This research concerns the digitalisation of archaeology, with a focus on Swedish contract archaeology. The aim is to understand how the archaeological discipline relates to the change that digitalisation brings and human involvement in these processes. The thesis is a study of the digitalisations impact on processes connected to archaeological knowledge production and communication. The work problematises how digital data might be understood within these contexts, but also illustrates where the potential of the digitalisation lies and how archaeology can make use of it. The theoretical approach re-actualises the concept of reflexivity in a digital context, combining it with various communication theories aiming to challenge existing archaeological workflow and connect it more closely to present-day society.

In case studies of Swedish contract archaeology several observations are made where it becomes clear that the digitalisation already shows positive effects at a government level, in organisations and projects within the sector. But there are also issues regarding digital infrastructure, knowledge production, archiving, accessibility and transparency. The biggest challenge is not technical but in attitudes towards digitalisation.

The research concludes that digital communication based on archaeological source material can be something more than mediation of results. With digital interactive storytelling there are ways to create emotional connections with the user, relating to the present and the surrounding society. By interlinking the processes of interpretation and communication an archaeological knowledge production might develop into an archaeological knowledge development.
Archaeological Challenges, Digital Possibilities

Digital Knowledge Development and Communication in Contract Archaeology

Licentiate Thesis
Fredrik Gunnarsson
ARCHAEOLOGICAL CHALLENGES, DIGITAL POSSIBILITIES: DIGITAL KNOWLEDGE DEVELOPMENT AND COMMUNICATION IN CONTRACT ARCHAEOLOGY

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To Ida and Selma

what life is all about
Abstract

This research concerns the digitalisation of archaeology, with a focus on Swedish contract archaeology. The aim is to understand how the archaeological discipline relates to the change that digitalisation brings and human involvement in these processes. The thesis is a study of its impact on processes connected to archaeological knowledge production and communication. The work problematises how digital data might be understood within these contexts but also illustrates where the potential of the digitalisation lies and how archaeology can make use of it. The theoretical approach re-actualises the concept of reflexivity in a digital context, combining it with various communication theories aiming to challenge the archaeological workflow and connect it more closely to present-day society.

The digitalisation of archaeology can be seen across the whole discipline with an emphasis on academia. This digital development has greater opportunities in larger research projects which have sufficient funding than in contract archaeology. In those projects leading the digital development, the reflexive approach has been re-discovered and the digital enabled for new processes of knowledge production to take place.

In case studies of Swedish contract archaeology several observations are made where it becomes clear that the digitalisation already shows positive effects at a government level, in organisations and projects within the sector. But there are also issues regarding digital infrastructure, knowledge production, archiving, accessibility and transparency. The biggest challenge is not technical but in attitudes towards digitalisation.

The research concludes that digital communication based on archaeological source material can be something more than mediation of results. With digital interactive storytelling there are ways to create emotional virtual connections with the user, relating to the present and the surrounding society. By interlinking the processes of interpretation and communication an archaeological knowledge production might become an archaeological knowledge development.
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Introduction

Most archaeologists today have a relationship with the digital whether they like it or not. A vast range of technology has, over the course of archaeology, been introduced into the workflow and archaeologists are used to taking new tools into account while collecting data for the archaeological record. This development has increased its pace over the last decade and a wider use of digital applications in archaeological documentation and communication has emerged and almost made the digital tools mainstream. Different actors in archaeology like universities, museums and contract archaeology companies are all engaged in and responsible for digital data collection, data management (Richards et al. 2013:312; Costopoulos 2016) and dissemination of digital data, in one way or another. Affordable and powerful mobile technology has left its mark in field archaeology and sped up the development of digital workflows within the craft, a development that just keeps on going (Zubrow 2006; Roosevelt et al. 2015:326; Wallrodt 2016:43).

