water archaeology, as the only way to experience the world in which deep-water archaeology operates is through mediated perception and the way in which the technologies are used in this discipline. Meditated perception via technology is, therefore, never identical to unmediated perception as a result of non-neutrality (Ihde, 1979). In mediated, or in other words, human-technology relations, Ihde shows that there are several basic and different sets of human-technology relations in which technologies mediate people's relation and perception of the world. The two most important, and which are the only ones I am going to cover in this thesis are embodied relations and hermeneutical relations, as Ihde identifies four different sets of human-technology-world relations.

2.4. Non-neutrality and multistability

As previously mentioned, postphenomenology discusses how technologies mediate and transform human experiences and perceptions of the world in archaeology (Rosenberger & Verbeek, 2015). Ihde argues that all science is related to some sort of variable interaction with technological instruments. Science is essentially tied to its technologies and uses technologies in its production of knowledge (Ihde, 2009). Ihde examines this notion of the nature of scientific practice and knowledge production through studies of different technologies, historical approaches to technology, and philosophical discussions. The main goal for these approaches is to show that technologies are related to contexts of human actions and that the use of technologies is related to the *cultural context* in which they are used and perceived. This ontological notion of that technologies cannot be separated from their use contexts, suggests that technologies have no "essence" (Verbeek, 2005). Technologies, once taken into *praxis,* are not just mere objects «in themselves» (Ihde, 1993, p. 34).

Here we see the pragmatist thought incorporated into postphenomenology, as pragmatism is anti-essentialist (McDavid, 2000; Zwier, Blok & Lemmens, 2015). Specific themes occur in postphenomenology that borrows its foundation from pragmatism, where there most important ones are the anti-essentialist, anti-foundationalist viewpoints and that "truth is rather made than found" (McDavid, 2000, p.227). As it turns out, the pragmatist elements in postphenomenology fit well with the existential nature of Heidegger's tool-analysis and Merleau-Ponty's phenomenology of perception in that the idea of technologies are related to the cultural context. This corresponds with the rejection of the fact/value split in pragmatist thought (Hickman, 2008). Also, according to Dewey, the scientific methods used in the sciences and its results are mostly constructed (Mitcham, 2006). Consequently, we can say that technologies, in postphenomenological terminology, are *non-neutral* and *multistable.* What does this mean, and what implications do this notion of technologies have?

Non-neutrality and multistability are deeply connected with how postphenomenology views the use of technology and how it changes us as human beings and our experiences of the world. First, the notion of technologies as non-neutral was first discussed in Ihde`s book "*Technics and Praxis"* (1979) and referred to how technologies transform direct perceptual experience that humans have of the world (Ihde, 1979, p.21). How this transformation is experienced, depends on the different technologically mediated intentional relations one has with the technologies itself, and in the cultural context in which they are used. Technologies in postphenomenology are not neutral tools as means of accomplishing tasks, or a means to an end, which suggests technological determinism. Ihde claims that there is such a thing as "mere use" of technologies (Ihde, 1998, p.47). Non-neutral technologies lead the transformation of experience through the use of instruments and other technological artifacts in what is called amplification/reduction structures (this will be explained in chapter 2.5) (Ihde, 1979).

Multistability, a term first introduced in Ihde's book "*Experimental Phenomenology: An Introduction"* (1977), is used for describing context-dependence and takes "*into account both the context and the observer's positionality*" (Ihde, 2012, p. 275). This concept from Ihde is derived from Husserl's phenomenology and his variational theory. Multistability focuses on the artifacts and in the ways in which technologies operate in human-technology relations, which is never singular, stable, or neutral. To demonstrate this, Ihde uses the Necker Cube as an example to demonstrate in the different ways of perceiving the cube (Ihde, 1977).

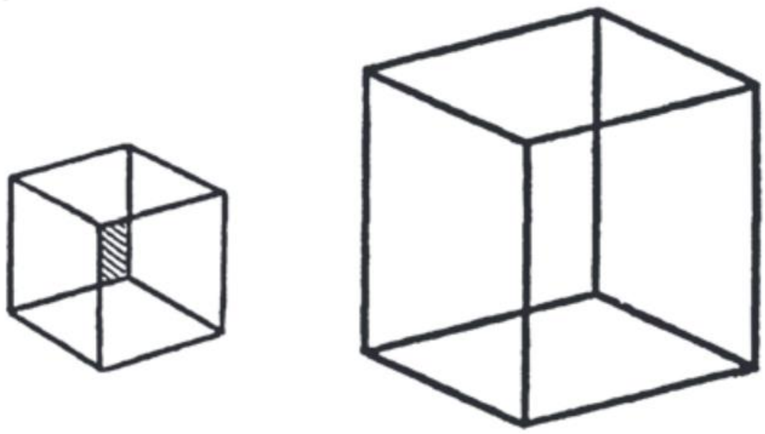


Figure 2: Ihde uses the Necker Cube for illustrating "multistability". From Ihde (2012), in *Experimental Phenomenology: Multistabilities* (p.68).

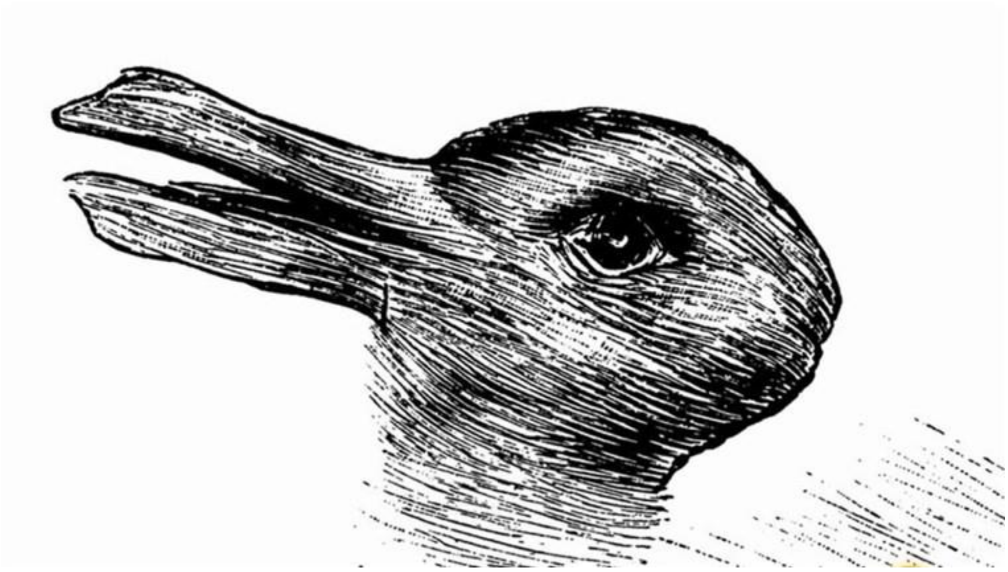


Figure 3:The duck/rabbit is an ambiguous image, which illustrates how an image can be multistable. Illustration retrieved from https://www.independent.co.uk.

To understand multistability, one has to know what Gestalt means. The German word Gestalt means the shape or essence of an entity`s form, taken as a whole. The effect of Gestalt comes from a set of informational elements that yields two or more recognizable patterns like the ones in figure 2 and 3. A perceptual transformation can be viewed as a "Gestalt-switch" (Micheli, 2012, p.1). For example, the cube can be perceived in variational ways, and through "gestalt switches" of the cubes, there are several ways in which the cube appears. In figure 2, the cube on the left is no longer a cube but may be" a spider in a web" because of the "filling" in the middle of the cube, giving a different illusion. The cube on the right side can be perceived as a "cube", but the position of the illusion can be viewed from multiple angles. You can either see below or from above the cube. Another great example is the rabbit/duck illusion in figure 3. In one instance, it is perceived as a duck, and in another instance, through a "gestalt switch", it can be perceived as a rabbit. These new appearances, or Gestalts, demonstrate that these images or phenomena in the ways they show themselves are not "stable" by nature but are instead multistable (Ihde, 2012).

What these illustrations "really" are is undermined, as it can be many things at once, which also applies to the use of technologies, as the use of technologies are "multistable". This means that technologies are technologies-in-use, a part of a broader cultural context, and can inhabit different meanings or identities in different cultural contexts (Verbeek, 2001). This pragmatist and anti-essentialist standpoint in postphenomenology mean that it is not interested in the "true" essence of technology, as it instead attempts to study the various practices and its implication of the uses of artifacts in various multistable ways.

This has implications on the existential human-technology relations, leading to different trajectories in how one correlates to an instrument and how technologies mediate the world. This relation renders our experience, which is historically and culturally embedded. (Ihde, 1979). As Ihde states, he wishes to "r*etain the sense of materiality which technologies imply. This materiality correlates with our bodily materiality, the experience we have as being our bodies in an environment* (Ihde, 1990, p.25). This is an important characteristic of multistability. An example of multistability is the use of the auger. From my personal experience, the use of auger in archaeology can be used in several different ways. The "primal" task of the auger is to collect soil samples that archaeologists use to get a sense of the stratigraphy in the ground and to identify potential archaeological sites. The auger can also be used as a probe to identify gravemounds, as gravemounds consist of rocks that can be identified by hitting it with a metal auger. Imaging technologies and the images it produces are also multistable, as what is imaged can be perceived in various ways.

2.5. Amplification-reduction structures

There are specific implications of technological mediations for our experience. The different positions in human-instrument-world relations, or technological intentionality, transform the world through amplification-reduction structures, as technologies transform experiences. This is caused by the non-neutrality of technologies (Ihde, 1979, 1990), and directly linked to Ihde's notion of perception as previously explained, and to Heidegger s analysis of the ways in which the tool is present to human beings (Verbeek, 2005).

Let us again use the example of the auger in archaeology: the auger does not only extend embodiment, but it also *amplifies* certain characteristics of the gravemounds. The auger, which is made of metal, amplifies certain essential characteristics of the gravemound – the presence of stones - that are covered in moss and grass. In a Heideggerian view, the auger then becomes "ready-to-hand", as the object of the experience is not the instrument. Instead, it is the gravemound that is the "object" or focal point of experience. The withdrawal of the auger suggests that the instrument, according to Ihde, "*becomes the means by which "I" can be extended beyond my bodily limit and it may be spoken of as a withdrawal into my now extended "self-experience*" "(Ihde, 1979, p. 19). Here we see Ihde is directing us towards Merleau-Ponty and the role of embodiment in perception (Verbeek, 2001, p.125).

The characteristics of what cannot be seen, are amplified through the auger. One can "feel" what is beneath the soil and gravemound. When metal meets stone, the way in which the auger mediates the characteristics of the stones is amplified, as metal hitting stone is quite dramatic. The auger gives me a certain sense of the *micro-features* of the gravemound as I can feel beneath the surface of the gravemound, hitting a stone. The part of the amplification of the auger or instrument reveals micro-features only partly available without digging and destroying the gravemound (Ihde, 1979). Nevertheless, this is what typically characterizes the role of amplification: the whole point of the use of technology in science, especially deep-water archaeology or remote sensing archaeology in general, is to amplify that which is not visible or out of reach. This amplification is often dramatic and stands out, and as a result, the amplification-reduction structures of the instrument make knowledge-gathering possible and serves as a condition for new ways of knowledge gathering (Ihde, 1979).

Because of the dramatic effect of amplification, it is easy to forget the two-way structure of the use of technology in archaeology. As certain features of the phenomena are amplified, there is a simultaneous reduction of the experience of other dimensions related to the gravemound through the auger. The gravemound is in a way taken "out" of its original context, and other important dimensions of the gravemound are reduced and backgrounded. This also illustrates that technologies are multistable, as "*they have* *structures ambiguities which allows that first appears as a "same" technology to be differently situated and have different trajectories*" (Ihde, 2010, p.126).

We can distinguish between different transformations within amplifications-reduction structures (Verbeek, 2001, 2005). Ihde distinguishes between what he calls low contrast transformation and high contrast transformations (Ihde, 1979). Especially with new technological advancements, human perception is transformed within technological contexts, meaning that contemporary archaeologist is situated and placed differently compared to the archaeologist in the late 19th century (Ihde, 2009).

With new technological advancements, this distinguishing between contemporary archaeology and older traditional archaeology can be related to the technological advancement in low/high contrast transformation in perception. In my view, a significant technological development can be characterized by the emergence of instruments that produce visualizations. These instruments often turn to high contrast transformations, producing visualizations that are complex and require certain theoretical scientific insights for interpretation (Nilssen et al., 2016).

2.6. Trajectories in human-technology-world relations

As just explained, there are several different positions that technologies can inhabit in human-technology-world relations. The technologies in themselves have different inherent ways in which they mediate the world and how we, as humans, experience it. In the diagrams for embodied and hermeneutic relations, we see that the mediational position of the instruments or the technologies, changes with regards to the materiality of the technology itself gives the user different experiences and to its results (Ihde, 1979, p.31). Ihde distinguishes between the technologies that extend and embody human experiences (embodied relations), and those that lay the groundwork for hermeneutic reflections (hermeneutical relations) (Ihde, 1979; Mitcham, 2006).

2.6.1. Embodied-relations

In embodied-relations in a postphenomenological perspective, the mediating position of the instrument in human-instrument-world relations directly embodies human perceptions and motions (Ihde, 1979, p.29).

(1) (human - technology) — world.

The position of the instrument is in direct contact with the human. The experience is then not that of the instrument, but the world through the instrument. Ihde explains this by the example of a dentist's relation with a probe to experience the tooth of a patient (Ihde, 1979). An archaeological example is the use of an auger to identify overgrown gravemounds. The auger is used to feel the stones beneath the grass or moss. The micro-structures of the gravemound itself come into "view", and our relation to the phenomena changes. A shift of perception has occurred using an instrument, as it has extended the human-bodily sensory field. The instrument can be said to be *semi-transparent (*this term only applies to embodiment-relations). Pure transparency from the instrument is not possible, but according to Ihde, embodiment-relation contains "*the highest degree of human-instrument symbiosis"* and that *"is precisely what characterizes such uses of instruments*" (Ihde, 1979, p. 29). This doesn't necessarily mean that embodiment-relations are "better" than other technological intentional relations as there is always in some way's bodily involvement in the use of instruments, which is especially the case for archaeology.

In his tool analysis, Heidegger discusses how the hammer withdraws as the focal point of the work and not of the tool itself, which is barely noticed (Ihde, 1979, p.28; Ihde, 1990, p.73). The same analysis can be attributed to the example of the auger, as we do not look at the auger as present-at-hand, but as ready-to-hand. In practice, this means that the auger does not call attention to itself, but instead brings aspects of the world given through the auger (Verbeek, 2005, p.126). The withdrawal or disappearance of the auger becomes the means by which we can extend beyond our bodily capacities, just like the blind man's stick (Merleau-Ponty, 1962, p.143; Ihde, 1979, p.19).

2.6.2. Hermeneutic -relations

Another trajectory in human-technology-world relations is the hermeneutic relation. Like the embodiment relation, the hermeneutic relation is one of the basic existential relations between the human and the world (Ihde, 1990, p. 94). Hermeneutics is historically concerned with interpretation or "reading" of texts. In our diagram, the instrument itself serves as an analytic deconstructor of the phenomenon (Ihde, 1979, p. 35). This instrumental deconstruction produces a "representation" or a "text" which tells us something about the phenomena which must be interpreted or read. How the phenomena become visible may vary with the instrumental intentionality.

(2) Human - (technology-world)

The mediating position of the instrument has moved from the experiencing *from* the instrument to experience *of* the instrument itself and the world it presents (Ihde, 1979, p.11). Such a hermeneutic relation suggests a more dramatic transformation of experiencing and seeing in contrast with the embodiment relation, where the instrument transforms experience directly in contact with humans. In hermeneutic relations, the instrument itself becomes a readable technology, which calls for an extension of one's hermeneutic and "linguistic" capacities through the instrument or technology. While reading, one retains the bodily perceptual location towards the technology itself (Ihde, 1990, p.88).

In hermeneutical relations, the instrument becomes the "other", presenting different possibilities not conceivable through embodied-relations (Ihde, 1979, p.12). This is because, in contrast with embodied relations, the instrument is not transparent, as it does not withdraw our relation to the world. Instead, it gives and produces a readable representation of one (Verbeek, 2005, p.125).

Making the world "readable" in hermeneutic relations consists of transforming what is not perceptible and making it perceptible through instruments, giving a "voice to things" (Ihde, 2009; Verbeek, 2005, p.141). Hermeneutical relations lead to transformations of higher contrast amplification/reduction structures, as the mediation in hermeneutical relations moves away from unmediated direct perception. The representation of the world implies that the design of the technology itself predetermines which aspect of reality becomes presented (Ihde, 1979, 1990; Verbeek, 2015). This leads to a certain discontinuity with mundane unmediated vision, pushing the hermeneutic relation into two variations: horizontal instrumental variations and vertical instrumental variations (Ihde, 1979, p.34-35). Horizontal instrumental variation is related to low contrast transformation, as the horizontal instrumental variant retains visual recognizability of the phenomena presented. So, when a low contrast transformation occurs, there is a horizontal instrumental variation going on, where the interpretive user comes into play, but must not necessarily be a trained scientist to be able to read the representation (Ihde, 1979).

The opposite of horizontal instrumental variation is vertical instrumental variation, which is related to the high contrast transformation. In a vertical instrumental variation, the result has moved drastically from human vision, leading to a "text like" result as there is no correspondence between the representation and phenomena (Ihde, 1979, p.35). It tells us something about the thing, but a scientific understanding of the results is required to be able to read it.

Even though the instrument in hermeneutical relations in a way is "distanced", being seen as an "other", there is still an embodied dimension to hermeneutical relations. As technologies have no "essence", they exist in an existential relationship with humans, in human-technology-world relations. As showcased in the tool-analysis of Heidegger, all technology is linked to a human-technology context that implies bodily action, perception, and praxis (Ihde, 2009, p. 46). For Ihde, contemporary science is embodied in instrumentation, or in other terms, science as praxis is a "*knowledge-gathering activity which only occurs by being embodied*" (Ihde, 1979, p. xxvi). In hermeneutical relations, the instrument in Heidegger's words becomes present-at-hand, where the technology becomes the means of experience rather than the object of our experiences (Verbeek, 2005, p.124).

2.7. Conclusion

In this chapter, I have introduced the core concepts and ideas on technology in postphenomenology. The purpose of this chapter is to prepare the reader for the next chapters of this thesis. Deep-water archaeology as a research field is at the forefront in the development of new ways of visualizing phenomena, much due to its interdisciplinary nature and through its use of marine technology. As we get higher contrast mediations, we are in the continuum turning from embodied relation towards hermeneutical relations (Verbeek, 2005).

Chapter 3: M/S Helma: a case study

3.1. Introduction Background for the case study

In April 2019, the TMR4120 Underwater Engineering course at NTNU surveyed a wreck site at Skogn in Trøndelag. The wreck site had already been detected in 2014 by NTNU's Applied Underwater Robotics Laboratory (AUR-Lab). I was able to join the engineering students on the one-day survey to conduct an archaeological survey using underwater technology, including optical and acoustical sensors. Historical records suggest that the wreck is *M/S Helma*, which burned and sank in the area in 1927 as it was transporting hay. The wreck site was at a depth of 50 to 60 m.

The main goal of the survey was to identify the ship and to record the wreck site with acoustic sensors with the AUV and with ROV with mounted stereo-camera for photogrammetric modelling. The data presented here includes data from the initial 2014 discovery of the wreck site. In addition to accounting for data acquisition during field operations, this case study will look at the interpretation of such data in relation to archaeological theory and analysis. Especially the raw image data from the Skogn poses significant challenges for photogrammetry processing due to varying image quality (light attenuation). This case study must be seen from the perspective of an archaeological survey.

3.2. A short biography of M/S Helma and Ottesen Skipsbryggeri(shipyard).

M/S Helma was built at the Ottesen Skipbyggeri in Sagvåg on the west coast of Norway. It was founded by Otte Ottesen in 1825, and it is one of the oldest still running shipyards in Stord. In the beginning, fishing boats like the Norwegian "Jekt" and "Slupp" were built by hand with axes, saws, knives, and hammers. During the last half of the 19th century, there was an increase in fishing as a result of the "Iceland-expeditions". Because of this, the ships had to be built larger in order to tackle the open sea. In the years from 1800 to the end of 1890, fishing and trolling in the North Sea increased, and Ottesen Skipsbryggeri went over to more mechanized ships. After 1901, the shipyard got upgrades in the form of more modernized ship-building techniques and technology, which includes M/S Helma (Høyland, 1973, p. 305-309).

Information on M/S Helma is quite limited, but fortunately, there are some records about the construction and the shipyard it was built. M/S Helma was built as a three-masted motorized schooner in 1919 and sold to Georg Hess from Bergen in 1923. It was then sold to G.E. Hansen from Sandefjord in 1925, and two years later, sold again to an unknown owner in Ålesund. According to the records, it burned down during the transportation of hay on March 26, 1927 (Tandberg, 1993, p.31). According to historical sources, M/S Helma was approximately 38m in length, 8 m wide, and 4 m in depth (Tandberg, 1993, p.31). The wooden schooner was also equipped with a two-cylinder engine produced by Norsk Motor A/S Bergen. There were built at least one more ship of this kind called M/S Velma.