Digitalisation can be seen to have affected the archaeological discipline, and its processes are currently ongoing, which makes it an important field of study. With this research I want to explore the significance of this development and how it leaves its mark. What does digitalisation mean for archaeology? How big is the impact of digital methods used for data recording and dissemination and how do the theories surrounding them affect archaeological knowledge production?

This research further extends to include an analysis of the Swedish case of contract archaeology, putting it in perspective alongside international examples from both contract archaeology and academia. The discussion presented here acknowledges the archaeological challenges connected to digitalisation but also argues for its possibilities in and outside archaeology. How can a digital archaeology be proceeded to enlarge a relevant position for contract archaeology in society by identifying its needs and working towards them in the process of knowledge development? In this thesis I want to contribute to the theoretical discussions connected to these issues by studying the processes of digitalisation. The thesis reflects on the current situation in archaeology, but also suggests future approaches. Researchers have identified that self-awareness and reflection about the underlying processes digitalisation will bring, is what is needed (Huggett 2015:89; Gordon et al. 2016:3). I count myself among those who are a part of what Jeremy Huggett defines as a “third wave” in digital archaeology:
However, a broader perspective of what might constitute a ‘third wave’ within Digital Archaeology is one which seeks to examine the ways in which digital technologies may have changed what we do, how we do it, how we represent what we do, how we communicate what we do, how we understand what we do, and how others understand what we do. (Huggett 2015:88)

This research is valuable because of its aim to put the spotlight on the processes of digitalisation as a phenomenon, which affects, as I see it, the most important contribution of archaeology to society, namely its ability to create new knowledge. The Swedish contract archaeology market is responsible for over 90% of the excavations being conducted, including all new knowledge produced as a result (Börjesson 2017:33f). Much of this information is digital and is, to an increasing extent, being “born” that way. At the time of writing, this vast amount of data is, in most cases, not open for scrutiny until after the cleaned and interpreted data, along with a narrative, is presented in the archaeological report. This can often be a long time after the data was originally recorded (Andersson et al. 2010; Börjesson et al. 2016). The history of not sharing data has a long tradition in archaeology and data hoarding, where archaeological data is kept by archaeologists, is a real problem (Huggett 2015:9). Primary data is mostly kept by the organisation that created it and only a fraction is presented in the publication (Löwenborg 2018:42). This protectionism may be natural in a competitive business but is a big problem when it comes to democratic values, scientific knowledge production and, ultimately, society as a whole, limiting the information’s usefulness in creating new knowledge. We as archaeologists must ask ourselves: for whom are we doing archaeology and why?

**Aims**

With this dissertation I aim to investigate how contract archaeology relates to the change that digitalisation brings. My research focuses on digital developments within archaeology, with the perspective of Swedish contract archaeology. I examine what these developments mean for knowledge production and communication of archaeological source material and how archaeological workflows can be improved further with digital solutions.

It’s my preconception that the quality of archaeological information, or digital data, is always dependant on the situation in which it was collected and interpreted, and by whom. We can’t discuss digital tools and processes involved without discussing archaeology as a whole. Digital archaeology is not in itself a separate entity, or shouldn’t be, from the rest of the discipline. The digitalisation of archaeology can be observed right across the discipline and needs to be perceived that way for the research to be of some value. The main
goal of my research is to understand how digitalisation is affecting archaeology and how the discipline can make use of it to benefit its quest of pursuing good archaeology. I need to study the digital tools through the processes of digital workflows and how people are engaging with them, how the human part of digitalisation affects the outcome. This work is a study of the archaeological discipline and how archaeology is being conducted, and transformed, in the light of digitalisation. In my research, I do not only try to describe the research field and its theoretical approaches, I also try to address, simply the issues of digitalisation with the mindset of a human studying other humans, in relationship to digital processes. I will accomplish this by approaching my research questions from a wide angle, from the three perspectives in the trench, in archaeology and in society.

With this research, I want to create a tool that helps archaeologists to think and act when involved in archaeological digitalisation processes, whether it is at a national level, within an organisation or in the excavation trench. My intention is that this research will contribute to a more reflexive digital contract archaeology where knowledge development and communication is put into focus. I want this to be a useful document when digitalisation, especially within the sector of contract archaeology, is considered or carried out.