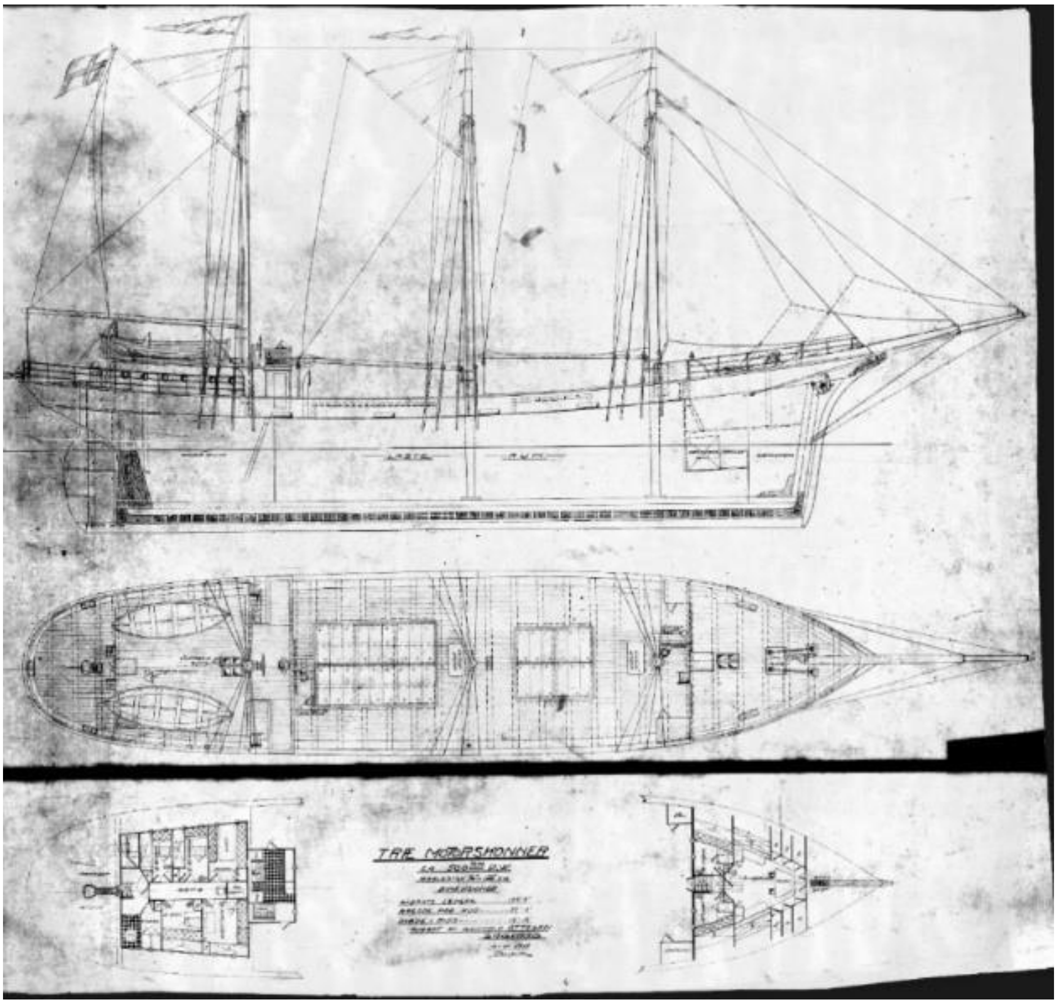


Figure 4: A drawing called "Three Motor Schooners" from Ottesen Skipsbryggeri (English translation). One of these was the M/S Helma. Drawing from Hordaland Fylkesarkiv

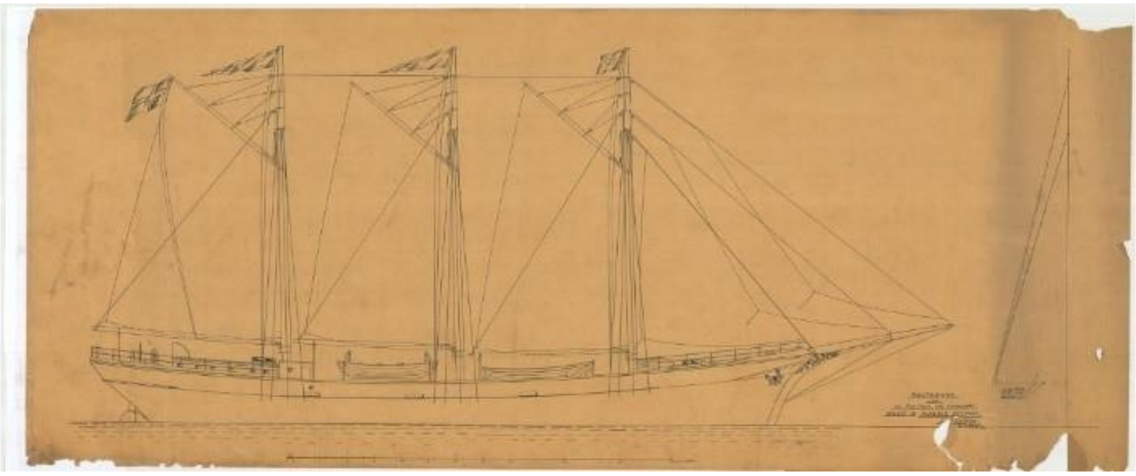


Figure 5: Another drawing of M/S Helms. Drawing retrieved from Hordaland Fylkesarkiv

3.3. R/V Gunnerus and Multibeam Echo Sounder (MBES)

The archaeological survey was conducted from the ship R/V Gunnerus, which is owned by NTNU. The ship can hold personnel of 25 people, and it is equipped with wet and dry labs along with computer labs, making it a great vessel for deep-water archaeology. R/V Gunnerus is equipped with the Kongsberg Maritime EM 3002 single head MBES with dynamically focused beams (Ødegård, Ludvigsen, Johnsen, Sørensen, Ekehaug, Dukan & Moline, 2012). The bathymetric survey was conducted in 2014 with the Kongsberg EM 3002, as the equipment during our expedition was not functioning. The Kongsberg EM 3002 is a high-resolution MBES for seabed mapping with an operating depth from 1 m to 150 m depth, depending on the attenuation in the water surface. The operating frequency is 300 kHz (Kongsberg, 2004). It is best suited for shallower waters. As figure 6 illustrates, the sonar is fixed to the hull of the ship.

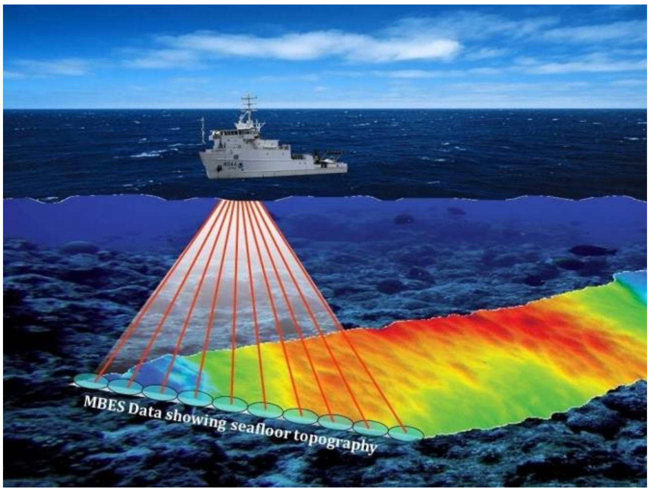


Figure 6: The MBES was mounted to the hull of the ship. Illustration from https://www.wikipedia.com

MBES is generally used to create bathymetric maps of the seafloor by using acoustic pulses and listening for received echoes. The receiver measures the time from when the ping via the transmitter was transmitted and when the echo is received, which then is used to estimate the range to the seafloor (Norgren, 2018 p.25). The seabed images produced from MBES is similar to SSS seabed images, but there are noticeable differences in its results (Ødegård et al., 2012). First of all, as illustrated in figure 6, the MBES is connected to the hull of the ship, which limits the operational radius of the MBES. MBES can also be mounted on an AUV or ROV, which would give a higher resolution data as it is closer to the seabed (Blondel, 2010; Ødegård et al., 2012, p.773). The data is also processed through Seafloor Information System software (developed by Kongsberg) while surveying, making it possible to view the data in real-time.

Secondly, the main difference compared to SSS, is that the MBES transmit several beams to extract and measure the directional information from the returning echoes. The MBES can produce XYZ values based on these echoes for each point from the beams, creating bathymetric data that gives depth measurements and their position on the seafloor (Ødegård, Sørensen, Hansen & Ludvigsen, 2016).

Processes that operate in the natural environment determine which wrecks are preserved on the seabed. The multibeam data allows for the detection of undiscovered shipwrecks and provides an opportunity to examine these processes on the seafloor on a regional and local scale (Plets, Quinn, Forsythe, Westley, Bell, Benetti & Robinson, 2011).

3.3.1 Results

The NaviModel software (developed by EIVA) was used to review the data. The ship parts and form are spatially more complicated as a result of the hull not being intact. Without knowing the position of the shipwreck, this feature could be interpreted as a marine geomorphological feature if it was not for the vertical structure, as shown in figure 7. This anomaly was hard to find because of the resolution of the MBES data.

If the wreck site consists of scattered individual artifacts that are less prone to degradation, the resolution of the gridded MBES data is too low for such objects, making it impossible to perceive and detect (Plets et al., 2011). This is definitely the case in these data sets, as the resolution is too low to get a detailed view of the ship. Therefore, MBES is mostly used in deep-water archaeology for locating potential anomalies of interest. This does, of course, depend on the application of the MBES sensor. MBES can be mounted on an AUV, which is able to survey the wreck at a shorter distance, creating higher resolution data.

By combining SSS imaging with MBES bathymetry, the combination of these two improves the interpretation of acoustic measurements. For archaeological purposes, 3D representations of the seabed speed up the interpretation process (Blondel, 2010, p. 43-44). While this combination of data has its benefits, both the SSS and MBES usually contain missing information that is necessary to do a complete archaeological survey and information gathering (Blondel, 2010). As pointed out previously, the resolution of the MBES data is too low to come with any interpretations that can further identify the ship as Helma. By combining the SSS data with the MBES, one can make a 3D representation that can give a better picture of the site. With the use of the XYZ points from the MBES data, the SSS image can be used as a "texture" on top of the MBES data.

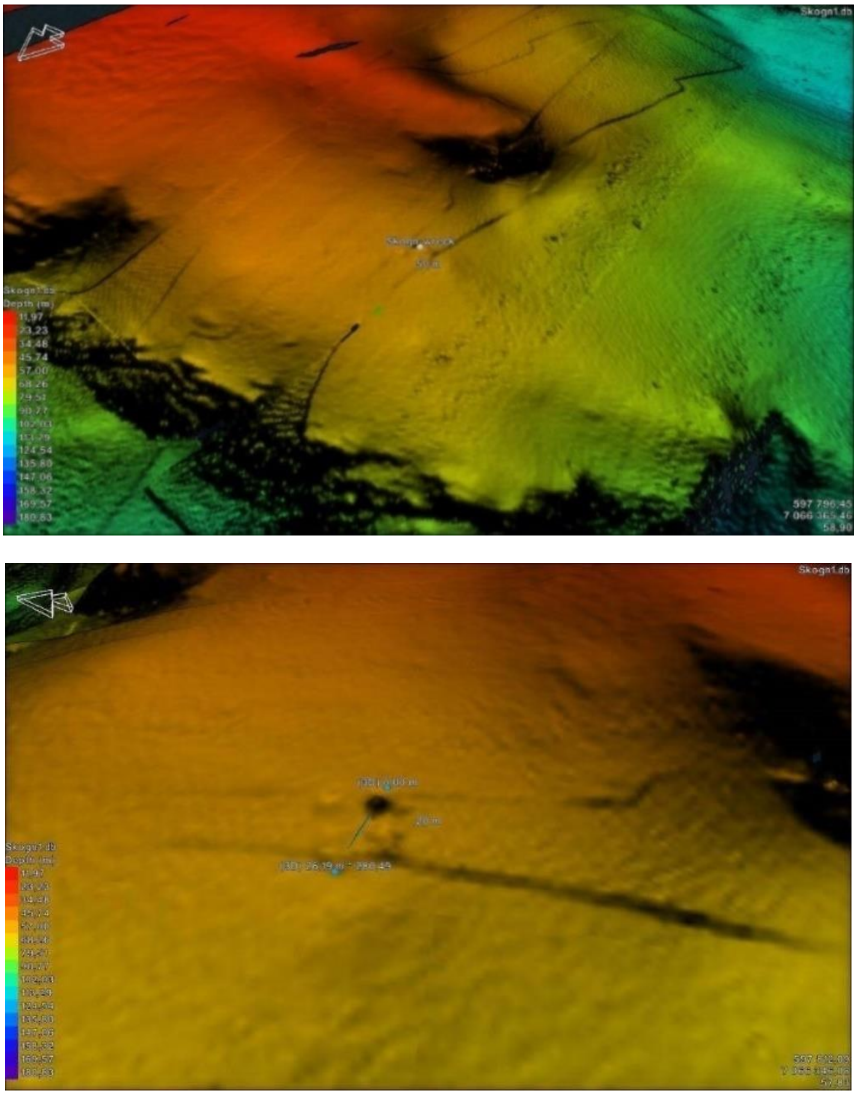
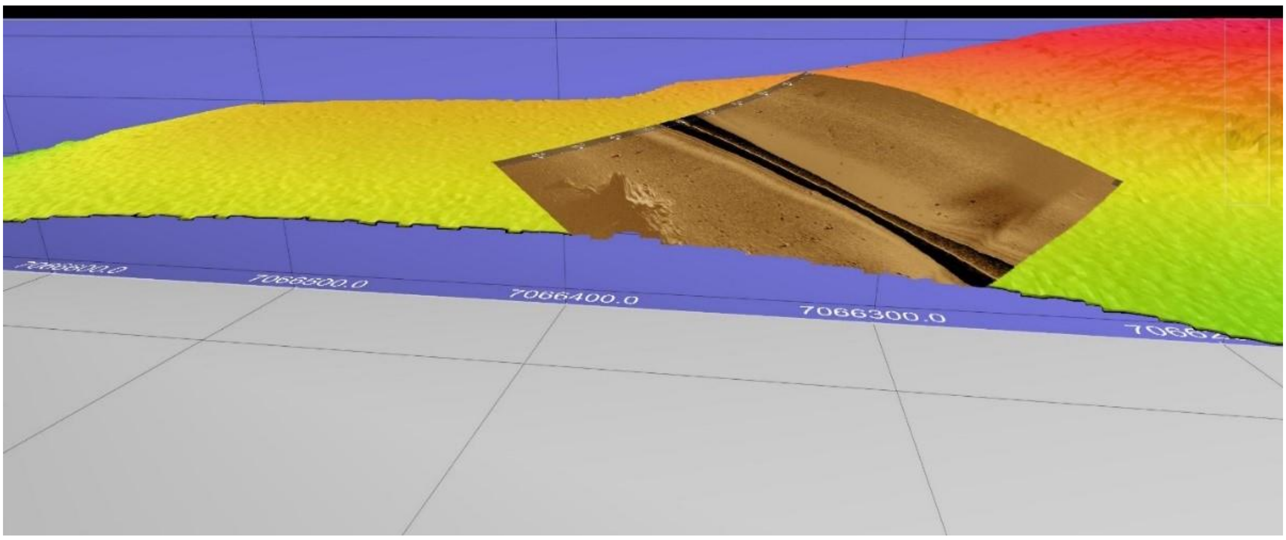


Figure 7: Results of the MBES data which gives a good overview of the seabed. White point in the middle is the location of M/S Helma



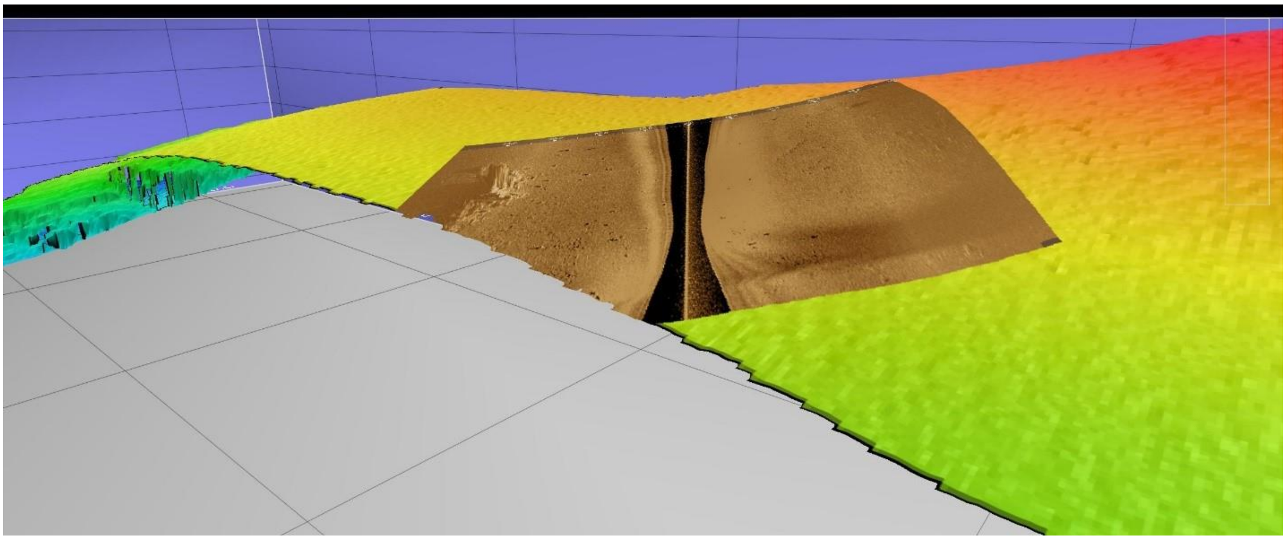


Figure 8: A fusion of MBES and SSS data, creating a 3D representation that gives more information about the wreck site.

3.3. AUV and SSS

The shipwreck was discovered in 2014 with the use of Autonomous Underwater Vehicle (AUV) and Side Scan Sonar (SSS). AUVs are used for a wide range of different oceanographic tasks in different scientific disciplines such as biology and archaeology and can perform surveys of large areas (Carreras, Hernández, Vidal, Palomeras, Ribas & Ridao, 2018; Seto, Paull & Saeedi S, 2013). AUVs operates autonomously based on preprogrammed maneuverers in mission plans to maintain desired depth, pitch, roll and heading by using real-time data from sensors like pressure sensor, altimeter, compass, gyroscopes and more (Martin, 2013). Most AUVs today are shaped like a torpedo-like the ones in figure 9. The AUV in deep-water archaeology is quite useful, as it can cover larger areas in a systematic matter. It can also access places not reachable with a ship like under the ice on the North Pole.

Because of technical problems with the AUV, we were not able to capture new SSS data during our 2019 survey. The AUV used for the capturing of the SSS data in 2014 was the Remus 100. The Remus 100 has a max operational depth of 100m and a battery capacity of approximately 8 to 12 hours. Typical endurance is about 4-5 hours with a speed of 3-4 knots (Ruud, 2016). The AUV is equipped with the MSTL SF 900kHz SSS and can obtain a flight path 3m in altitude to the seabed (Ruud. 2016; Ødegård et al., 2012). It weighs 31 kg in the air with a vehicle diameter of 19 cm (Ruud, 2016).

Figure 9: Pictures of AUV. The left photo is of the AUV from the 2019 expedition. The picture to the right is of the AUV used in 2014. The photo on the right from https://www.ntnu.edu.

3.3.3. Side Scan Sonar

Side scan sonar (SSS) is an acoustic sensor that shows backscattering imagery of reflections and shadows on the seabed that enables visual interpretation of wreck-sites. It is widely regarded as an instrument of choice in marine archaeology for conducting seabed mapping, as it can cover large areas and gives a good view of the seabed. SSS uses two side-mounted sonar transducers that emit pulses and then record the time and strength of the echoes, creating imagery of the seabed (Singh Adams, Mindell & Foley, 2000; Ødegård et al., 2016, p. 487-488). SSS systems are usually attached to a torpedo-shaped carrier that either can be towed or self-propelled. The resulting imagery has a black gap in the middle (directly under the sensor) because of the transducers being attached on the sides on the carrier. The pulse is then emitted at an acute angle with the seabed (Singh et al., 2000).

According to the control experiments of backscatter responses for archaeological side-scan sonar surveys conducted, the resolution of the SSS imagery is not only dependent on frequency (Quinn, Dean, Lawrence, Liscoe & Boland, 2005). Factors such as the velocity in which the acoustic waves travel will also vary in different water temperatures or salinity (Blondel, 2010, p.12). Acoustic waves during their propagation will be affected in the water column on the way to the seabed. The further the acoustic waves move from the transmitter, the waves will spread over a larger volume, resulting in lower resolution. This is often referred to as the range-resolution trade-off, meaning the type and length of the pulse governs the resolution of the data (Blondel, 2010, p. 10-11). The higher the frequency, the higher resolution in the imaging. The higher operating frequency of the instrument is not the only factor that dictates the resolution of the acquired SSS data, as the pulse length and beams angle of the transmitted pulse also play as a dominant factor (Quinn et al., 2005, p.1259) For site-specific archaeological investigations, the lane spacing should be set at 5 to 10 m and swath width (the distance covered on either side of the AUV) to a maximum of 80 m in order to acquire effective data sets with a proper resolution for archaeological interpretations (Quinn et al., 2005, p.1263).

The presence of “shadows” in the data indicates an anomaly with vertical relief blocking the seabed behind it, but the actual acoustic return of the vertical object is often unclear. This means that without the shadow that the vertical object causes, it will be hard to see the vertical object itself (Singh et al., 2000). Some sort of vertical objects, such as masts, would be hard to detect without these shadows. These shadows are a crucial element in the understanding of SSS data, as it highlights and amplify the physical features of shipwrecks, making it in many ways “easier” to interpret shipwrecks. Still, errors can be made, as sometimes it can be impossible to differentiate between archaeological artifacts and natural objects. Especially with smaller objects, as it is tough to know what archaeological artifacts or natural objects. For the SSS data from the Skogn site (data from 2014), the computer software SeaScan survey (developed by Marine Sonic Technology) was used to review the data.

3.3.4. Results

The SSS results from the 2014 survey had sufficient quality and resolution for analysis. The figures 10-12 show the wreck of M/S Helma. As the image shows, the shape of the ship itself is apparent, but we can see evidence of structural breakdown that is likely due to damage from the fire, impact with the seafloor during the sinking and subsequent post-depositional processes. Most organic materials from the ship are gone, leaving only in-organic materials left, as chemical degradation takes a longer time than biological degradation. The hull, which was made of wood, is almost completely gone, suggesting that most of the hull burned away in 1927 and degradation over time because of post-depositional factors. The large shadow at the stern on the starboard side is a reflection of a vertical object or structure.

When a vessel sinks, it typically leaves a debris trail as it plummets to the seafloor. As the ship leaves the surface, it gains speed on the way down to the seafloor, which can be a violent event. The air escapes the internal compartments, which gets filled with water. As a result, portions of the ship can begin to come apart, and as the vessel hits the seafloor, the force of this impact can result in a collapse of the vessel structure, producing massive amounts of sediment and impact crater (Church, 2014, 27-28). The SSS data supports this theory as there is a scattering of objects on the seafloor around the shipwreck. As mentioned earlier, it is hard to differentiate between debris and natural occurrences around the wreck in SSS imagery.

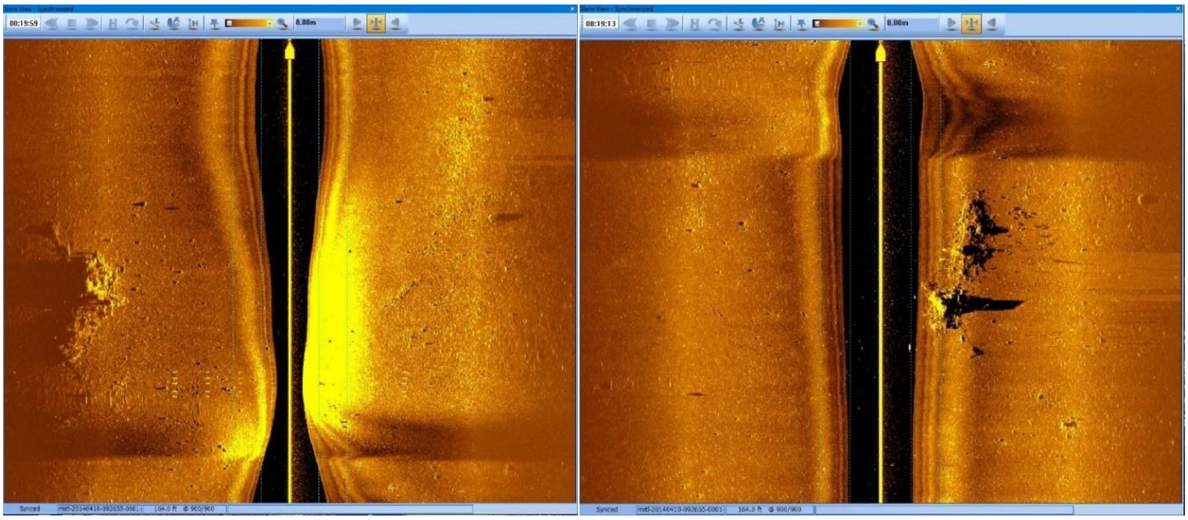


Figure 10: SSS data of M/S Helma.