**Research Questions**

- How might digital data be understood within the context of knowledge production and communication in archaeology?
- What can be said about digitalisation’s level of impact within archaeology and especially contract archaeology and how can it be further problematised when it comes to knowledge production and communication?
- Where lies the potential of digital communication and how can archaeology make use of it?

**Research Scope**

This work aims to describe the digitalisation of archaeology on a theoretical level, with discussion on different scales. Studies are made on an international scale and data collection through literature studies has been made with a Western and Northern European perspective, also including examples from the USA. Furthermore, the perspective is narrowed down to Swedish archaeology with examples presented both from academia and contract archaeology. Data collection through interviews has been focused on a number of people in Sweden within different parts of the contract archaeology sector. The work is further centred on the study of practices of digital documentation, interpretation and communication with a focus on the humans involved in the processes of
digitalisation in relation to the digital. The research does not include studies of social media and how they are perceived in an archaeological context.

This Licentiate thesis focuses on setting the groundwork in understanding the digitalisation of archaeology. In the doctoral thesis this will be taken further with more elaborated analyses.

**Methods**

To work with the research questions stated above and to get a good overview of the digitalisation of archaeology, I need to study different parts of the archaeological discipline including both academia and contract archaeology. Research contributions concerning digital archaeology within the context of contract archaeology are too narrow and wouldn’t on their own make a good basis for my analysis. The same can be said for the Swedish context and by extending my research to include international projects and literature, I manage to expand my research process, helping me to understand how I can approach the case of Swedish contract archaeology. To accomplish a data collection related to different parts of the archaeological world, I use a mixed method approach including literature studies and online surveys, qualitative and quantitative data collection (interviews, questionnaires) and applied research.

**Literature Studies and Online Surveys**

Addressing the first two research questions problematising how digital data can be understood in relation to archaeological knowledge production and communication and to observe the level of impact digitalisation has on archaeology, I have conducted literature studies in combination with online surveys.

I’ve looked at experiences from archaeological projects engaged with digitisation of archaeological workflows and their reflections regarding how it has affected the doing of archaeology within their specific context. Most of these projects have been carried out as research projects with sufficient funding and continuity, but there are also examples from the sector of contract archaeology. Published works on the subject and the literature studies of them, formed an important part of the foundation on which I can build when approaching the other research questions. In addition to the literature I have also conducted online surveys and looked at resources such as project websites, web applications and published databases. The results from digitalisation work within archaeology like published datasets or interfaces for communication often end up on the Internet which makes it an important field of study and therefore deserves attention. Here, these observations are part of the general discussion of the processes beneath their surface of interfaces.
Qualitative and Quantitative Data Collection

To study how digitalisation of contract archaeology is perceived by the sector and to further trace its impact within the sector (see ‘Digitalisation of Contract Archaeology’), I need to investigate how digital knowledge production and communication of archaeological results is perceived on different levels. In addition to literature studies, I conducted several interviews with various actors in the Swedish sector of contract archaeology. In the thesis they are presented as research source material along with others and the interviews have mostly been carried out at a governmental level where the important work of the Swedish National Heritage Board (NHB) has been conducted as regards the digitalisation of contract archaeology. Representatives from the NHB’s DAP programme (Digital Archaeological Process) and Digisam (Secretariat for National Coordination of Digitisation, Digital Preservation and Digital Access to Cultural Heritage) have been interviewed with the aim of grasping this development in archaeology and cultural heritage from their different perspectives. I’ve also conducted interviews on organisation, project and individual levels, to evaluate previous digitalisation projects and ongoing ones.