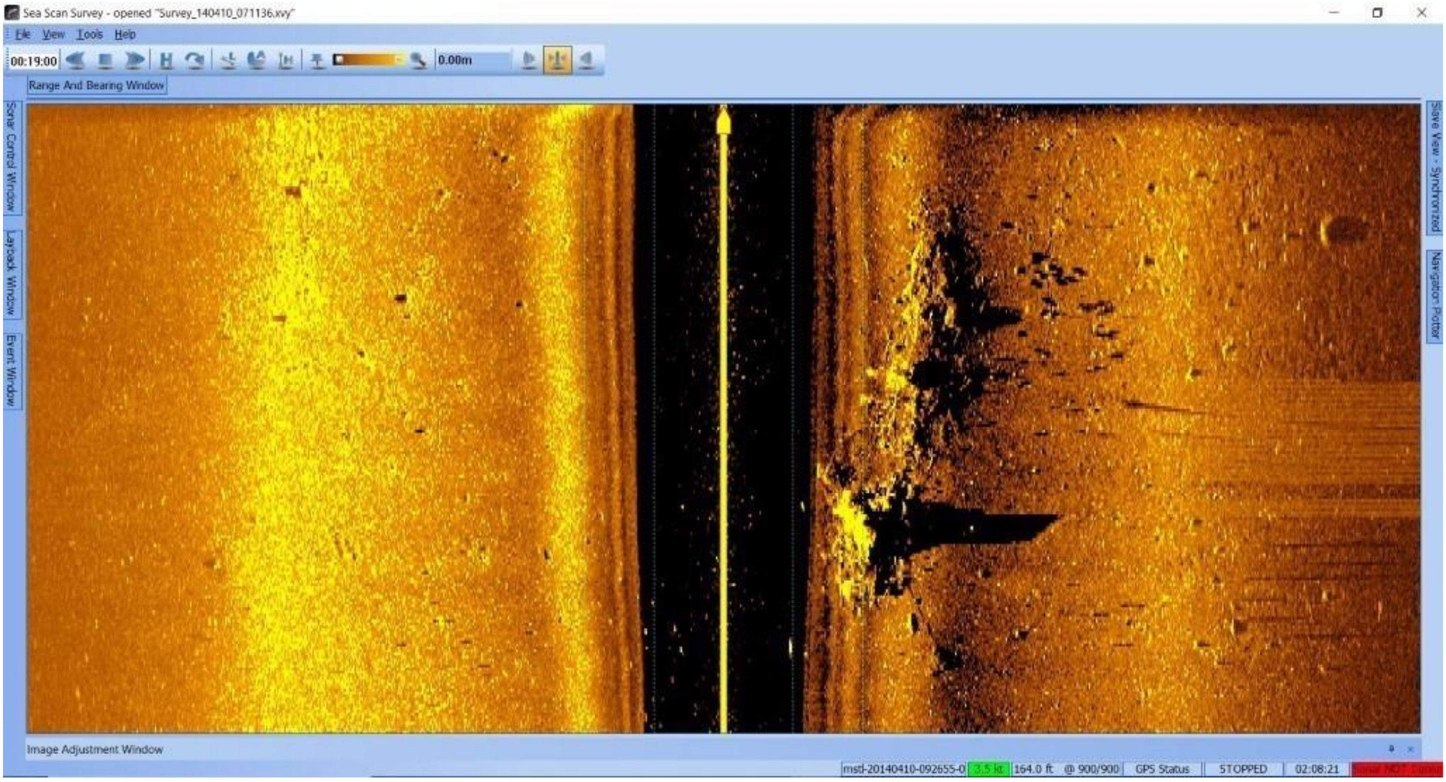


Figure 11: SSS data of M/S Helma, left side.

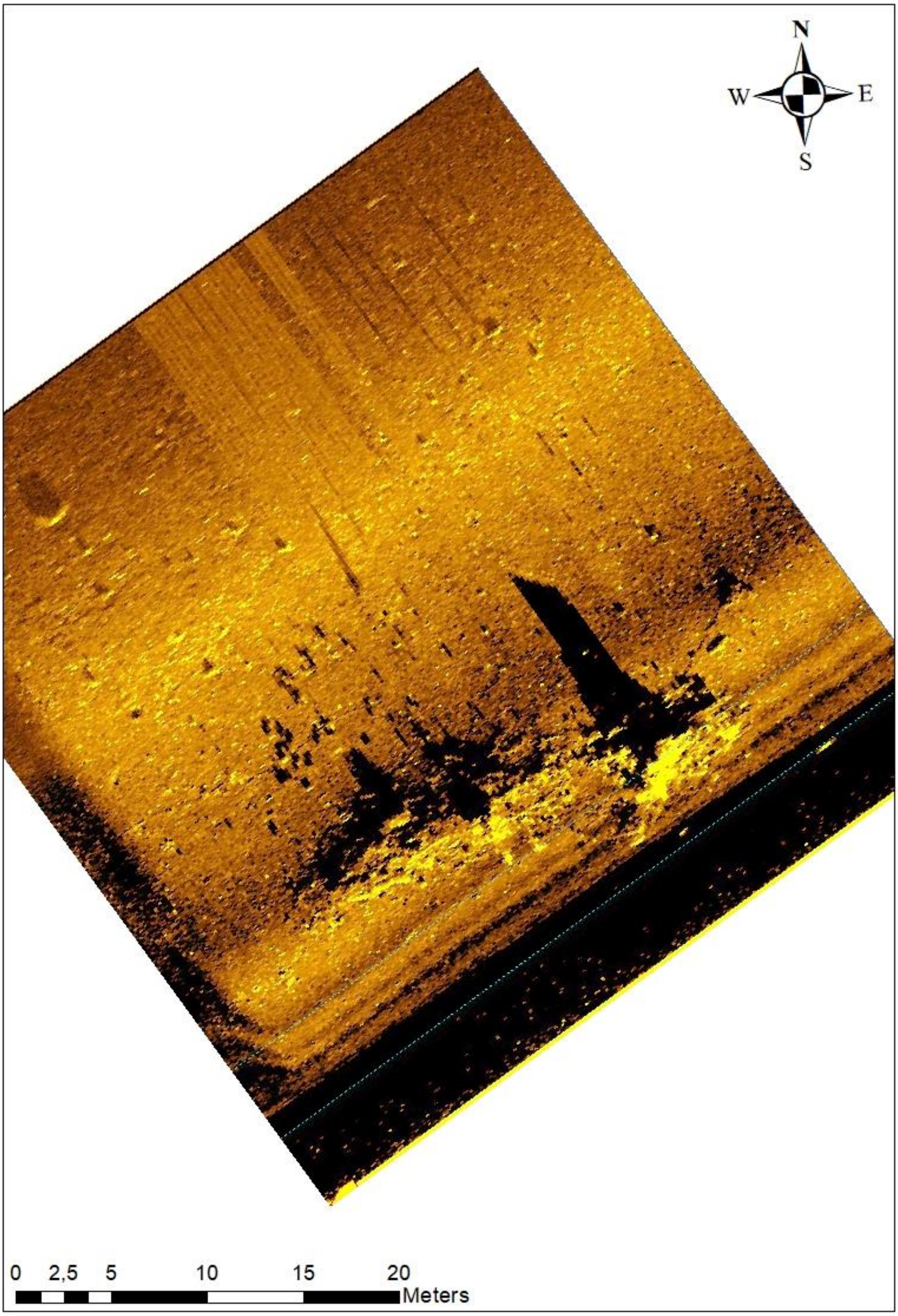


Figure 12: Georeferenced SSS image.

3.5. ROV

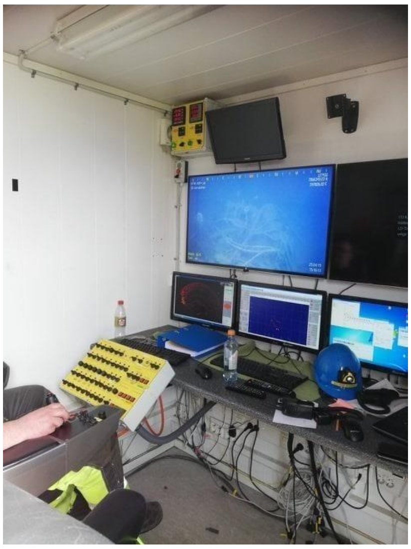


Figure 13: A picture inside the operating room the 2019 survey. Photo by Benjamin Morris King

The SUB-Fighter 30K ROV was specially designed and engineered by Sperre A/S. The ROV system consists of three parts: the control room, a winch, and the ROV. The ROV itself is rated to 1000 m and has a 600 m long umbilical. It weighs approximately 2 tons, and the vehicle's metric dimensions are 2.6x1.5x1m. The ROV can be equipped with different sensors. For photogrammetric documentation, the ROV had two AVT GC1380C cameras. For lighting, the ROV was equipped with 2 HMI lamps. For underwater positioning of the ROV, R/V Gunnerus Kongsberg HiPaP 500 system is normally used, but due to technical issues, this was not operational during the Skogn wreck survey. Consequently, we were not able to record the underwater positions of the ROV and recorded datasets (Nornes, Sørensen & Ludvigsen, 2017).

The purpose of the ROV was to record the wreck with video and photography. The most critical step when undertaking a photogrammetric survey is to achieve a good high-resolution dataset that has good coverage of the archaeological site under investigation (McCarthy & Benjamin, 2014). Therefore, a couple of archaeologists and I stood behind the ROV operator while surveying the wreck to make sure good coverage and pointing out objects or structures of interest.

During the investigation of the wreck, 5500 photos of the shipwreck were acquired. Because of poor lighting due to light attenuation, lower resolution cameras, and currents that made it more difficult for the ROV operator, it was clear early on that some sort of color correction procedure would be necessary to process data and create a point cloud from photogrammetry. The downside to this is that the production of the photogrammetry model would be more difficult than anticipated. Compared to the shipwreck M/S Herkules (Nornes, Ludvigsen, Ødegard & Sørensen, 2015), which has a more intact hull, the Skogn wreck is a much more complex wreck site as it is spatiality more complex.

Figure 14: The Sperre SUB-Fighter 30K. (1) and (2): Avt GC1380C cameras. (3) and (4): Lights. (5): videocamera. Picture: Benjamin Morris King

3.5.1 Light attenuation and image quality

The quality of underwater images is heavily influenced by the underwater environment and by the Inherent Optical Properties (IOPs) of the water, like absorption, scattering, and light attenuation (Nornes, 2018, p.27). When images are taken underwater, the water causes the attenuation of light.

Stein Nornes (2018), in his doctoral thesis, shows a way to be able to use various color correction techniques to obtain the natural color of the scene by compensating for light attenuation. According to Gallegos & Moore (2000, p. 35), two processes diminish the light in water: absorption and scattering. Absorption removes light while scattering changes the direction of propagation and does not directly remove the light from the water. Instead, it increases the path length or distance that the light must travel. The interaction between absorption and scattering interact in a complex and nonlinear way to govern the attenuation of light underwater (Gallegos & Moore, 2000, p.35). Compared to photogrammetry with sunlight as its main source of lighting in terrestrial archaeology, the sunlight is not strong enough to light up and illuminate deep-water archaeological sites.

Water temperature, salinity, water chemistry, and particles such as plankton has a significant impact on the color spectrum and brightness of the images. The images of the Skogn wreck also has a varied color and brightness because of the distance to the object and camera perspectives (Bryson, Johnson-Roberson, Pizarro & Williams, 2016). Some pictures after color-correction with the Contrast-limited adaptive histogram equalization algorithm (CLAHE), some images had a concentrated beam of light in the images that leads to overexposure of the lights from the ROV. This again has an impact on the quality of the images. These kinds of factors make the images harder to interpret for archaeological end-users, who are dependent on getting as much information on the images as possible.

The light configuration on the ROV led to blurriness in the pictures during the survey and a reduction of shadows. Moving light casts shadows that prevent alignment of images, even those that closely overlap each other (Pacheco-Ruiz, Pacheco, Adams, Pedrotti, Grant, Holmlund & Bailey, 2019, p. 5). In addition to the lighting and blur, changes in the scene can occur because of a dynamic underwater environment. Sediment in the water column or movement of flora and fauna can interfere in the images. According to Pacheco, Adams & Pedrotti (2018), these changes the apparent outline, hue, and contrast of objects in the scene, which can result in datasets where images that closely overlap will not align (Pacheco-Ruiz et al., 2018, p. 122). This made the photogrammetry work more time consuming, which shows how important it is to have good light conditions in photography to be able to create photogrammetry.

The results could also not be adequate for the point cloud in Agisoft Photoscan. Fortunately, there are automated procedures for making this process faster and better. An issue concerning image enhancement is the preservation of a natural look and features without the over-enhancement, which leads to an unnatural look and loss of information (Chang Jung, Ke, Song & Hwang, 2018). Especially for photogrammetry, the loss of information can have a significant consequence on the results, leading to difficulty with alignment.

3.5.2 Histogram equalization

Histogram equalization is a simple color correction technology to improve the contrast in images. A histogram describes the color tone distribution of the image. For the HE, I used the free software GIMP version 2.8. I used the same color correction as Nornes (2018) in GIMP called "Auto White Balance".

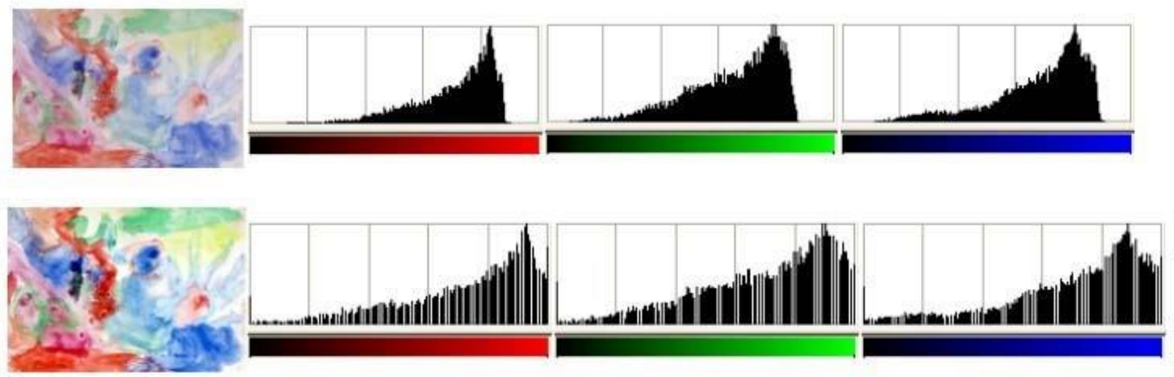


Figure 15: The top figure shows the histogram of the image before "White Balance". The other picture shows the results of the "White Balance" command. This function stretches out the histogram and creates gaps between the pixel columns. Areas with poor white in the image are replaced by pure white color. Illustrations from https://docs.gimp.org/2.10/en/.

The white balance function in GIMP automatically adjusts the colors of the image by stretching the Red, Green, and Blue channels separately**.** The images have an overabundance of the colors green and blue. This command suits for these images because of its lack of white and black colors (GIMP, 2020).

This algorithm lights up the image and gives a lesser homogenous color scheme, which is already a vast improvement and makes it easier for Agisoft Photoscan to detect points for the point cloud. The downside of this algorithm is that it creates a vignetting effect. The darker corners of the image, along with a bright center, characterize this. Since this project consists of over 5000 images, to be able to automate this process, there is a free plug-in software called BIMP. Through this software, I was able to batch process all the images. To automate such large datasets is essential, since doing it manually for each image is too time-consuming. The vignetting effect is also caused by the camera itself, where the geometry of light passing in from the lens and aperture of the camera (Bryson et al., 2016, p. 859). The inherent shortcoming of HE, according to Chang et al. (2018), is the over-enhancement of images as it creates large smooth areas, resulting in an unnatural color scheme and a washed-out appearance. This is especially the case for the Skogn-wreck images. The reason for this is that dark images captured in poor light conditions. (Pizer et al. 1987; Chang et al., 2018, p. 11782; Cambridge in Colour, 2020).

3.5.3 Contrast Limited Adaptive Histogram Equalization (CLAHE).

Image contrast enhancement is a technology used to improve the visual quality of images in computer vision, pattern recognition, medical imaging, remote sensing imaging, and computational imaging. It is especially useful for images with a low light condition, which is often has reduced dynamic range, low contrast, and noise that causes poor image quality (Chang et al., 2018, p. 11782).

The CLAHE technique is a good method to counteract the vignetting effect of the HE. In addition, the HE technique led to overexposure of brightness, which again leads to the loss of valuable information. It also improves the image by improving the visibility level of the foggy effect in the images. For the CLAHE algorithm, I used the computer software MATLAB (developed by MathWorks) that was pre-scripted in advance. I only had to implement a couple of lines to make it work, and it an easy, straightforward method that can be used by underwater archaeologists to improve the quality of underwater imagery.

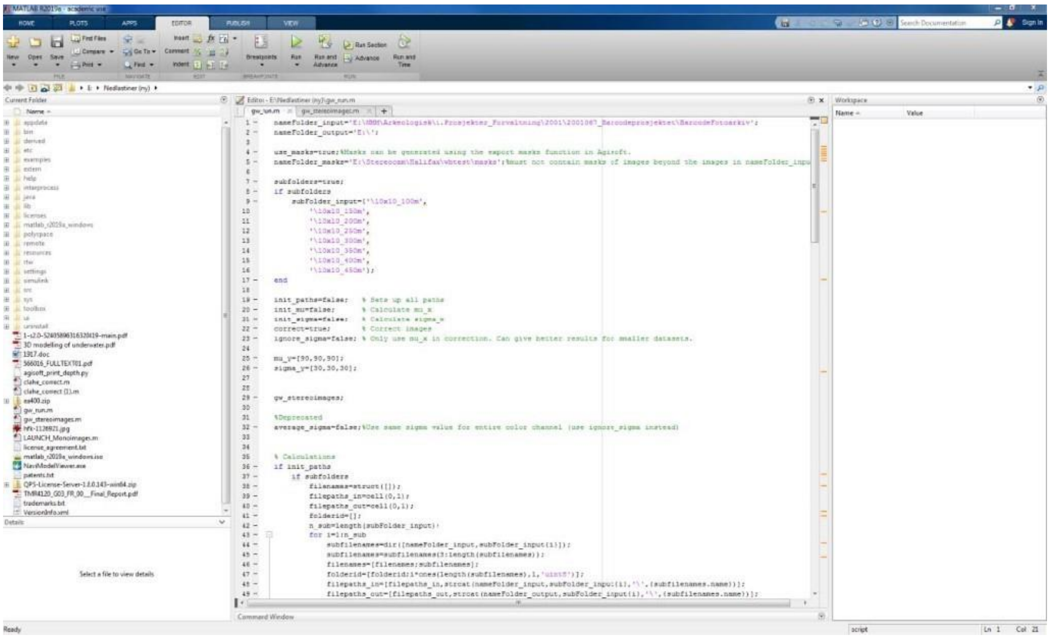


Figure 16: Screenshot of the software MATLAB with the CLAHE script.

The CLAHE is an extension method of the HE method, and according to Raffei, Asmuni, Hassan & Othman (2015), it can address the noise amplification problem (p.42). In this case, the CLAHE algorithm used for these images amplifies the noise in the images, which is usually produced by the sensor. This can be caused by *luminance noise* and *chrominance noise* in the images. Luminance noise is caused by variations in brightness and gives a grainy appearance as a result of noisy, bright pixels. The grainy appearance can range from fine grain to more distinct speckle noise, as shown in figure 17 (Ballabeni, Apollonio, Gaiani & Remondino, 2015). Chrominance noise is also noticeable in the images and the 3D model, as clusters of colored pixels like green and magenta, as shown in figure 17. The occurrence of magenta color is due to the inability of the sensor to differentiate color as a result of low light levels, creating errors in the way color is recorded (Ballabeni et al., 2015, p. 316). The easy implementation and flexibility of CLAHE still lead to an improvement, even if it leads to haloing and misrepresentation of the actual color (Nornes, 2018, p. 30).

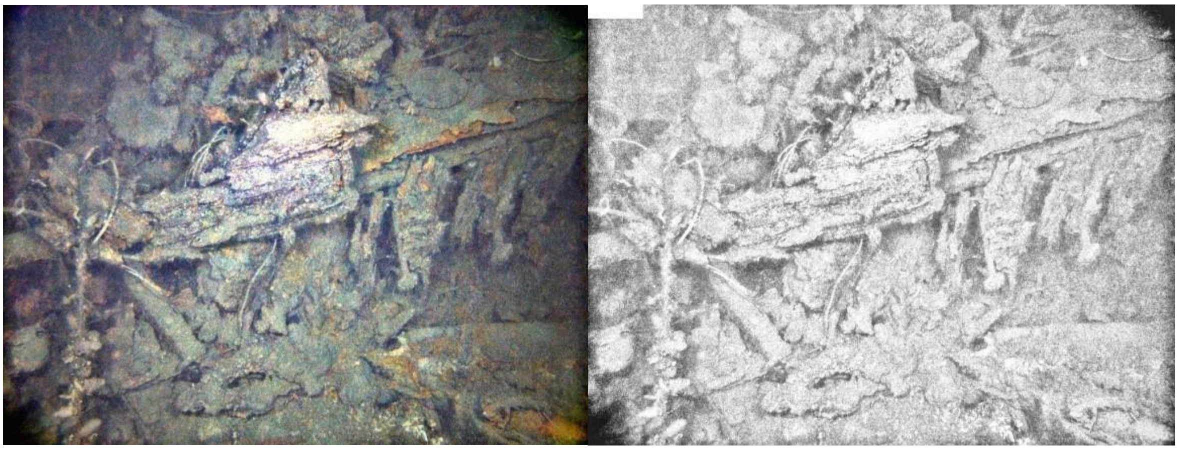


Figure 17: Picture from CLAHE to greyscale. As both pictures show, there is much noise. Picture from the starboard at the stern

While this algorithm improved upon the images, there is also some downside to consider when using this CLAHE-algorithm script in Matlab. As shown in figure 17, the pictures get more pixelated because of the CLAHE algorithm. This leads to lower resolution pictures in the process. While this is a downside with this algorithm, it is still an improvement over the last image color correction process (HE). I also want to point out that this is also a result of the raw original images, as they already had much noise. The color correction process just amplified the noise. I have also experimented with the script by making it more flexible. By using a different *adapthisteq* script in Matlab, I was able to adjust the RGB tuning, but I was not able to get better results.

The results of the color correction improved the model in terms of the color, which in turn made the photogrammetry software able to make better point clouds and make calculations on the positions and based on spatial relationships between each photo. While the color is not one hundred percent accurate, it is still an improvement and made the model more interpretable and perceivable, as it is easier to investigate ship when we can see it as if it was on land.

3.5.6. Agisoft Photoscan

For the photogrammetry process, I used Agisoft Photoscan (version 1.4.5.7354) (developed by Agisoft), which is a computer software for producing photogrammetry models and is widely used by archaeologists for 3D documentation. In short, photogrammetry is a process for taking measurements from photographs and applying those measurements to create 3D rendered models (Semaan & Salama, 2019). The preferred overlap of photos varies but should be somewhere between 50 to 80% overlap.

The raw pictures of the wreck were not suitable to produce a photogrammetry model on the Agisoft Photoscan software. This is the first part of the process, which is known in the program as "Align Photos". During this step, the unsorted dataset is developed into points from the images and creates a point cloud that represents the points of similarity between the different images. The software can calculate and locate the position of each photograph by using the angles of capture to create the model (Howland, Kuester & Levy, 2014). The next step is building the geometry by using the function "Build Dense Cloud" and "Build Mesh," which calculates depth information based on the camera positions and creates the geometry of the model. The next and final step is applying the textures from the images through the function "Build Texture".

While this is a time-consuming process and less than ideal, the color correction process made this easier to be able to identify and interpret several points in each chunk for merging. Because of problems with the georeferencing systems on the ship, we were not able to georeference the model. The main goal of the model is to be able to understand the wrecking site and its contexts to be able to identify the shipwreck. Before alignment, georeferencing the images allows scaling and georeferencing the final 3D model, but this was not possible because of technical problems (Nornes, 2018, p.35-36). The model was instead georeferenced with the use of GIS after alignment, as shown in figure 21.

Even after color correction, the software still had problems to estimate the camera locations during photo alignment when aligning the whole dataset in one go. Because of the photos, I was not able to align the photos into a complete model of the ship. This is because of the quality of the photos, as explained earlier, and because of the overlap between them. There was a strong current that day, making it challenging to operate the ROV and creating the necessary overlap between many of the photos and structures of the wreck.

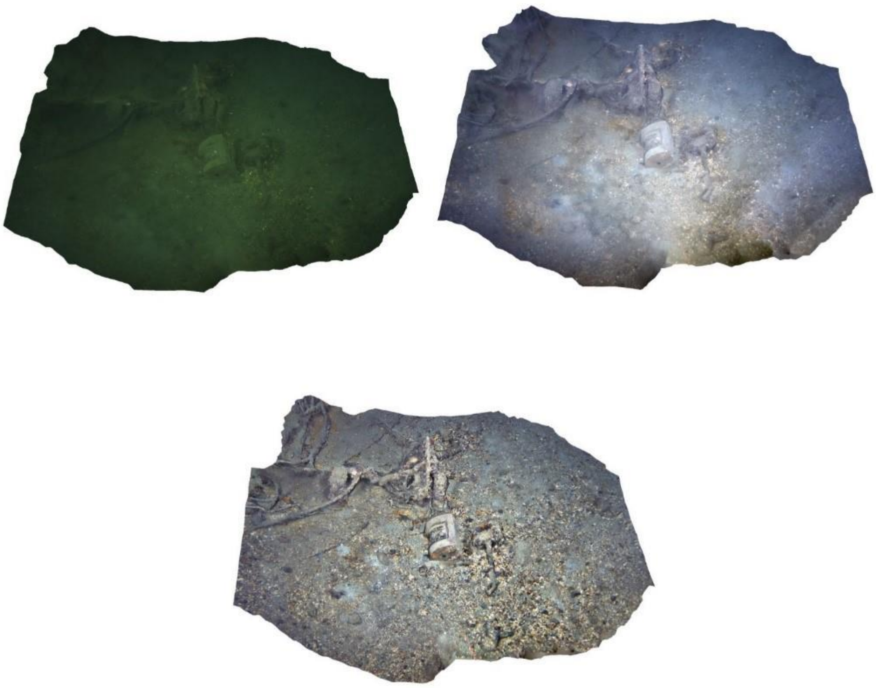


Figure 18: As these models show, the color correction improved the images, making it easier to see. The model on the bottom is the end result.

Figure 19: An almost complete model of the wreck. We are looking towards the starboard of the ship.

Figure 20: Orthophoto of the M/S Helma model.

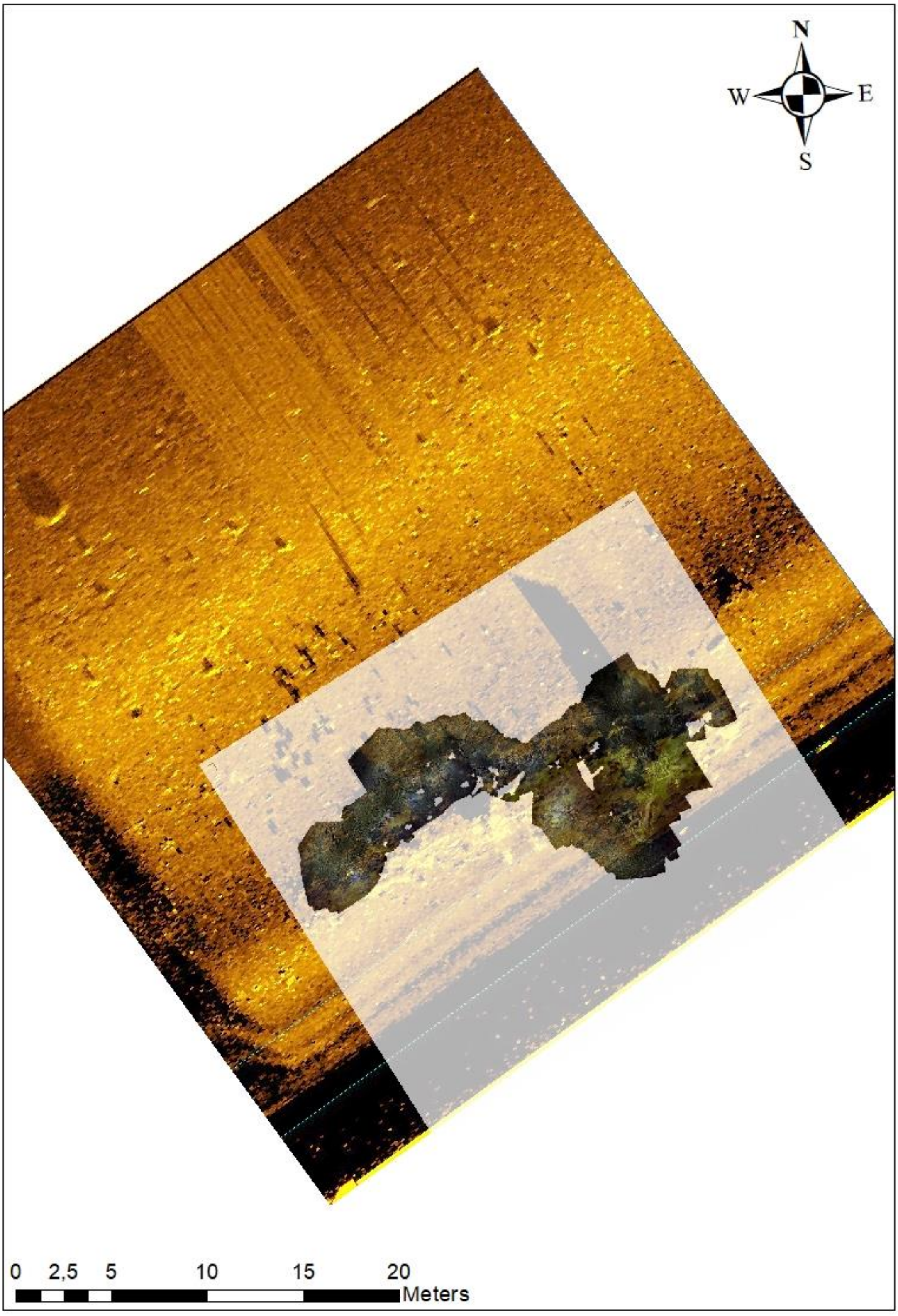


Figure 21: Orthophoto of M/S Helma. Visual placement based on georeferenced SSS data.

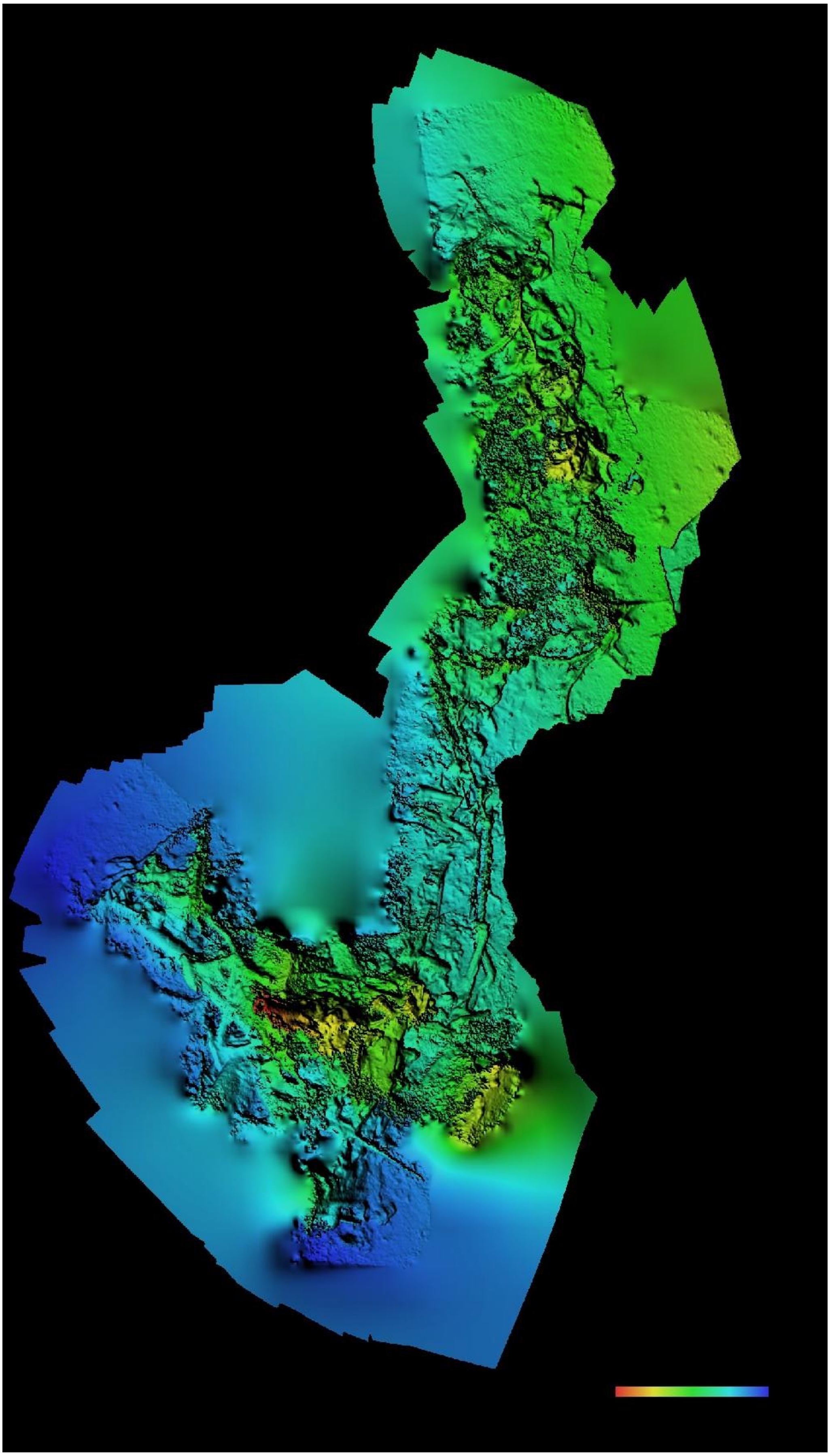


Figure 22: DEM model of M/S Helma. Not georeferenced.

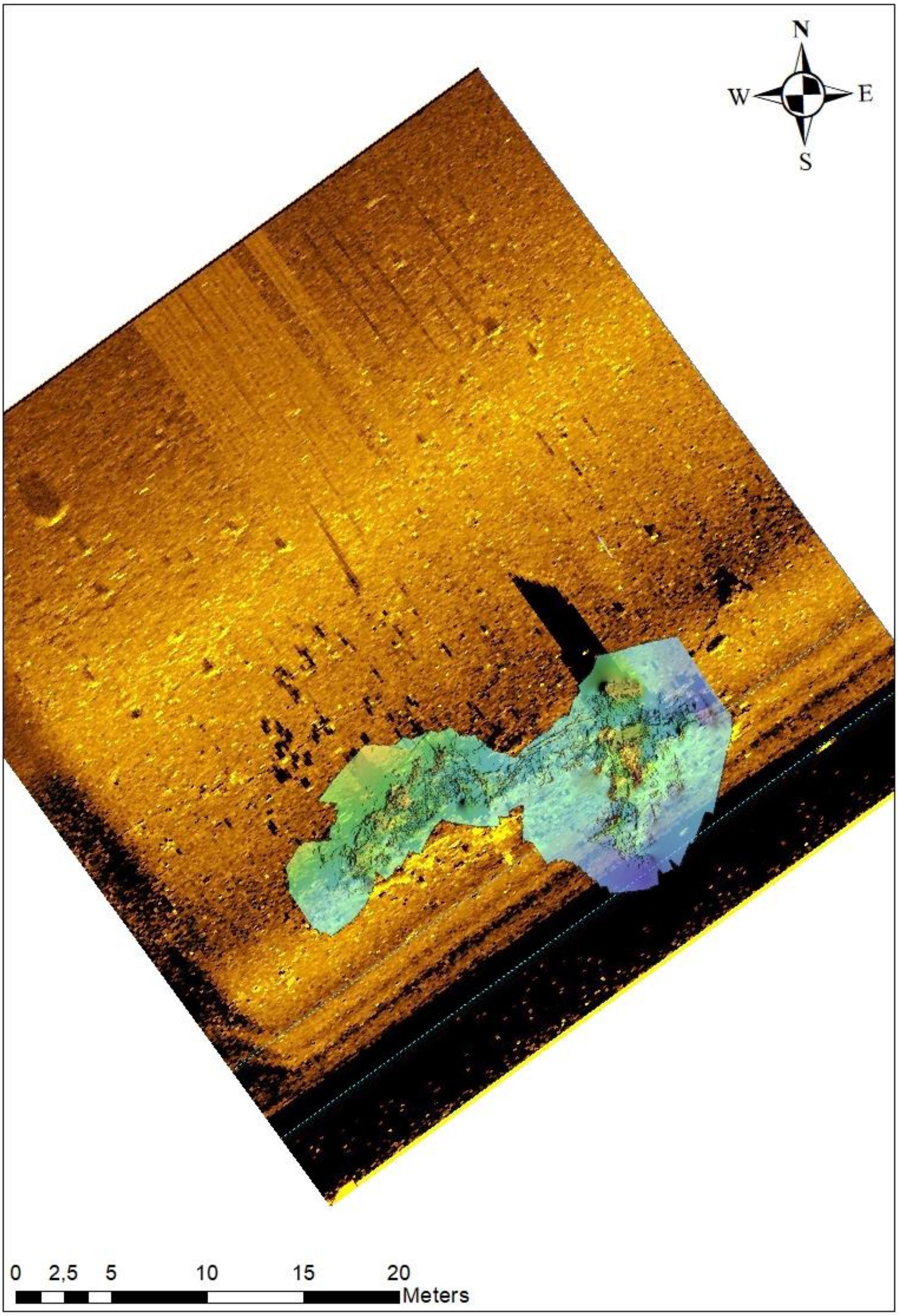


Figure 23: A DEM model georeferenced by the use of visual recognition of the georeferenced SSS image in figure 17.

3.5.7. Results

There were several challenges in the attempt to create a complete model of the wreck itself. These challenges were mostly related to the quality of the pictures and because of the complexity of the site. While the color correction of the images made it possible to use the photos to make a model, it still made it hard for the program to align the photos. This is because of the resolution of the pictures, which contains less information and because of the noise. Even so, I was able to make a large model (fig.9), creating a hermeneutical understanding of the site and the spatial relations between the smaller models (fig.8). There are several more models in the appendix which has not been georeferenced.

The model in figure 19 shows most of the stern where the engine is and the starboard side of the shipwreck. It is missing most of the port board side of the ship, which is presented as separated 3D models in the appendix. Also, these models have been modeled with pictures by just using the CLAHE correction, as this worked better than the pictures, including the HE color correction.

3.6. A short archaeological analysis

The archaeological research of shipwrecks starts by understanding the deposition and site process. The main basis for the archaeological analysis of the data is the use of the flow diagram by Keith Muckelroy (fig?). The flow diagram represents the process of wrecking and post-depositional factors. An important perspective on how to view the flow diagram is to view a wreck site as a system that is transformed through time within the constraints imposed by the more extensive system at play (Mukelroy, 1976). By using the data and analyzing through Muckelroy's theoretical framework, one will be able to identify the Skogn-shipwreck. By investigating the relevant inputs and outputs and the consideration of the site's environment, it should, in theory, be possible to understand the five processes involved. This model and theoretical framework are especially useful when the historical record of the ship is limited, which is the case with the Skogn wreck (Mukelroy, 1976). I am going to focus on the characteristics of the wrecking in the data show some individual objects to come with observations and interpretation based on the data

3.6.1. Process of wrecking and individual objects

As previously shown, the ship burned down. This has altered the ship itself during the wrecking process. The fire would burn away most of the structure that was made of wood during the fire and burned material would either burned away. Also, most of the wreck has not been buried by sediments, which either suggests that the current is strong or there is little sedimentation. This has left much of the wreck exposed to biological activity.

As O'Shea (2002) points out in his article, the pre-depositional processes and context are just as important as the process of the wrecking. The reason for this is to get a better understanding of circumstances of a given wreck and may give a systemic context and pattern in the martial remain in the archaeological deposit (O'Shea, 2002, p. 213).

When a vessel sink, it typically leaves a debris trail as it plummets to the seafloor. As the ship leaves the surface, it gains speed on the way down to the seafloor, which a violent event. The air escapes the internal compartments, which gets filled with water. As a result, portions of the ship will begin to come apart, and as the vessel hits the seafloor, the force of this impact can result in a collapse of the vessel structure, producing massive amounts of sediment and impact crater (Church, 2014, 27-28).

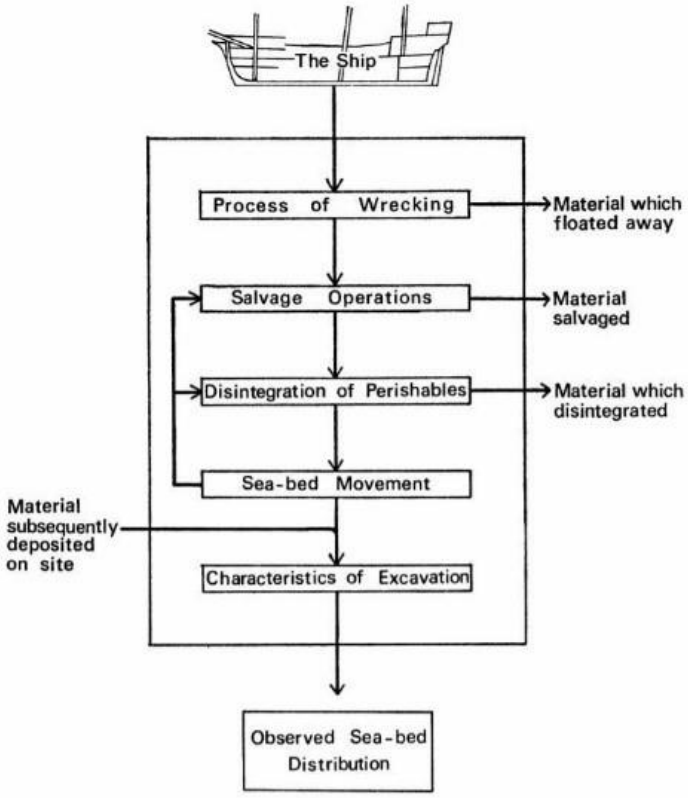


Figure 24: Muckelroy`s Flow diagram illustrating the process from when a ship sinks to becoming an archaeological site. From Muckelroy 1976, Fig.6

This could explain its state, as the burning of the ship would have burned a lot of the ship that was above the water line and because of post-depositional factors such as biological processes, making most of the hull gone as it burned down in 1927. This will also have caused a more extensive spatial scattering of objects along with deterioration over time as shipwreck usually breaks down. This is because shipwrecks sites act as open systems, and a combination of different processes drives formation processes at wreck sites such as chemical, biological and physical processes, where the most dominant process being physical processes in initial phases of site formation (Quinn, 2006). With utilizing the data of the wreck-site, there are a few indicators on the processes that occur at the Skogn-wreck site.

The Skogn wreck composes of different materials and elements. Iron wrecks and wooden wrecks do not break down in the same way, but one pattern they have in common is the survival of the bow and the stern of the ship but with a flattening of the hull (Ward, Larcombe & Veth, 1999, p. 563), which is the case with the Skogn wreck. Another major difference is in the disintegration process between iron and wooden ships. While physical processes influence both types of ships, the iron ships deteriorate as a result of chemical processes like corrosion, while wooden ships deteriorate as a result of biological processes (Ward et al., 1999). As the photogrammetry model shows, the biological, as well as the fire during wrecking, has led to an almost complete disintegration of the wooden hull, leaving only the iron parts of the ship left, what mostly remains of the structures is the boiler and engine at the stern (MacLeod, 2002). Waters in colder regions are dominated by different colonizing marine organisms that cover corroding iron wrecks. Marine organisms such as algae, barnacles, and tunicates cover corroded iron wrecks, which is also observable on the video recordings and photos of the Skogn wreck (MacLeod, 2002, p.698).

Based on the drawings of M/S Helma and the photogrammetry model, the fire probably burned most of the ship that was above the water, keeping most of the ship below the water line intact when sinking.

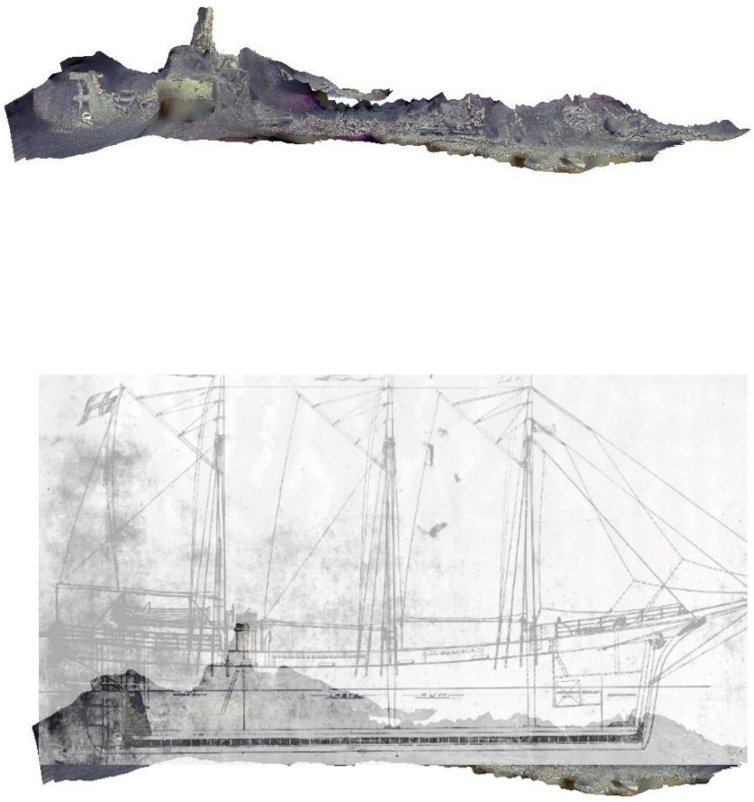


Figure 25: Placing the drawing of M/S Helma on the 3D model based on visual alignment.

The DEM model shows (figure 22) that M/S Helma has a complex 3D structure with both horizontal and vertical faces. As the previous data shows, there are a lot of ropes, wires, and possibly two to three masts. This will not only pose a challenge for the modelling, but it also poses a risk of entanglement with the ROV (Nornes et al., 2015). The bow and stern are the parts of the ship that is most preserved. The midship is almost gone and won't require as much overlap as the bow and stern. The midship does not have the complex 3D structure as the bow and stern of the ship. As the SSS data shows, a big part of the midship is completely gone, only part of the wooden shell is intact.

Some individual objects are possible to see what it is. The first is the chip log in figure 26. A chip log is used for measuring and determining the speed of the vessel. It was thrown off at the stern of the ship and worked as a drogue. It remained in place as the vessel moved while sailors counted the knots the passed through their hand in a given time to determine s ships' speed. This finding suggests an older wreck, which builds on the theory that this is indeed M/S Helma.

Another object is the lantern, as shown previously. The lantern is at the bow of the ship. In the ship's drawings, there is a lantern that is mounted on one of the masts at the bow of the ship. While this does not necessarily mean that this lantern is the same as the one in the drawing, it still has some of the same characteristics of the one in figure 4.


Figure 26: A chip log located at the stern of the ship. Used for measuring speed known as knots. The picture on the left from https://www.digitaltmuseum.no.


Figure 27: Lantern located at the bow. The picture on the right from https://www.digitaltmuseum.no.

3.7 Conclusion

Based on the deep-water archaeological study of the wreck at Skogn, we can say that this is almost certain M/S Helma that burned down in 1927. There has not been found any other shipwreck in near proximity of this wreck and based on historical sources and data acquired during the expedition leads to the conclusion that this is most likely M/S

Helma. What has been illustrated in this chapter is the usual practice and approach in deep-water archaeology. The methodological approach starts with the detection of potential anomalies, then follows documentation, interpretation, and data representation. Deep-water archaeology is entirely dependent on many different technologies such as robotics and advanced imaging technologies, which is what differentiates this discipline. Not just in terms of method and equipment, but also in the way in which we experience deep-water archaeological sites. This will be explored and analyzed in the next chapter.

Chapter 4: Amplification and reduction structures in deep-water archaeology

4.1. Introduction: The human-technology-world relation and perceptual situation in deep-water archaeology

In deep-water archaeology, the archaeological contexts and sites are inaccessible by means of embodied-technology relations. Therefore, to be able to reach the depths of deep-water cultural heritage, the position of the instrument must be moved from embodied relations to hermeneutical relations to gain information and knowledge. In deep-water archeology, the mediating position of the instrument moves away from experiencing the instrument itself (ready-at-hand) as described above to experiencing the instrument itself (present-to-hand). The perceptual situation as a result of human-technology relation reveals different dimensions of the world, which suggests different amplification/reduction structures.

Figure 28: Inside the ROV operating room during the 2019 survey. There is a hermeneutic activity going on during an ROV survey. Photo by Benjamin Morris King

Imaging technologies used in deep-water archaeology produce representations that require interpretations with the use of computer processes and the "reading" of the images itself. This is a big part of the praxis in deep-water archaeology. For example, photogrammetry and sensor fusion of different images requires time and is itself an interpretive process, a sort of visual hermeneutics (Ihde, 2009). Within this visualist system, its "proofs" are focused around the things we see, but these things are never just seen. They are *prepared* and made readable (Ihde, 1998, p.177). The process of taking pictures with the ROV, color correction using MATLAB, and then put them together in Agisoft Photoscan, is a sort of visual hermeneutical process as the data is prepared and made readable.

"Readable" technologies call for the extension of hermeneutic capacities and retain the bodily perceptual location as a relation *with* or *towards* the technology, which then mediates the world (Ihde, 1991, p.88). For the archaeologists, the hermeneutical relation is still characteristic for the way we experience and practice deep-water archaeological as this diagram shows:

In hermeneutical relations, compared to embodied-relations, there is a less "pure" semi-transparency in the way we experience the world. The Skogn-wreck presented to me (and the reader) is transformed, meaning the visualization itself moves away from the unmediated bodily vision and towards a discontinuity with bodily vision through technologies. This is not a bad thing, as this gives new perceptual possibilities that are not possible in embodied-relations (Ihde, 1979). This perceptual situation in deep-water archaeology needs a trained form of vision, in this case, an archaeologist or someone with experience with interpretation of the kind of images used, in order to apprehend the content of the image and the archaeological site itself (Rosenberger & Verbeek, 2015, p.34).

If we look back at the example of the duck/rabbit illusion or the Necker cube in chapter 2, there are several multistable interpretations of an image and uses of technologies. This is something deep-water archaeologists' is aware of as instrumental variations, denotes a stable interpretation of an image. Therefore, deep-water archaeologists use what Rosenberger calls a *hermeneutic strategy,* which is common in several disciplines concerning the use of technologies (Rosenberger, 2008, p.65). Such a hermeneutical strategy contains specific technological mediated transformations through different processes that are specifically aimed to achieve established ways of perceiving and seeing in deep-water archaeology.

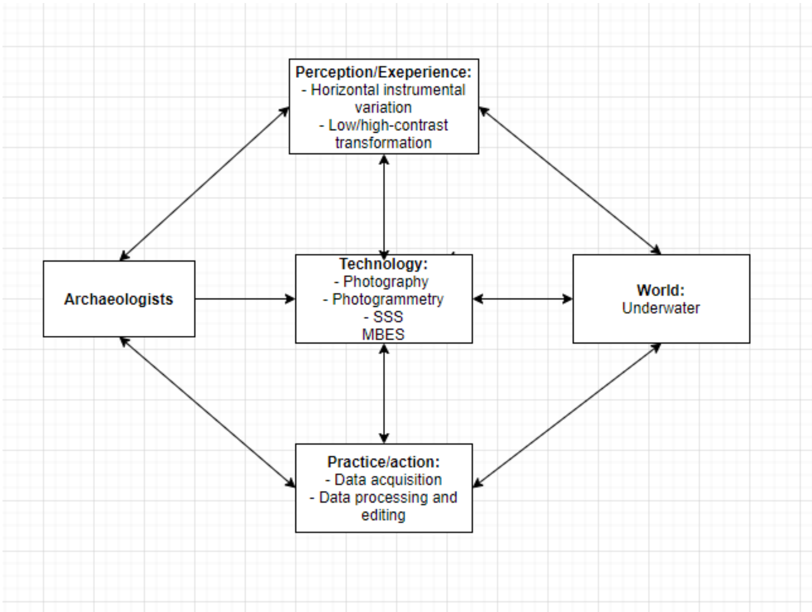


Figure 29: A diagram illustrating the hermeneutical relation with technologies in deep-water archaeology as shown in diagram 2.

If we look back at the case study in chapter 3 and look at the order in which I present the different technologies, we can see that there is a specific hermeneutical strategy. The Skogn wreck expedition is a typical survey of an unmapped area that is determined by the imaging technologies in use. Most surveys executed in this order:

- MBES for bathymetric mapping for finding potential objects of interest.
- SSS for a closer look and identify if the potential structures shown in the MBES data may be of archaeological interest.

- Use of optical sensors and ROV for the recording of an established wreck site (Ødegård et al., 2016).

These methods of surveying and data sampling are connected to the non-neutrality of the instruments of use, creating different strategies on how to apply the underwater robots and their payload sensors in the best way possible. The imaging technologies used in chapter 3 has a different set of amplification/reduction structure which transforms perception in different ways. The ways these technologies are used to represent the different hermeneutic strategies in deep-water archaeology. In next part, I am going to analyze these amplification/reduction structures of the technologies used in chapter 3 and look at its consequences in the way human interprets their world and how the scientific praxis in creating the images is a form of a visual hermeneutic strategy.

4.2. Photography and color correction

4.2.1. Instrumental variation and transformation in photography and color correction.

Photography is a horizontal instrumental variant as photography retains visual recognition of the thing itself (Ihde, 1979, p.34). Even so, this way of visualizing implies an amplification/reduction structure as this technology carries a sort of quasi-transparency relation with the world. The representation is of the thing itself, or in other words, *isomorphic*. In ordinary experience, isomorphism is a level of *naïve realism* (Ihde, 1998, p.178). When images are isomorphic, things are taken to be what they are seen to be because of the isomorphism between the depiction and the object (Ihde, 1998, p.178). Because of the isomorphism in images, the transformation experience that is of a low contrast variation.

Figure 30: In this figure, we see the amplification/reduction structure in action. Certain features of the wreck are amplified while others are reduced.

4.2.2. Amplification/reduction structure in photography and color correction

The color correction done in MATLAB was an important hermeneutic strategy and process to enable alignment of photos for the 3D model. In a postphenomenological perspective, the goal for the color correction was to amplify the micro-features into perceptual range, as the perceptual situation underwater without proper lightning does not yield the wanted amplification/reduction structure to produce the 3D model. The goal then was to make it more “naturalistic,” or in this case, make the photos look like they were taken on land or fully lit. These changes in the photos, in this case, the “environment” or the situated context of the shipwreck, are necessary changes for archaeologist experience of the environment as the water was fully transparent. Here, the computerized color correction turns the data into displayable geometric objects (Miller & Richards, 1995, p. 19).

Light attenuation and light condition in the original images from the Skogn wreck had a major impact on many of the photos, making them hard to “read” or interpret, which post phenomenologically means that the images produced were beyond the visual gestalt capacities of embodied archaeologist as a result of light attenuation (Ihde, 2006, p.81). This illustrates the point the role of human bodily perceptual experience has in scientific imaging (Rosenberger & Verbeek, 2015, p.34). As illustrated in chapter 3, the color correction process improved the quality, amplifying and improving the light condition, dynamic range, and low contrast, making pattern recognition possible and engages visual gestalt capacities of embodied humans (Chang et al., 2018: Ihde, 2006).

As figure 30 illustrates, the original photo on the left has poor lighting and color, making it hard to identify or understand what is in the photo and to engage the visual gestalt capacities of me as an archaeologist. The color-corrected image on the left engages these capacities to a more significant degree, but it is still hard to tell what it is because of the noise in the image and of the framed nature of the photo, making it hard to come with an interpretation of what is seen. This is not necessarily the case for some photos of individual objects, where we are to identify the object. Figure 30 also illustrates the reduction structure in deep-water archaeological photography, which is the framed nature of photography. We are not able to understand what is in the photograph in figure 30, as the framed nature takes what is seen out of the in-situ context. We are not able to see the full “picture” of the wreck itself and, therefore, not able to identify what it may be.

Color correction scheme brings different phenomenological variations. While this process was used on original photographic images from the Skogn wreck, the postphenomenological implications suggest then that this isomorphic depiction is not just merely an “image” anymore. This color correction can be seen as a type of “false coloring”, to make a scientific image “readable” (Ihde, 1998, p.181). The color correction method suggests that the end-user of these types of methods chooses a color relative to the purpose needed to achieve the desired effect, or a desired amplification/reduction structure as a part of a hermeneutic strategy. The desired effect, in this case, was to make the pictures more “readable” not just for myself as an archaeologist, but also for the photogrammetry software Agisoft Photoscan. As discussed in the case study, the software was not able to create a point cloud with the use of the original photos. Even after color-correction, I was still not able to put all the pictures together.

The reason behind this is the technological translational functionality of the technology itself. While the interpretation of the pictures was “easier”, suggesting a low-contrast transformation, the translational functionality of the color-correction did not translate well over to photogrammetry (Friis, 2015). This is because of the effects of the CLAHE script in MATLAB, leading to an even more grainer and noisier images that are hard for the software to “interpret.”

In most cases in deep-water archaeology, color correction and other image enhancement methods are used as a part of a hermeneutic strategy because of the circumstances in deep-water archaeology such as light attenuation or poor lighting. This can lead to images with poor dynamic range, low contrast, and noise. This results in confusion of textures and objects (Chang et al., 2018). Through the color correction process, these are the dimensions of the image we want to reduce, while we want other dimensions to amplify in order to "reveal" relevant visual information carried in the image. Here, the amplification/reduction structures lead to a change from the color perception in water to the human visual color spectrum through histogram equalization and contrast enhancements algorithms. This results in a certain continuity with the mundane visible world as more of the features of the wreck come into the human-perceptual range (Ihde, 1979). These mediated perceptual situations give new ways of experiencing, and therefore "new" certain types of knowledge of the phenomena and yet a non-neutral transformation of what is known (Ihde, 1979, p.49). This level of techno-construction is a big part of science praxis in deep-water archaeology.

4.3. Photogrammetry

4.3.1. Instrumental variation and transformation in photogrammetry.

Photogrammetry presents the shipwreck as an interactive 3D model, taking away the reductive way in which framed images reveal the world. The mediated transformation takes the shipwreck from its ordinary in situ field on the sea bottom and changes it, giving it a transformed observational context (Ihde, 1993). Photogrammetry contains hundreds of framed images and transformed contexts that are within a limited instrumental field of observation. Photogrammetry amplifies this instrumental field of observation and reduces the "framed" technological design of original photography (Ihde, 1993). Therefore, photogrammetry is a horizontal instrumental variant of low-contrast transformation, as it is an isomorphic representation (Ihde, 1979).

4.3.2. Amplification/reduction structure in photogrammetry

Compared to terrestrial-based photogrammetry, there is a more dramatic effect in underwater based photogrammetry because of the transformed observational context in which brings the shipwreck into perceivable vision as a consequence of amplification/reduction structure. The result of the color correction method, which already has its own amplification/reductive transformative characteristics, the amplification/reduction structure of the photogrammetry model from the Skogn wreck is even more dramatic. As discussed in chapter 3, this dramatic effect would not be possible without the color correction as the software was not able to create the point clouds required to create the models presented in this thesis.

The transition from the static two-dimensional photos to a three-dimensional technological model, the goal of the transformation is to make the shipwreck more perceivable, suggesting a low-contrast transformation. The photogrammetry constitutes an important technological artifact, which then gets "easier" to interpret as low-contrast transformations are closer to the human vision. This makes me able to account for archaeological features of interest, such as the lantern that enables a typological dating and a descriptive interpretation of the shipwreck. Here we see an interplay between micro, - and macro-perception. To be able to engage the macro-perceptual dimension, the point of the technological transformation of underwater photogrammetry must first engage the micro-perceptual dimension in order for macro-perception to come into play by engaging our gestalt capacities. Here we see the two dimensions of perceptions not separated but always connected as the model must engage the micro-perceptual dimension in order for archaeologists to interpret the model. The jump from 2D images to 3D representation using photogrammetry leads to a "gestalt switch" as illustrated by the example of the Necker Cube in chapter 2, as photogrammetry changes the positions and angels in the ways we view the wreck, giving new meaning and gestalt engagements (Ihde, 2012).

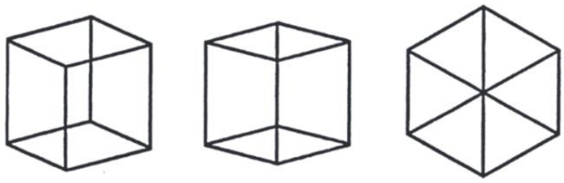


Figure 31: The Necker Cube can be viewed from separate angles. We want to "stabilize" an image in deep-water archaeology to be able to see the archaeological objects "as they are". From Ihde (2012) Experimental Phenomenology: multistabilities (p.72)

The results suggest a specific *perceptual configuration* that is applied to the transformation of perception with the use of imaging technologies (Ihde, 1998, p.171). Through a specific configuration of our perception, we want to "stabilize" the images through "gestalt switches". If we use the duck/rabbit example (figure 3 chapter 2), which can be interpreted as a duck and rabbit at the same time, a perceptual configuration "stabilizes" the images, only making us see the "duck". In archaeology, this is important, as we depend on perceiving the archaeological objects "as they are" in order to identify shipwreck, other archaeological structures, or objects.

Here we see how multistability is inherent in the use of imaging technologies in deep-water archaeology. With photogrammetry, the photos get a different meaning as it creates different ways of seeing, and what follows is multiple interpretations of what is seen. The use of technologies is a part of a broader cultural, scientific context; therefore, technologies can have different meanings and identities (Ihde, 1998). In deep-water archaeology, the use-context in also determined by technological intentionality as technologies provide a framework for human actions, forming our hermeneutic strategy (Rosenberger, 2008: Verbeek, 2001).

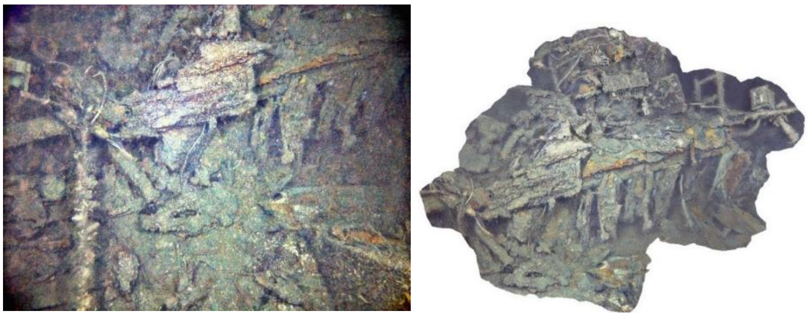


Figure 32: Here we the "gestalt switch" in the transition from 2D to 3D. Just like the Necker Cube in figure 17, we want to "stabilize" what we see to be able to come with an archaeological interpretation.

The hermeneutic nature of photogrammetry is, therefore, a popular technological transformation, as low-contrast transformation helps the interpretive archeological process as the inherent knowledge within the images is transformed into the micro-perceptual field. It is also clear that the computer is an integral part of deep-water archaeology, as it entails computer capacities to store and construct images and models (Ihde, 1998, p. 181). Here, the epistemological advantage of underwater photogrammetry and scientific imaging, in general, are the repeatable Gestalt features as a result of its isomorphism, which occurs within a technologically produced visualization by a computer. The computer then becomes a hermeneutical device (Ihde, 1998, p.161).

The statement that a computer is a hermeneutical device means that the interpretive efforts of deep-water archaeologists are dependent on the technological translational functionality of a computer. This is analogue to a hermeneutical process that is not limited to textual or linguistic phenomena (Ihde, 2009, p.56). This applies to all imaging technologies used in this thesis and to other imaging technologies used in archaeology.

Therefore, the process of interpretation also includes the production of the photogrammetry model itself as I put together the images and try to figure out the spatial relations in the photos to be able to make the models presented in chapter 3 and in which the computer is the hermeneutic device. The outcome makes the representations not a pure objective depiction of the shipwreck, which is, of course, not possible because of non-neutrality as the technology itself has specific technical constraints (Kiran, 2015, p.130). For that reason, the process of capturing the images, color correction process, and the construction of the photogrammetry model, is in a sense, an interpretation prior to what we usually would consider the interpretation of an image. The whole process, from collecting data to the desired product, is, therefore, a hermeneutic process (Kiran, 2015).

This illustrates another effect of amplification/reduction structure with optical images, photogrammetry, and acoustical images on perception. This transformation also alters what Ihde calls for *distance* of the phenomena being experienced (Ihde, 1979, p. 21). These instruments in deep-water archaeology allow for the shipwrecks to arise within the horizon of perceptual experience as the very transformation of these technologies changes the distance aspects of the ship, which bring into vision a new set of phenomena (Ihde, 1979, p.22). Just like the telescope, these technologies transform space and make it near in terms of human perception (Ihde, 1979, p.23). This is especially the case for photogrammetry and optical sensors in general.

Why is this especially the case for photogrammetry? In comparison to acoustic imaging, the use of optical instruments and ROV (also AUV, which can be equipped with optical sensors) makes us able to close in the very “distance,” even more than some of the acoustical sensors used in the case study. This is the reason why the acoustic instruments in deep-water archaeology are mostly used to locate and discover shipwrecks while the ROV, with its optical sensors, is used to identify and investigate it archaeologically to gather information. With the use of ROV and optical sensors, this closes the distance more than the acoustic sensors, as shown in chapter 3. Because we can perceive the micro-features of the wreck, such as the lantern, the propel, and other archaeological objects, we are now able to typologically date the ship through optical sensors. ROV with optical sensors then becomes the necessary instrumental perceptual extension condition for perceptually gathered of what I would call archaeological micro-features of the wreck site (Ihde, 1979).

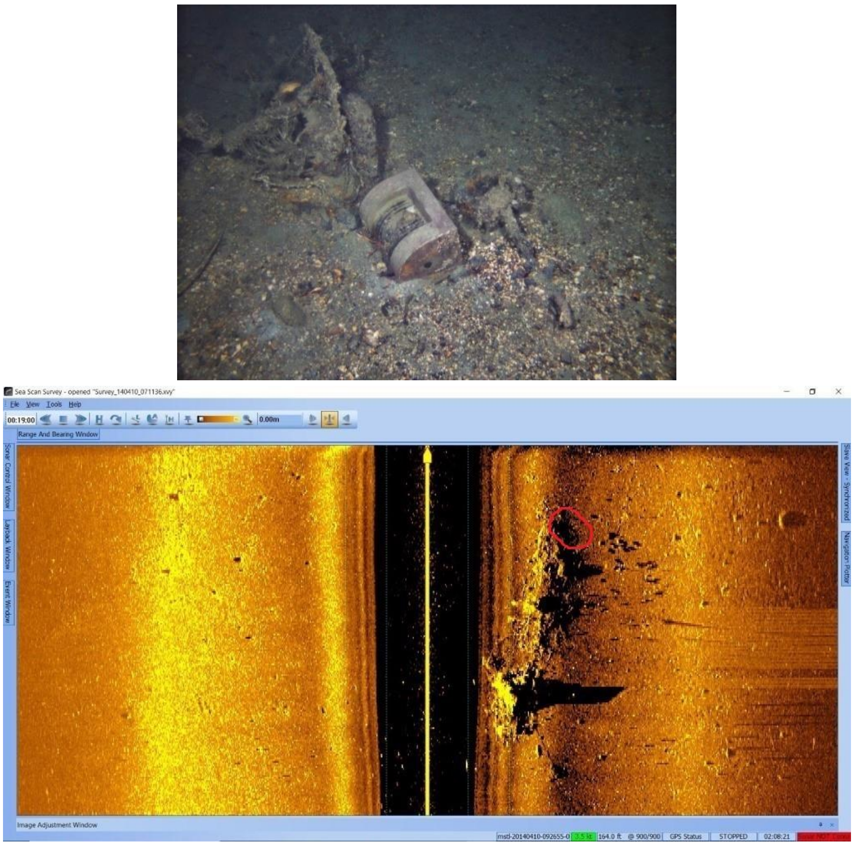


Figure 33: This figure illustrates the different "distances". Optical and acoustical technologies have different amplification/reduction structures that reveal different sets of archaeological micro-features and are therefore used for a different task in deep-water.

What these imaging technologies in deep-water archaeology do is to reveal what from a terrestrial/earthbound *position* is a micro-structure, meaning the visual extension is bringing closer what is there to been seen (Ihde, 1979, p.23). It is apparent that the distance or range does not change physically, but phenomenologically the technologies bring that is out of reach by direct, unmediated experience and "closes the distance" phenomenologically by the use of imaging technologies. Through a 3D model, we get access to a higher spatial resolution than a what a human eye can see, and spatially reducing the distance compared to acoustic imaging (Nilssen et al., 2016).

4.4. Acoustic techniques and sensor fusion

4.4.1. Instrumental variation and transformation in SSS and MBES

Both the SSS and MBES falls under the category of horizontal instrumental variation, as the images produced by these technologies remains continuous with human vision and gestalt capacities in that the features of the phenomena in the image are recognizable (Ihde, 1979, p.34). However, there is a difference between SSS and MBES within this horizontal instrumental variation that differentiates these technologies in its imaging. Firstly, SSS images have the more isomorphic quality to it, suggesting a low-contrast transformation. Secondly, MBES falls also under horizontal instrumental variation, as it remains continuous with human vision. The difference lies in its transformation, which is of high contrast transformation (Ihde, 1979).

4.4.2. Amplification/reduction structures in SSS and MBES

Imaging technologies used in deep-water archaeology transfer ranges of phenomena into visual forms or gestalts. This constitutes a form of technological constructionism (Ihde, 2002). Technologies such as MBES, or SSS, can translate the shipwrecks and the seafloor into visual forms that, in many ways, trough amplification-reductions structure by making the water "transparent" (Ihde, 2002). By making the water "transparent", we are able to bring in to view new phenomena into our perceptual field that is out of reach. The amplification is dramatic, and it can be easy to forget the two-way structure of non-neutrality (Ihde, 1979).

Acoustic techniques used in deep-water archaeology go beyond the optical ranges because of the translation capacitates in the sound wave phenomena from the SSS and MBES (Ihde, 2002). The SSS and MBES images illustrate what Ihde (1998) calls "false color" (p.181). "False color" refers to the manipulation of data under different conventions that visually depict phenomena beyond embodied experiences and the range of optical sensors, which in turn deliberately enhances to better display and visualize the seabed and shipwreck. This is also as a result of acoustic imaging technologies, as it's not an optical device. For example, the data from MBES uses "false color" to illustrate the bathymetric data for archaeologists to perceive the characteristics of the sea bottom and shipwrecks, making what is under the vessel transparent.

Spatially, the seafloor and shipwreck are now in a technologically transformed observational context, an enhanced and extended perception through mediating instrumentation (Ihde, 2015). Because of the water, the shipwreck is not accessible through direct, unmediated experience. Acoustic technologies visualized through digital tomographic processes, can, therefore, be seen as an *instrumental translational perception* (Ihde, 2015, p.38). There are two types of instrumental translation perceptions; the first is the translation between sensory dimensions from sound to sight with digital tomographic processes as used in acoustic technics for deep-water archaeology. The second is the translation from non-perceivable sensory dimensions such as the underwater hyperspectral imaging, which an optical sensor for seeing beyond the non-perceivable electromagnetic spectrum that exceeds sensory-dimension to be able to classify objects in deep-water archaeology (Ihde, 2015, p.40; Ødegård, Mogstad, Johnsen, Sørensen & Ludvigsen, 2018a).

Ihde, in his book "*Bodies in Technologies"*, calls this instrumental intension like the use of false-color "second sight imaging". Second sight imaging means that through a deliberate set of manipulations, one utilizes contrast and enhancement techniques to instrumentally translate patterns that are beyond ordinary human visual capacities (Ihde, 2002, p.47-49). We want to amplify the macro features of the shipwreck, so that it is as close to the human perception as possible (low contrast transformation). It is important to note that instrumental reductivity is an aspect that may be forgotten when using such technologies (Ihde, 1979, p.45). These "false colors" can be changed within a computer software like the use of Sea Scan Survey (for SSS) or NaviModel (MBES) where you can change the colors or lighting conditions within the data, making certain features more visible. Deliberate enhancement and contrast methods, like the one illustrated in figure 12 or 34, is a hermeneutic style of envisioning phenomena, as it retains the advantages of gestalt and phenomenological visions (Ihde, 2002, p.47). Therefore, the use of optical sensors and ROV is used for further investigation to reveal the micro-features of the wreck.

Micro-features such as individual objects and structures such as the lantern or engine part, as this is not perceptible in the acoustic images of the Skogn Wreck.

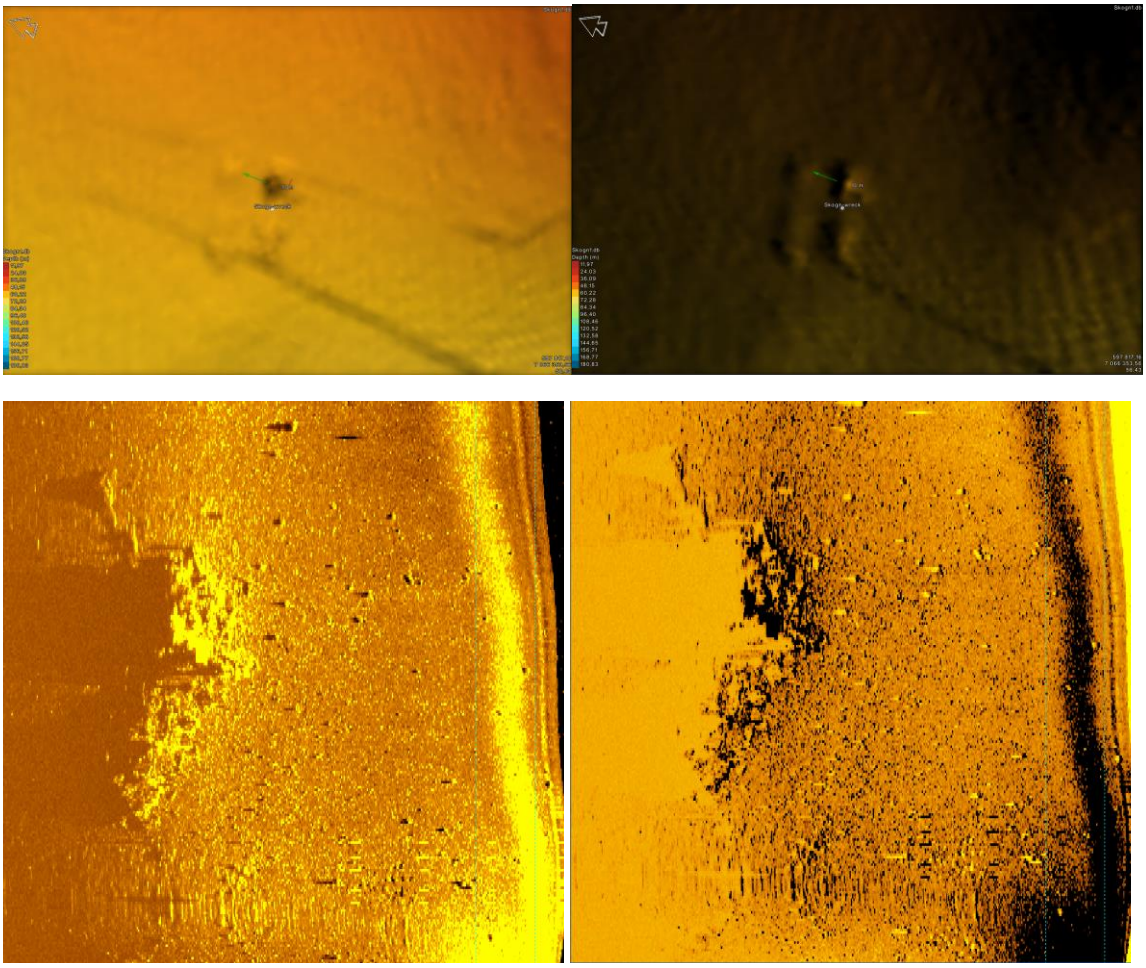


Figure 34: By changing the lighting and color settings, one can make a "better" translation as the features become more visible. Second sighting is a form of hermeneutic style of visualization

Here we can see the difference in amplification/reduction structures. As previously mentioned, the SSS is of low-contrast amplification/reduction structure, as the wreck retains recognizability as it is a sort of an isomorphic image. MBES, on the other hand, retains a transformation of high contrast, as the recognizability of the wreck disappears (Ihde, 1979, p.37). I will also claim that these transformations may also vary. As explained in my case study, the use of these technologies may actually change these transformations between low and high contrast depending on the application of these technologies. If we had an AUV with MBES mounted on it, we would get higher resolution data as it would bring the technology closer, creating MBES data of a lower contrast transformation because of the recognizability increases as a result. This is illustrated in figure (?), which is a shipwreck from the Philippines (see fig.(?) right image). This also shows that the quality of the images also depends on the condition of the ship itself.

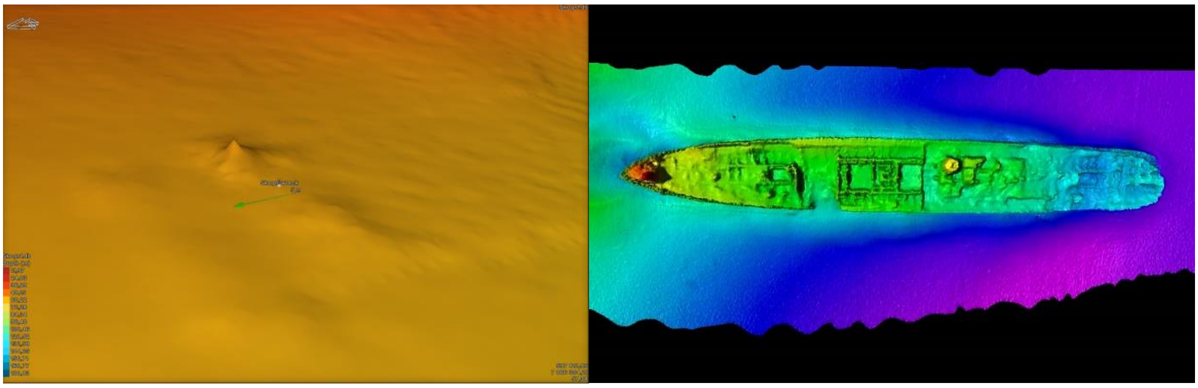


Figure 35: Here, we see the importance of resolution and of the state of the ship itself. The more abstract data on the right has a higher contrast-transformation as a result of the resolution. The one on the left is from another ship from the Philippines. The picture on the left retrieved from https://www.bluenomads.org.

With acoustic imaging in deep-water archaeology, one does get a better understanding of the spatiality of the ship, but because of amplification/reduction structure, it only gives an overview look as we are still at a "distance" like a map. There are different "distances" inherent in SSS and MBES images. This is because SSS is an orthographic projection, only giving us a specific perspective and view of the ship itself. MBES is not an orthographic projection but a 3D projection, but the visualization is more abstract, making it more suited for the detection of potential objects of interest in a larger area. When MBES is more abstract, the transformation moves away from low contrast towards a higher degree of high contrast transformation depending on the application of the technology. Therefore, it may be challenging to differentiate between natural and potential archaeological structures and objects, needing a more trained eye and visual structural skill within gestalt pattern recognition (Ihde, 2002). Sometimes, this not even possible because of low-resolution data or because of the degradation stage of the shipwreck, as it is almost completely gone.

In comparison to optical sensors, the SSS and MBES data are more of a "graphic depiction" of phenomena that cannot be perceived in an embodied, situated perspective, as the sound waves are visualized through computer processing (Ihde, 2006, p.82-83). Nevertheless, they still can have, depending on the resolution, have isomorphic qualities. These acoustic instruments applied for the M/S Helma wreck does have a clear low-contrast amplification/reduction structure and puts into view that what cannot be seen in an unmediated direct embodied experience. You will always need some technology to be able to perceive the wreck on the seafloor. An example: instrumental translations of the seabed through multibeam echosounder amplify the macro-features through coloring (as seen in fig.2), and the collection of x, y, z points puts us towards horizontal instrumental variation of low contrast based on resolution. If the resolution is low, one does get the more abstract like visualization, suggesting a move towards a higher contrast transformation as it gets harder to interpret depending on the application of the technology and resolution.

Low-contrast transformations make it easy to interpret and read, but the micro-features of the seabed are almost all gone in the reduction process. Therefore, the amplification "translates" aspects of the world into visible results that are better suited for seabed classification and detection of undiscovered shipwrecks, which is standard praxis and use of this technology (Ihde, 1979; Ødegård et al., 2012). As mentioned in chapter 3, because of the lower resolution of the MBES data, individual scattered objects, and other archaeological micro-features of the wreck is not perceivable. However, this abstracted image is "image-like," which has gestalt patterns that are recognizable if you have a trained eye. Shipwrecks can be perceived through SSS and MBES, but the "distance" from which they are perceived is more like that of a map (Ihde, 2006). Nevertheless, the instrumental translations of the SSS and MBES still have amplification/reduction variables that differentiate these acoustic sensors. This is the result of the materiality of these technologies, like engineering designs of the sensor, leading to different visualizations within amplification and reduction. The most significant difference in the visuals is the framed nature of the SSS visualization and is the acoustic imaging technology that functions more like a map. The MBES produces 3D bathymetric visualizations, creating a different instrumental translational perception of the sea bottom. Through processing, we see a composite result that is reconstructed by computer processes (Ihde, 1998, p.189). While this may be thought of as a computational move towards "disembodiment", where the technologies are seen as a neutral artifact, it is actually instead a return of interpretive embodied activity which is humanly perceivable through images and 3D models (Ihde, 2006, p.81).

4.2.5. Sensor fusion of acoustic data

Sensor fusion refers to the merging of several types of methods and visualizations to make one type of representation of the world that is not possible by using one type of sensor. In the case study, through the use of computer processes, we were able to merge SSS and MBES data to give a new way of seeing the shipwreck itself and sea bottom in a new way, which in turn gives a different amplification/reduction structure. While many of the same amplification/reduction structures and present in this way of presenting the shipwreck, there is still, in a way, a gestalt switch that is going on here that is important to analyze here.

The capability to create one model with the use of sensor fusion brings with it its different sets of amplification/reduction structures that can serve as a tool for further archaeological interpretation (Ludvigsen & Søreide, 2006). The amplification/reduction structure in SSS data leans more towards the same amplification of isomorphic depictions, as it amplifies more of the micro-features of the shipwreck. Compared to MBES depictions, MBES is more of a graphic depiction of the shipwreck by using "false color" to depict bathymetric data to show the topography of the sea bottom. This graphic depiction cannot be perceived in this way from an embodied and situated perspective, as the whole sea bottom is reduced to a single image (Ihde, 2006). The bathymetric data is used to create a 3D representation of the SSS data. So why do we want to create a 3D representation of the SSS data with the use of bathymetry?

The point with sensor fusion in deep-water archaeology is to create a gestalt switch. The SSS image is framed vision. Once we can create a 3D representation of the SSS, it engages the macro-perceptual dimension, as the amplification is engaging our micro-perceptual capacities, as sensor fusion leads to a low-contrast transformation in a horizontal instrumental variation, which is a part of the hermeneutical strategy of deep-water archaeology.

All these kind of processes in imaging technologies that requires computer processes to create an image, which is, in this case, acoustic data is a new trajectory compared to isomorphic images presented in the previous part. Here, the instrumentation is more actively interventional compared to isomorphic images, as the computer takes the acoustic data collected on the field and creates an image that engages the human perceptual capacities.

I also want to point out the multistability of sensor fusion, like this example, along with the photogrammetry model, which are good examples of the multistability of technologies and images. In chapter two, I explained the notion of multistabilities by using the example of the Necker Cube and duck/rabbit to illustrate this phenomenon. I believe that many similarities are happening in this example compared with the jump from 2D representation to 3D, as this implies a straightforward phenomenological variation (Ihde, 1993). As mentioned, there is a kind of a "gestalt switch" in the sense that there are several different perceptual possibilities as a result of instrumental phenomenological variations as the application of several sensors and computer software forms a different situated form, creating different hermeneutic possibilities for interpretation. With a gestalt switch, by using the duck/rabbit example, we want to achieve a "stable" interpretation that leans toward the duck than the rabbit as a part of a hermeneutical strategy.

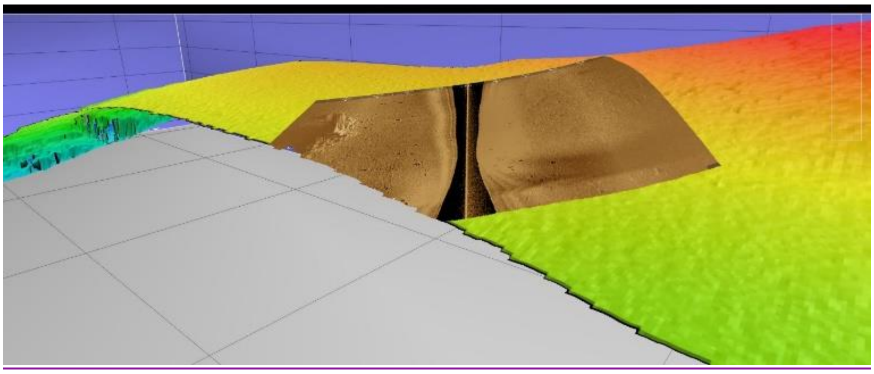


Figure 36: When viewing this model in the right software, it is a 3D model, leading to a "gestalt switch" as a result of sensor fusion. This switch leads to a horizontal instrumental variation of low contrast.

4.3. Conclusion

An important question to ask is this: does the theory, method, and analysis answer the research question? The answer so far is yes. The theory has worked well and demonstrates to be a useful tool for analyzing the role of technology and its implication perception. This is because of its descriptive nature. The case study, along with my analysis, has shown that postphenomenology is a theory with exciting aspects and terminology that is useful in the understanding of how technology affects our perception and experiences. A critical aspect is the lack of more "text like" visualizations in my case study and analysis. Also, the descriptive nature is, in many ways, a first-person type of phenomenological research, and I do not make accurate predictions or any "objective" answers or determining cause and effect.

The descriptive nature of my analytical approach is only based on my work in this thesis, and the few times I have been involved in deep-water archaeological surveys. Because of the descriptive nature, there may be a certain bias in my analysis, or what is known as the "halo effect". Even so, the results of chapters 3 and 4 show that postphenomenology has been a helpful tool in the understanding of how technologies are used deep-water archaeology and its implication on perception. As I will now discuss, the are several archaeologists that have been discussing the role of technology in archaeology.

Chapter 5: Discussion

5.1. Primacy of Vision in deep-water archaeology

My main research question for this thesis is as follows:

How can post-phenomenology help us in the understanding of how technology affects the archaeologist perceptions and praxis in deep-water archaeology?

There have been several archaeologists that have argued that visual modes of perception have been overemphasized in phenomenological research and been linked as a mode of appropriation from the modern Western world (Brück, 2005, p.50). While I am not going to discuss the politics of vision and technology, I do think that this discussion reflects the general view on vision and technology and its relation to archaeology and perception.

According to Adams (2003) in his article "*Experiencing Shipwrecks and the Primacy of Vision*", we are just as reliant on other senses like touch to be able to "see" things in the dark and get a cognitive understanding of underwater archeological contexts and materials (p. 87-89). By being there in diving equipment and make drawings to document and understand wreck sites have an essential role in the cognitive process (Adams, 2013).

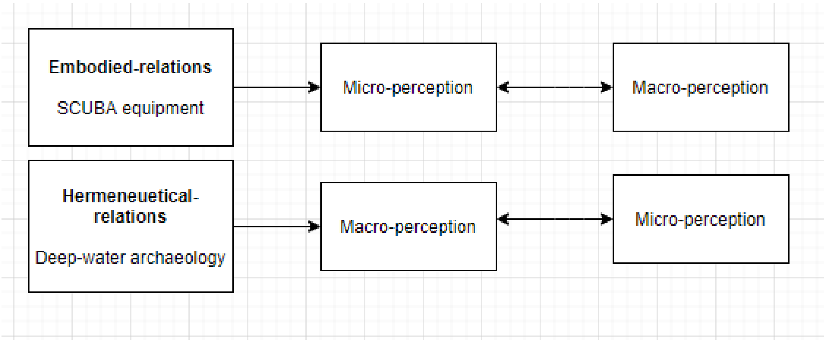


Figure 37: Deep-water archaeology is a hermeneutical field in which the macro-perceptual contextualizes our micro-perception. With the use of SCUBA equipment, the micro-perception contextualizes macro-perception.

The praxis of deep-water archaeology is visual hermeneutics, where whole-body perception is in play, even though the technologies used leans towards a primacy of vision, which raises questions on how we experience these sites. In chapter 4, I analyze the different imaging technologies used in deep-water archaeology and its non-neutrality. This has consequences because of amplification/reduction inherent in these technologies. In some cases, one must learn to "read" these images to apprehend and interpret the image. Because we are mostly in a hermeneutical relation with technology in deep-water, we moved away from experience wreck sites through technologies like the diving equipment and moved towards the experience of technologies and their mediation of the world and shipwrecks (fig.13) (Ihde, 1979).

From a postphenomenological perspective, this illustrates the relationship between micro- and macro-perception. As described in chapter 2, these are never separated, but are always in a mutual relationship, informing and orienting each other (Ihde, 1990, p. 29, 40; Ihde, 1993, p.74; Verbeek, 2001; Hasse, 2008). While micro-perception is in use in embodiment-relations, it is the macro-perception that comes first and used in hermeneutical relations, as deep-water archaeology is more of an interpretive activity, as illustrated in diagram nr. 2 (Ihde, 1990, p.39).

The diving equipment, which is able to situate the archaeologist directly with shipwrecks underwater, plays a vital role in the cognitive process of coming to know and understand the archeological sites as a result of the bodily and micro-perceptual action and experience. This contributes to the macro-perceptual understanding of an underwater archeological site as the embodied relation with diving equipment can situate a human body in places it is not able to reach otherwise. The senses are able to give other kinds of interpretations. Deep-water archaeology starts in macro-perception, as we are only able to access wreck sites at a depth we cannot dive to with the use of technology. The primacy of vision in deep-water archaeology is, therefore, somewhat determined by the technologies itself as the trajectories of technological intentionality form the praxis.

5.2. Postphenomenology and archaeological theory and methodology: The «postphenomenological walk”

In this part of the discussion, I am going to discuss Tilley`s phenomenology and his view on technology by analyzing some of his statements on this issue, which is mostly about the software Geographical Information Systems (GIS) and its use in landscape interpretation and documentation. The reason for choosing Tilley is he has an entirely different view on technology compared to postphenomenological thought.

Phenomenology was first popularized in archaeology by Christopher Tilley (1994) in his famous book "A Phenomenology of Landscape" during what is known as the post-processual theoretical paradigm. It has since been a heavily debated book in archaeological theory. Tilley's body of work has been hugely influential in Norwegian archaeology, as Tilley's phenomenological method called "The Phenomenological Walk" has often been used by archaeologist in Norway for the interpretation of landscape, cave paintings and rock carvings (Ljunge, 2013) (see example Bjerck, 2012 on phenomenological research on cave paintings). Tilley`s work has also been highly criticized.

There are several interpretations of what phenomenology tries to explain and achieve. For Tilley, the phenomenological approach is:

> "*Phenomenology involves the understanding and description of things as they are experienced by a subject. It is about the relationship between Being and Being-in-the-world. Being-in-the-world resides in a process of objectification in which people objectify the world by setting themselves apart from it. This results in the creation of a gap, a distance in space. To be human is both create this distance between the self and that which is beyond and to attempt to bridge this distance through a variety of means – through perception (seeing, hearing, touching), bodily actions and movements, and intentionality, emotion and awareness*

residing in systems of belief and decision-making, remembrance and evaluation" (Tilley, 1994, p. 12).

He applies phenomenology to the interpretation of landscapes as a way to understand the humans of the past and their relationship with the landscape. Here is where the concept of "the phenomenological walk" comes in. This is related to the term "embodiment", as one experiences the landscapes through one bodily sense, which involves participant observation (Tilley, 2010, p.25). To be able to understand landscapes from a phenomenological perspective, you have to walk through them, since our experience through our bodies is always a blending of different senses, a multisensory approach that the humans of the past would experience the landscape (Tilley, 2010, p.27-28). In short, a direct bodily sensory experience which is not mediated by an instrument or technology. This is one of the only ways in which one could understand landscapes phenomenologically, as Tilley would say that "phenomenologists works and studies landscapes from the "inside"" (Tilley, 2010, p.25). The "outside" experiences of landscapes, the mediated or abstracted representations through maps or other types of technologies can "*only provide only a relatively superficial and abstracted knowledge*" and that there "*is no substitute for personal experience, for being there*" (Tilley, 2010, p.25-26).

From my understanding of Tilley, in the mediating relationship between one's body and landscapes become present-at-hand through technological instruments, which is not the way past humans experienced the "world". Through direct bodily sensory experience, landscapes and places become ready-to-hand, as it will no longer be seen as a singular object but as a set of relations between humans of the past and the landscape. This mode of present-to-hand will then build upon the mode of readiness for use, as one objectifies the world and ordering it as "standing reserve". In my understanding, this is what Tilley means when he says that objectification of the world is setting people apart from it (Tilley, 1994, p.12). Mediated experiences of landscapes such as technological representations are present-at-hand, and we no longer see our self in relation to the landscape as the humans of the past did. It becomes an object or "standing reserve," that is there to be observed and reduced to its sums of its part as a result of technologies. Our perception of the landscape is abstracted and taken away its meaning because of technology, and we will not be able to understand humans of the past.

The reason behind this is that the approach to landscapes through maps and measurements was not the way in which the people would have experienced it in the past (Harris & Cipolla, 2017). According to Tilley GIS is:

> "*incapable of providing an embodied encounter with a landscape, or a monument, a feeling for the place in which the place itself exerts its agency, exerts its own powers in relation to human perceptual experience. And part of that is the human capacity to make memories from one place to another, to situate and sequence them in relation to different encounters and paths of movement*" (Tilley, 2010 p.477).

We see here a direct confrontation to "new geography" and "new archaeology" (processual archaeology), which considered space as an abstract dimension that could be objectively measured in terms of an abstracted geometry of scale, which led to a neutral view of space divorced of meaning. Through "quantification, mathematization and computer modelling", this took away landscapes and places agency and meanings (Tilley, 1994, p. 9).

I don't necessarily think that Tilley is against the use of technology, as he uses GIS in chapter 3 in his book "*Interpreting landscapes: geologies, topographies, identities; explorations in landscape phenomenology 3*" (2010) as the use of GIS in landscape interpretation can be useful in situations where contemporary present obscure visual fields possible in the past (Tilley, 2010, p.477).

I am not going to dive further into the role of GIS in landscape interpretations (I refer the reader to David Crystal's article "*Postphenomenology and archaeology: towards a temporal methodology. Time and Mind*" for further discussion on this topic). I do believe that the use of technological instruments in archaeology, even though they mediate a transformed world, may still actually bring to light unseen perspectives and phenomena of the past humans that are not perceivable through direct, unmediated experience. The technological instruments give the landscape a different technological mediated meaning and experience of landscape, a mediated sense of place in which the landscape itself exerts its agency but mediated through a technological instrument that transforms the world because of non-neutrality.

This is an important ontological and epistemological phenomenological framework that sees technology and visualization as a part of a transformed experience. This is not to say that direct, unmediated experience of landscape is better or worse than technological mediated experience. In the production of archaeological knowledge, technologies play different roles in our attempt to understand humans of the past. In deep-water archaeology, without the so-called abstracted representations and "outside" experience through technologies, we would not be able to bring to light the shipwrecks of the past. This is not to say that technologies are or should be seen as a substitute for personal, unmediated experience, but technologies give a transformed way of "being there" or being-in-the-world. Therefore, I am, in a way, "being there" at the Skogn wreck site but mediated through a technological instrument and its inherent perceptual non-neutrality.

All of this, understandably, is about experiencing the landscape in a direct unmediated matter in order to experience the landscape like the humans of the past did (Tilley, 1994, 2010). This phenomenological framework has its values in the discussion in understanding past humans, but this does go against the postphenomenological view on perception. While the micro perceptual dimension, if ones separate it from macro perception, has not changed in any significant matter in thousands of years, one can say that we do in a way get an insight about the humans of the past and their experience of the world as an important point of a common connection between present and the past (Tilley, 1994; Brück, 2005). Since macro-perception cannot be separated from micro-perception, how the micro-perceptual sensory dimension experiences the landscape in the present, and which informs the macro-perception. This dimension also plays a role in the micro-perceptual dimension as it contextualizes the sensory bodily position (Hasse, 2008). This notion is in line with several other theories that the body is also a product of social relations and cultural values that shapes interpretations, and in this case, also shapes micro-perception, the sensory dimension (Brück, 2005).

When it comes to knowledge production, the history of archaeology shows how cultural habits change how we produce knowledge and interpret archaeological material and contexts through and with archaeological visualization. These cultural habits from these different eras formed and shaped the ways in which we visualize archaeological material, forming different micro-perceptual dimensions that are contextualized by the macro-perceptual context, in which visualizations and interpretations are made. This also applies to direct unmediated experience of landscapes as a mode of knowledge production and archaeological interpretation. Therefore, present visualization with the use of AUV, ROV, and visualization techniques such as photogrammetry or acoustical visualizations does not suggest a positivistic approach to archaeology. I am suggesting a kind of humanistic approach that sees technologies as a part of archaeological praxis of knowledge production and interpretations. This also does, in my opinion, diverge from phenomenology as the phenomenological framework of Tilley is seen as a kind of subjectivist epistemology (Thomas, 2001, p.174).

What is overlooked by Tilley is the ways in which instruments can be technological embodied (Ihde, 2002, p.56). One result is that the move towards technological instruments has been considered as a move towards "disembodiment"", a move towards object/subject dichotomy. As a result, Tilley is not subtle in his view on the role of GIS in archaeology:

> "*GIS provides a dumb, indeed surreal, view of landscape in which everything is equally visible and therefore equally important – which is clearly never the case – and, of course, it can cope only with the visual rather than with other forms of sensory experience. Like any other mathematical technique, it is terribly impoverished experience and inevitably makes inhuman assumptions in the form of the modeling that is involved.*" (Tilley, 2010, p.477).

Here we see Tilley not seeing the non-neutrality of technologies and its multistable uses. GIS, like all imaging technologies, does not provide neutral visualization because all imaging technologies have an amplification/reduction structure that amplifies and reduces features of the phenomena visualized (Ihde, 1979). Technologies are a part of a cultural context, but a dystopian view of technology has framed the discussion on its implication on knowledge gathering and presentation in archaeology and perception. As Ihde claims, there is no determined destiny of technological development (Ihde, 1993, p.34).

Archaeologists who view technology as neutral with utopian possibilities rely only on emphasizing amplification while ignoring reduction. This notion can be attributed to processual archaeology. At the same time, there are people who only or mostly emphasize the reduction while ignoring amplification that is opposed to humans (Mitcham, 2006). This can be attributed to the post-processual archaeological paradigm, but both uphold the nature-culture distinction when it comes to the use of technologies in archaeology. In postphenomenology, amplification and reduction are equally crucial as technologies are non-neutral and multistable as technologies co-shape both the scientific observer and world under observation (Rosenberger & Verbeek, 2015). The objects of study and its location mean that this form of praxis in deep-water archaeology is constituted through the mediation of different imaging technologies.

The use of technologies in archaeology, especially in deep-water archaeology has created sophisticated visual hermeneutics that is more a perceptual interpretation than a linguistic interpretation (Ihde, 2009). This blurs the division between natural sciences and archaeology as a field, as different use of technological instruments is a type of material hermeneutics. In Ihde`s book *Postphenomenology and Technoscience* (2009, p.70-74), he uses the famous iceman Otzi and the investigation process to illustrate material hermeneutics. When Otzi was first believed to be a recent death incident, through the use of different kinds of technological instruments such a CTs scan and carbon dating, and of course the archaeological material, it was concluded that Otzi was a prehistoric human (5300 BP). Otzi was given a "voice" and set in a situated context where the technological instruments gave the archaeological material "voices" (Ihde, 2009, p.70-74). In deep-water archaeology and with my case study, things like the shipwreck are given a "voice" in a non-linguistic technological manner. The understanding of hermeneutics as only belonging to human sciences is blurred.

My main point is this: when it comes to the understanding of how technology affects archaeologists' perceptions and experiences in archaeology, there is no predetermined destiny of technology. Technologies have no "essence" as a result of multistability, as technologies are linked to humans-in-culture and should not be understood as an independent power that holds culture in its grip, or the other way around (Verbeek, 2001, p. 134). We got to start looking at imaging technologies in archaeology and the implicit hermeneutics within archaeological praxis with the use of these technologies. The view on technology if often colored in a nature-culture distinction that holds the presumed difference between "natural" objects and "artificial" objects (Ihde, 1998). Instead, technologies should be regarded as a mean by which our perceptions and our experiences are modified and transformed (Ihde, 1998).

While the Cartesian gaze and Vision has been the so-called "master-sense" of modernity that has objectified the natural that has led to a nature-culture distinction, the phenomenological framework of Tilley and many other archaeologists operate in the same distinction when it comes to the discussion on technologies (Thomas, 2001). Instead, these technologies should be understood as mediators of experience with an inherent non-neutrality and multistability and that we are embodied in the world through technologies. The multiple technological trajectories, mostly visual instruments, constitutes a material and visual hermeneutic praxis that is a part of a cultural context and which shapes archaeological practice. In deep-water archaeology, its broader praxis is just as multidimensional and bodily actional as any human activity (Ihde, 1998, p.187).

5.3. Archaeological visualization, technology, and perception

According to a book review of Peter-Paul Verbeek`s "*What things do: Philosophical reflection on Technology, Agency, and Design*" (2005), which is frequently used in this thesis, Kaplan (2009) criticizes Verbeek`s understanding of mediation for being undialectical. Kaplan claims that "*Mediation relates not only subjects and objects but the historic development of entire environments*" (p.235).

If we consider that mediation is dialectical, where history influences our experience and in turn manifests and shapes technologies, institutions, and practices of the present day, then we have to look back at what historical conditions that shaped deep-water archaeology (Kaplan, 2009). To be able to understand visual hermeneutical practice in deep-water archaeology and its historical conditions, I am going to discuss the history of archaeological visualization in a postphenomenological perspective. There are several other conditions, such as political, economic, and other societal conditions involved, but this would go beyond the scope of this thesis.

Deep-water archaeology is related to the history of archaeological visualization, as today's constructed imaging retains an analogue to art processes used in earlier archaeological visualization (Ihde, 2006). In what way is deep-water archaeological visualization already a historical continuation of earlier types of archaeological visualization? Throughout the history of archaeological visualization, we see that there have been different ways of visualizing, creating different perceptions and ways of presenting knowledge. The term "archaeological visualization" has two dimensions. First, it refers to the "*products from graphically representing archaeological materials*" and secondly, "*refers to the process of interpretation embodied in this visual translation*" (Moser, 2012, p.295). Archaeology as a discipline is dependent on archaeological visualization and is now getting more dependent on different kinds of imaging technologies as a key part of the research process (Moser, 2012).

As new technology emerges and used in archaeology, a cultural question arises as new scientific trajectories in archaeological practices are developed. The abstract line drawings that before was produced utilizing paper and pencil are now produced via computer software such as Photoshop Illustrator and with the help of 3D scans (Gilboa et al., 2013; Morgan & Wright, 2018). Archaeological applications of these technologies are not just limited to field methodologies where most of these drawings stem from, but it also extends to data representation as it creates new ways of imaging and visualizing the past (Mesick, 2013, p.65). Here, there arises a hermeneutical question (or what is also known as contextual hermeneutic theory) on the conditions of archaeological understanding of the past as archaeologists encounter a technologically mediated world, in which imaging technologies should be understood as transformative mediators of human experiences (Johnsen & Olsen, 1992; Rosenberger & Verbeek, 2015, p.33).

The difference between drawing and imaging through optical sensors is the ways in which specific features changes in amplification/reduction structures, as the way in which these different type of mediation of micro-perception affects macro-perception and how archaeologist interpret their world (Verbeek, 2001). The visual representation and translating archaeological material into images have been a significant concern in archaeology, as it is an integral part of archaeological interpretation (Bonde and Houston, 2013). Even modern computer-based visual representations may seem first as a radically new way of doing and representing data in archaeology. In the literature concerning technology in archaeology, there is a polarized debate between those who are advocates of these new imaging technologies and skeptics of technology such as VR applications (Mesick, 2013).

Several archaeologists have been researching archaeological visualization, the ways in which visualization influences the production of archaeological knowledge (Moser, 2012). Moser sees a clear connection between antiquarian illustration to the development of scientific illustrations (Moser, 2014). There are several historical examples of archaeological illustrations that led to a new development in archaeological research and documentation. The earliest illustrations of artifacts can be found in paintings and manuscripts from St. Albans Abbey by the monk Matthew Paris from the mid-13th century (Griffiths, Jenner & Wilson, 1991). Also, in France during the 19th century and in Europe in general, there was a huge surge of the production of illustrations of objects and archaeological sites (Lewuillon, 2002). Therefore, as time has passed on, the constant development of archaeology as a field has been closely linked to these illustrations or visualizations. This has made visualizations important in archaeological practice. From a theoretical perspective, they possess an "a*rchaeological "view" of material culture and sites, but also because they have undergone a complex process of encoding in order to achieve this signifying role*" (Moser, 2012, p.302).

This is what Ihde calls for "visualism", which is a cultural habit in sciences that constitutes a form of technological constructionism (Ihde, 2002, p. 37). While archaeological visualization, and as pointed out earlier, has not always been using computer-based visualization technologies, visualization has at least for 500 years have depicted archaeological objects for scientific use (Moser, 2012, p.303). While hand-drawn visualizations are not technologically constructed in the same sense as deep-water archaeology, there are several similarities as it is a sort of visual hermeneutic process. Even today, one of the most important forms of documentation has been through different kinds of visualization techniques to be able to produce and communicate archaeological knowledge. For example, drawing as a form of documenting can be seen as a form of "visualism", as the use of different technologies such as a pencil or paper is used to visualize important archaeological features, which suggests a mediated experience of archaeological material in the production of archaeological knowledge and as a tool for analysis (Moser, 2012).

Therefore, we see that all of science and in the production of archaeological knowledge is in different ways, "technologically embodied" (Ihde, 2009, p. 46). The meaning behind this is that the science is embodied in its instrumentation, and what these perspectives imply, is that science is seen as *praxis.* As praxis, science is a "knowledge-gathering *activity* which only occurs by being embodied" (Ihde, 1979, p. xxvi). In my understanding, one cannot separate science away from technology and the other way around or think that technologies and archaeological visualizations are "neutral" in the production of scientific knowledge. They are linked in an intentional relation that shapes the human experience and praxis in human's relation to the world.

From a historical perspective on archaeological visualization in a postphenomenological framework, archaeology has at its core has always been a form of a visual hermeneutics, because it uses mostly visualizations as a transformative mediator of human experience that shapes the scientific observer and the world under observation (Rosenberger and Veerbeek, 2015, p. 34). This is especially the case for deep-water archaeology, as its dependence on several imaging technologies gives access to that which is inaccessible for archaeologists without the use of technology. Also, terrestrial archaeology uses different kinds of imaging technologies, such as photogrammetry and geophysical methods.

As shown in my elaboration in the "research status" in chapter 1, contemporary archaeology, such as deep-water archaeology, is "*dragged forward through the development of instruments*", in this case, underwater robotics and imaging technologies (Rosenberger and Verbeek, 2015, p.33). This is to show that much of marine archaeology and terrestrial archaeology concerns itself with imaging technologies and visual representation (Bonde and Huston, 2013). As my study illustrates, the application of different imaging technologies is not just limited to field methodologies but requires data processing that extends into the presentation of data as a part of knowledge production (Mesick, 2013). We see a historical continuation of visual hermeneutics from earlier archaeological illustrations to deep-water archaeology.

Figure 38: A drawing from one of Leonardo Da Vinci`s notebooks. From https://www.theconversation.com.

What I believe is the case for the history of archaeological visualization and what it shows is that science praxis is deeply rooted in the hermeneutics of visualization and imaging technologies (Ihde, 1998). This is because, in a more general sense, from a historical perspective, scientific practice has been concerned with and preferred scientific visualism (or imaging) to translate phenomena into visual forms (Ihde, 1998, 2002, 2009, 2019; Rosenberger and Verbeek, 2015). In archaeology, hermeneutical philosophy in the epistemology of archaeology is closely related to the post-processual archaeology or "contextual archaeology" proposed by Ian Hodder, where archaeology is understood as an interpretative practice (Johnsen and Olsen, 1992, p.97). While archaeology has been concerning itself with the factors that play a role in the understanding of the past, postphenomenology approaches the relation between human beings and their material through "material hermeneutics" where there is a mutual constitution between humans and the world (Veerbeek, 2005).

Figure 423: " "The Marriage of the Virgin" by the artist Rapahel. This painting is a good example of "Renaissance perspective ". From https://www.wikipedia.com.

What is underestimated, in my opinion, on the history of archaeological visualization, is the relationship between technology and art. The art practices from the Renaissance, the artistic establishment known as the "Renaissance perspective," is closely connected to the camera obscura. Artists such as Leonardo da Vinci used this optical technology to achieve naturalism in his anatomy drawing found in his notebooks (Ihde, 2015; Piggott, 1965, p.169). Ihde calls Leonardo Da Vinci a "handcraft imagist" (Ihde, 1998, p.159). This would have a profound implication on the practice of art, as the camera obscura enabled artists to create convincing representations by incorporating Renaissance perspective conventions of linear perspective and geometric line to give the illusion of depth and space to painting, especially in the 17th, 18th and 19th century (Kleiner, 2013, p. 711, 744). It is no coincidence that the coming of the modern era was connected to this new way of looking at the world, as it enabled a "realistic" rendition of the three-dimensional world on a two-dimensional canvas (Thomas, 2004, p.178). The camera obscura is the predecessor to the camera, which is still used in archaeology.

Throughout the history of archaeological visualization, or scientific illustrations, there have been developed several conventions on how archaeological objects are rendered. The most important development, according to Piggott (1978) in archaeological visualization, is the transition from the more naturalized and watercolor illustration from early antiquarians to the more abstract and line drawing illustrations. Abstract pictorial reconstructions are still quite common in archaeological practice (Moser, 1996). As this way of visualizing archaeological objects was adopted, it was seen as a new kind of scientific illustration, replacing the more naturalistic illustrations (Moser, 2014). This transformation led to a different kind of scientific-based amplification/reduction structure, where the illustrators choose what features of the archaeological object should be highlighted and which should be reduced to convey the most meaningful traits of the object, breaking with the naturalistic style of Renaissance tradition in illustrations (Moser, 2014). Archaeology and archaeological fieldwork are now increasingly adopting digital recording strategies, which is changing archaeological visualization. Just like in abstract pictorial reconstructions, digital recording strategies are similar in that the results are planned and laid out with specific results in mind (Ihde, 2006; Morgan & Wright, 2018).

These different aesthetic conventions of archaeological illustrations served different kinds of functions in its depictions, but there is also a third significant shift in archaeological visualization during the processual archaeology paradigm. While drawings and photography were the primary way of visualizing, the processual archaeological movement during the 1950s and 60s changed the practice of archaeological investigation with the use of photography (Carter, 2015). For example, a scale in the pictures became a clear discussion for this movement and became an integral part of the scientific practice of photography in archaeology (Carter, 2015).

Photographs became popular once it became possible to print good enough reproduction of photographs, but drawings still outnumbered photographs in publications (Adkins & Adkins, 1989, p.6). When going back to deep-water archaeology, the historical conditions of archaeological visualization is still present, even if the visualizations created in deep-water archaeology are more technologically advanced.

The advanced imaging in deep-water archaeology is, in some ways, a direct successor to the early antiquarian illustrations (Miller & Richards, 1995), as it involves naturalistic or physical realism found in earlier illustrations. The difference is that today`s constructed imaging is more active than the seeming “photorealism” of earlier forms of scientific imaging (Ihde, 2006, p.85). This suggests a historical link with the present-day practice of visualization where the difference is clear in the perceptions and techniques of the illustrator's different time periods and present-day archeologist with imaging technologies. Just like the map, which plays a central role in archaeology, the digital images from the Skogn wreck are an ontologically privileged source of primary and direct observations, as the optical and acoustic images from the Skogn wreck are the only way to experience the wreck which is not possible to achieve a direct, unmediated experience.

5.3. Conclusion: “Epistemology engines” in deep-water archaeology

So, the question is: *“what are the epistemological advantages of visualizations”* (Ihde, 1998, p. 161)? There have been several studies through a historical perspective on the use of visualization in archaeology. These studies suggest that the impact of images and different kinds of visualization and imaging technologies has theoretical significance in the production and presentation of archaeological knowledge.

Not only this, but also in especially how the increased use of computer-generated visual representations has changed archaeological practice (Moser, 2012). This is to show that there could be no science, in this case, deep-water archaeology, without technologies or instruments. This is also the case for art practices, in which archaeological visualizations have their roots (Ihde, 2019, p. 13).

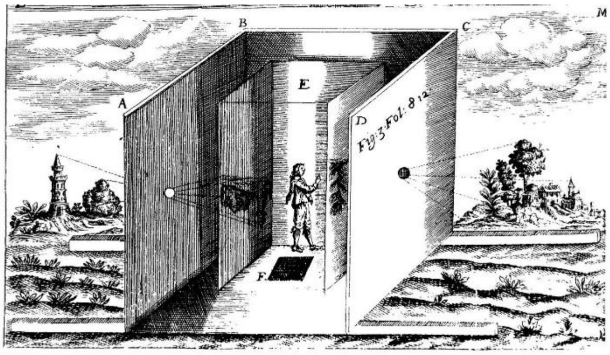


Figure 550: The camera obscura. Illustration by Athanasius Kircher. From https://www.sock-stock.com.

As explored, the camera obscura was a well-known optical device in the Renaissance, which led to the development of perspective drawing. This had a significant impact on art and later archaeological visualizations such as reconstruction drawings or landscape drawings. This had a major epistemological and ontological significance for archaeology that contributed to the formalization and professionalization of archaeology as an academic field (Perry, 2011, p.4). As some historians of science point out: "*Science owes more to the steam engine than the steam engine owes to science*" (Ihde, 2000; Ihde & Selinger, 2004, p.363). This also applies to the relationship between archaeology and technology in the production of knowledge.

This notion on the relationship between archaeology and technology suggests an *inversion* of the traditional priority of theory over practice (Ihde & Selinger, 2004, p.363). With this in mind, technologies can be viewed as "epistemology engines". "Epistemology engines" is defined as: "*a technology or a set of technologies that through use frequently become explicit models for describing how knowledge is produced*" (Ihde, 2004, p.362). To illustrate the meaning behind this, I will again discuss the camera obscura as an "epistemology engine" and its relation to René Descartes.

According to Ihde (2000), the camera obscura did not become an "epistemology engine" until the 17th century. Descartes, as well as the philosopher John Locke, deliberately constructed their notion on how knowledge is produced using the camera obscura: *"For them it is more than the eye that represents the world; the camera is to the eye as the eye is to the mind"* (Ihde, 2000, p.21). The eye is in this case, a metaphor for the mind (res cogitans) (Ihde, 2002). This gave birth to early modern epistemology known as the object/subject dichotomy, where an external "reality" that is detached from the subjects. This epistemology is modeled on the camera obscura in this way: the "external reality" outside the camera box is not known to the subjects who is inside the box: "*What comes from the outside are the impressions from the res extensa that are cast inside the box or body upon its receptor, the eye (retina) analogue where images form that represent the external world*" (Ihde, 2002, p.72-73).

This laid the foundation for Cartesian ontology and modernist epistemology because of the camera obscura, becoming an "epistemology engine". What phenomenology and postphenomenology do is to take the subject out of the camera and puts it in the world as an embodied entity (Ihde, 2002, p.74). If technology is a way for us to experience and to understand the world, science will then follow ontologically because science itself, and in this case, deep-water archaeology is a certain kind of knowledge gathering activity. This attitude is already a technological attitude, and thus making technology prior to science as technology paves the way for a kind of knowledge systematization that would not have been possible without the technology itself (Hongladarom, 2013, p.270-217).

Therefore, “epistemology engines” apply to deep-water archaeology and other technologies generally in archeology, as the technologies themselves are used to model the process of knowledge production (Ihde, 2006). From photography, photogrammetry, and acoustic technics, we see an emergence of theory from activity that is embedded in human-technology-world relations, shaping not only our perception of the phenomena studied, but may in fact, with its most dramatic effect have a profound influence on our notions of subjectivity. This is what with the camera obscura and Descartes's notion of res cogitans and res extensa did, as it affected our understanding of what it means to be human and to perceive from a human perspective (Ihde & Selinger, 2004, p.362). Technologies used in deep-water archaeology are “epistemology engines”, but we are no longer in the Cartesian camera, as technologies mediate and transform human experiences where humans are embodied in a world through technologies.

According to Sperry (2009) in his article *More than Meets the Eyes?: Archaeology Under Water, Technology, and Interpretation”* where he discusses the role of technology, Sperry concludes that:

> “*We need to consider that a critical implication of allowing the data to speak for themselves is that we are in danger of missing out the human interpretations that make archaeology both exciting and valuable. It can be argued that archaeology without interpretation is not archaeology but merely data collection; if this interpretation is missed out, there is arguably no distinction between ‘academic’ underwater archaeologists and the growing body of vocational underwater ‘fieldworkers’*” (Sperry, 2009, p.32).

While I don’t necessarily disagree with his conclusion or with many of his statements in his article, there are several things I think are interesting to discuss when one should consider the technologies used in deep-water archaeology as “epistemology engines”. In my postphenomenological analysis of the different technologies used in my case study, I show that these instruments lead to different trajectories in the amplifications-reduction structures as a result of the design of the instruments and how they collect data and gets processed. These “epistemology engines” becomes the model for how knowledge is produced in deep-water archaeology, making us archaeologist create theories and new ways of doing and presenting archaeological data.

If one follows the postphenomenological framework presented in this thesis, the data, or images does never “speak for themselves” (Sperry, 2009, p.28). There is always, even if archaeologists are not aware of this themselves, a mutual intentional relation between the archaeologist and the instruments. In this case, a hermeneutical relation. This is to show that there is always an intentional mutual relationship between humans and their world. Even if not one is directly embodying a technology, as one does with SCUBA gear, hermeneutical relations still implies bodily action, perception, and praxis (Ihde, 2009, p.46). This is why the data and images do not “speak for themselves” as this suggests a separation of “subject” and “object”. While Sperry is not negative towards technology, he suggests we should stop “playing with” technology and instead use the technology as a starting point for our interpretations (Sperry, 2009, p.28).

While I, in a way, support and understand this statement, the "playing with" is still an integral part of not only learning the use of instruments but also how to interpret the data it produces. By suggesting that archaeologists are just "playing with" technology, there is no interpretation, but just data collection that is missing the human side of the data (Sperry, 2009). If we view the technologies in deep-water archaeology as "epistemology engines", the reasoning behind Sperry`s statement, as referred to earlier, becomes clear: the statement suggests the traditional priority of *theory* over *practice* (Ihde & Selinger, 2004). This distinction is related to the mind-body distinction where theory is a product of the mind, while the practice is considered a product of the body. This distinction is upheld by Sperry when he says: "*I would argue that what we should actually be doing is not 'playing with' technology but rather using' technology to produce data-sets as a starting point for our interpretations"* (Sperry, 2009, p.28). Here, the mind takes precedence over the body, theory over practice (Ihde, 1979, p.xix). The idea of "epistemology engines" inverts this notion and instead thinks practice precedes theoretical reflection, which is what characterizes deep-water archaeological praxis in the first place (Ihde & Selinger, 2004).

In a way, the data collecting is already a starting point for our interpretation, as the non-neutral materiality of the technology itself transforms the world in its amplification/reduction structure. As my case study and analysis illustrates, the playing with the photogrammetry in Agisoft Photoscan made me understand the structures of the shipwreck itself better, as the software and images collected during the expedition the wreck site made me have to sit down with the images itself and put it together as a model. Tacit knowledge

I personally think that this illustrates Ihde`s idea about "epistemology engines" well. Epistemology engines is an excellent analogy to the technologies used in deep-water archaeology, and in the context of epistemology engines. The emergence of theory from activity embedded in human-technology-world relations is what defines this deep-water archaeology as a whole (Ihde & Selinger, 2004).

Chapter 6: Conclusion

The research question for this thesis was as follows:

How can post-phenomenology help us in the understanding of how technology affects the archaeologist perceptions and praxis in deep-water archaeology?

From a postphenomenological perspective, the technologies have no "essence" one taken into praxis and can therefore not be separated from its use contexts- or in other cultural contexts. Technologies in the field of deep-water archaeology work as mediators that transforms the world in specific ways as a result of non-neutrality. With non-neutrality follows amplification/reduction structure, which transforms the world by amplifying some dimensions while reducing others. By doing this, we can bring to light what is unseen and unreachable by us with the use of technology.

Postphenomenology inverts the notion of theory over practice. Praxis in deep-water archaeology is, in a way, determined by the technologies itself, creating different hermeneutical strategies that form the way in which we apply different technologies and process data. Here, we see the multistability of technologies, and more specifically, imaging technologies. There are no "stable" interpretations of a technological image, but much of the praxis in deep-water archaeology is about "stabilizing" the images in order to view what is there. This illustrates the role of human bodily perceptual experience in scientific imaging practice in deep-water archaeology and how technologies mediate and transform human perceptions and praxis.

Technologies can, therefore, be viewed as "epistemology engines", as deep-water archaeologists use hermeneutical strategies to achieve desired visualizations, which is already a continuation of the inherent visual hermeneutical praxis in archaeology. By applying this theory, one is able to understand how technology affects archaeologist's perception and praxis in deep-water archaeology. Postphenomenology forces us to consider what creates and constitutes our perception and praxis.

6.1 Future work

The application of postphenomenology in archaeology is endless. For deep-water archaeology, one can use this theory for the further development of methods and applications of technology to marine archaeology. This can range from underwater robotics to applied sensor fusion. By using postphenomenology as a theoretical starting point, one can investigate the possibilities and opportunities in the use of these advanced marine technologies, which is continually developing

For this thesis, I only explored the epistemological implications of human-technology-world relation in deep-water archaeology. Several other dimensions can be explored further, such as the political implications of the use of technologies. For example: how does the use of technologies relate to how the Norwegian cultural management bureaucracy manages and preservers archaeological heritage? How does the use of technologies further the ideas on what cultural heritage is and should be managed?

I have also only given a brief postphenomenological analysis of a niche discipline within archaeology. It would be interesting to broaden the use of postphenomenology to other areas in archaeology. Many other theorists within the STS discipline are relevant and who could come with other perspectives on the use of technology in archaeology and its implications on the discipline. As shown, we should consider using postphenomenology to understand the implications of the rapid societal changes, which is, in turn, being pushed by the development of technologies. The possibilities are endless.

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Appendix

Appendix 1: SSS map with markings

Appendix 2: 3D model from wreck site.

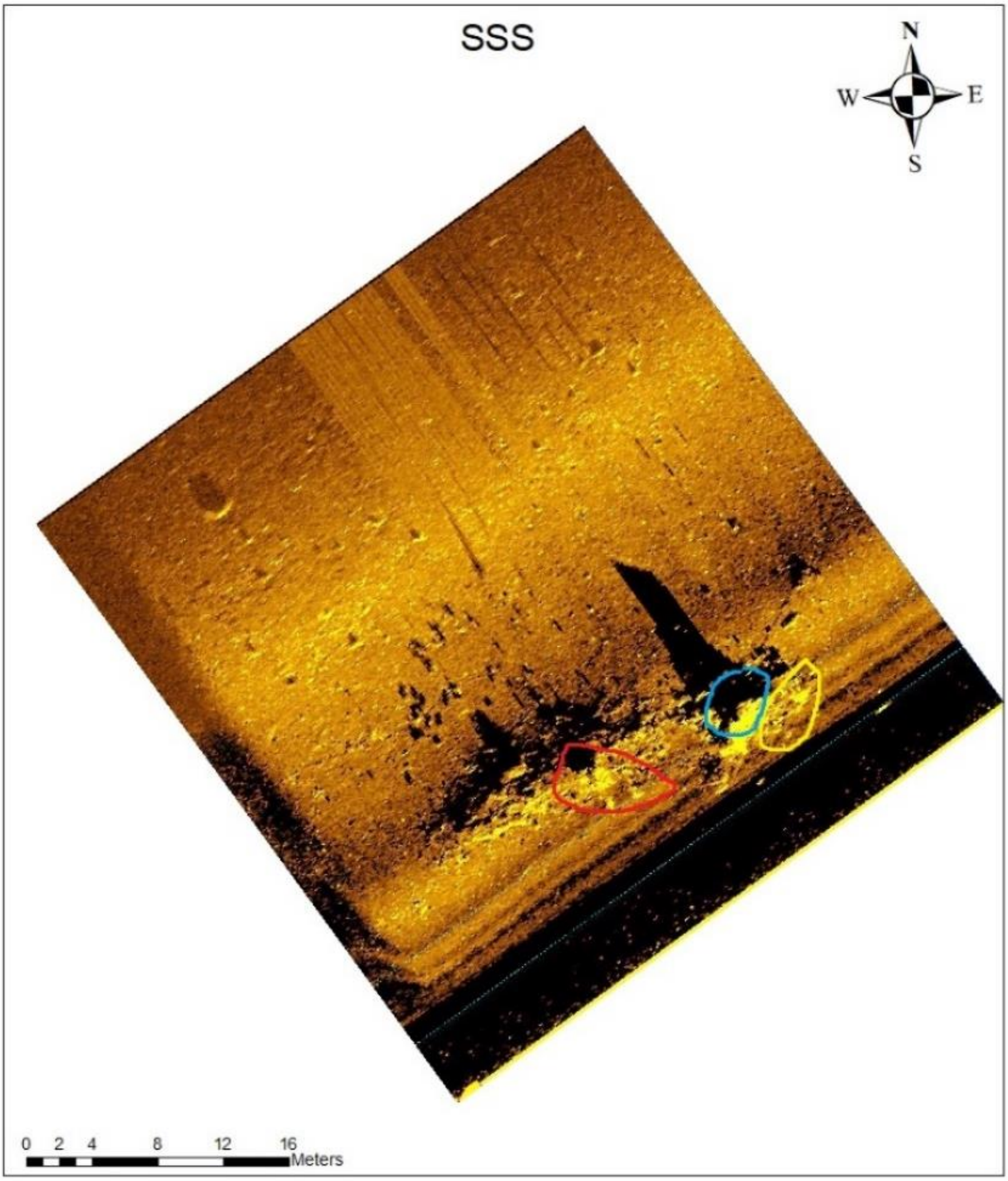
Appendix 3: 3D model from wreck site.

Appendix 4: 3D model from wreck site.

Appendix 5: Location of shipwreck.

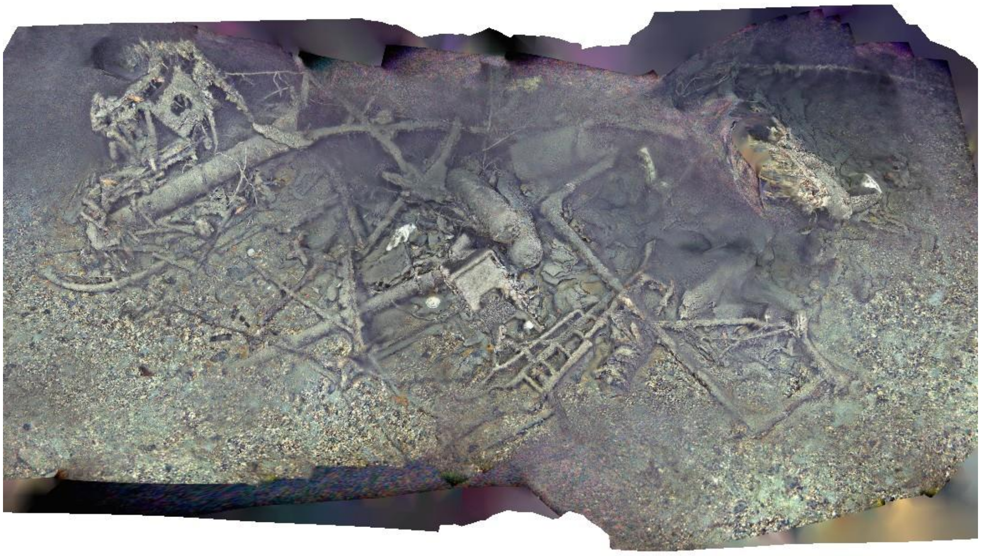
Appendix 1: SSS map with markings

Georeferenced SSS image. Yellow marking is the location of the model appendix 2. The blue marking is the location of the model appendix 3, and red is the location of the model in appendix 4.



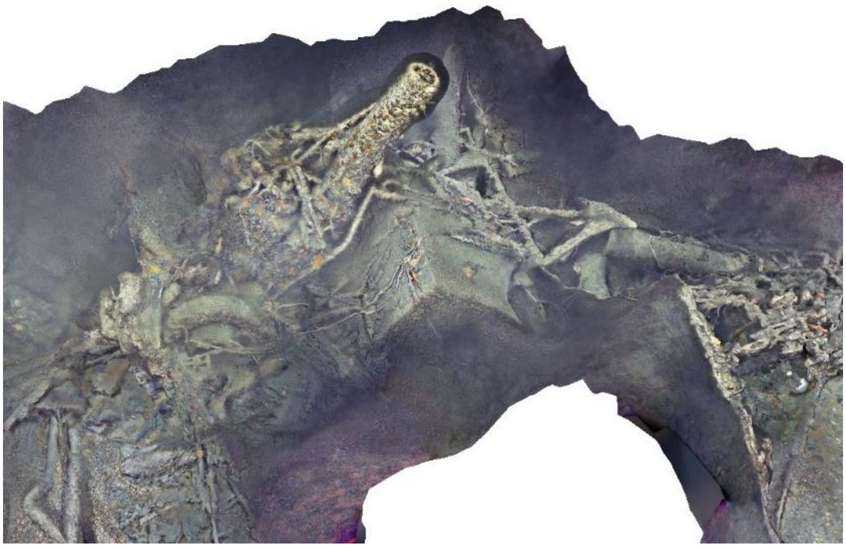
Appendix 2: 3D model from wreck site.

The placement of this model is in the yellow marking in appendix 1. Part of the port side at the stern.



Appendix 3: 3D model from wreck site.

Parts of the engine at the stern of the wreck. Marked by blue marking in appendix 1.

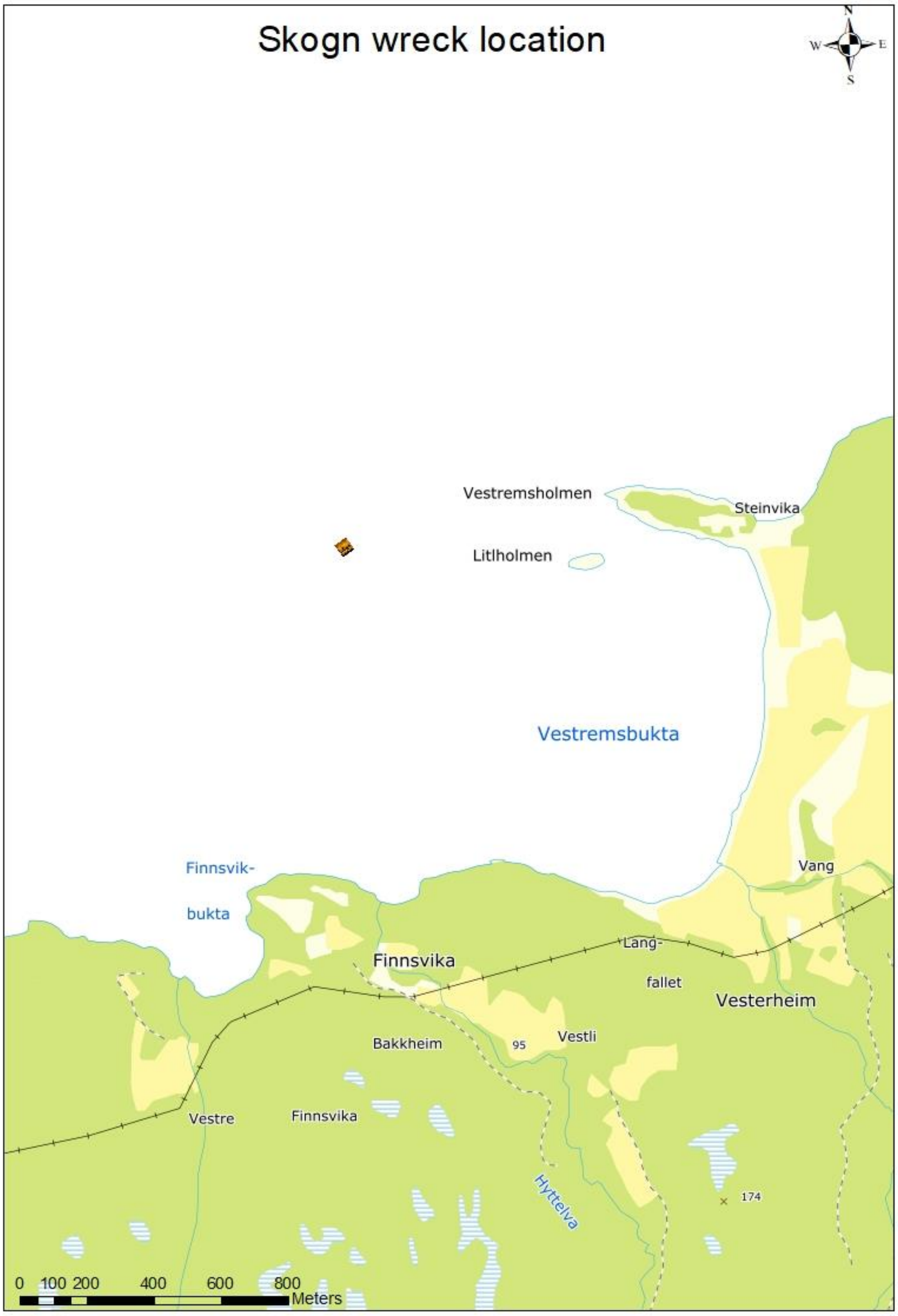


Appendix 4: 3D model from wreck site.

A part of the midship. Location marked with red in appendix 1.

Appendix 5: Location of shipwreck.

Overview map of the location site.



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