Interviews

The interviews have been conducted with a qualitative approach where the interviewer’s standpoint is made clear to the interviewed individual. These interviews have been carried out with the emic perspective where the objective is to learn as much as possible about an experience directly from the interviewed. The researcher and the participant construct data together in that exchange and in that sense, it does not have to be objective data that is collected. The interviews were semi-structured, with the aim of not steering the conversation too much while at the same time retrieving wanted information. This approach is most commonly used in later stages of interviewing but suits this research right from the start since much of the context has already been acquired beforehand (Olson 2016). The interviews have been recorded in Swedish and research notes later written and translated into English. Referenced in the text is my version of what’s been said during the interview but the interviewed has read the text before the publication of this thesis and has given his/her approval to use the content (Appendix 1). The individuals have been selected because of their relation to digitalisation in Swedish contract archaeology. The aim has been to find people in different positions at different levels, such as government, organisation, project and individual, to get a diverse view on how digitalisation is perceived by Swedish contract archaeology.

Questionnaire

Within the framework of this thesis and the chapter ‘Case study: Sandby borg’, a project investigating the use of virtual reality (VR) in creating a virtual emotional connection, was conducted. The questionnaire worked as a tool for
evaluation for the applied research approach presented below. To evaluate the user experience and to investigate if an emotional connection with the archaeological source material and the story created from it, could be made. A user questionnaire was created to gather information and collect data regarding the user, the technical equipment and the emotional impact (Gunnarsson et al. 2018:49). Evaluation of this kind is viewed as being crucial for my research to address the research question regarding the potential of digital communication and how archaeology might make use of it (see ‘Research Questions’).

Applied Research
The perspectives from previous research in digital archaeology and interviewed people from different parts of contract archaeology present invaluable information for this research analysis of the digitalisation. Even so, the data collected from these sources is still a representation of thinking made by others. I need to try theories in practice, adding another perspective to the mixed method approach, to reach a deeper understanding of the processes involved when engaged in digitalisation work. Therefore, the element of applied research is put at the centre of the methodological approach within this thesis. The archaeological research project of Sandby borg (L27) has worked as an arena where new digital ideas have been implemented, tested and evaluated in a context of interdisciplinary collaborations (see ‘Sandby borg – a Case Study of the Digital and Virtual’). These digital prototypes and products relate to the research question aiming to explore how archaeological knowledge production can interlink with digital communication and what the possible consequences of doing so, might be. To further problematise the impact of digitalisation on archaeological knowledge production and digital data’s significance for interpretation a theoretical discussion should be raised in relation to “[...]an intense experimentation phase.” (Dell’Unto 2018:66). Within the context of contract archaeology, allocation in the budget for such items as methodological development and experimentation are rarely seen. Experimentation through applied research in this research is therefore conducted within the Sandby borg research project, with the long-term aim to implement successful methods or products, in the sector of contract archaeology.

Terminology
The following definitions clarify how the terminology is used in this thesis.

Contract Archaeology
The Swedish term ‘uppdragsarkeologi’ describes the competitive sector where archaeological actors such as museums, private companies and institutes compete for the same jobs based on the “polluter pays” principle. Other terms describing market-dependent archaeology such as rescue archaeology,
commercial archaeology, preventive archaeology or development-led archaeology (Demoule 2012), are not used in this thesis even if they describe similar market-based archaeology. In this work the English term contract archaeology is chosen to describe archaeology businesses dependent on contracts that are in competition with other companies or organisations. The term is also included in the name of the graduate school GRASCA (Graduate School of Contract Archaeology), of which this work is part.

Digitisation vs. Digitalisation
This research finds it important to make a distinction between the terms digitisation and digitalisation. The words can easily be confused, especially for Swedish speaking readers that are used to using the term digitalisation (‘digitalisering’) in both cases.

Digitisation can simply be described as when analogue information is transformed into a digital form. It could also be a representation of a physical item, let’s say a 3D reconstruction of an artefact. The goal with digitising is for example to automate workflows, or to make source material like archives available in digital form. Data can also be born digital, not digitised, which digital humanities often calls “Natively digital data objects” (Lupton 2015:44; Brennen & Kreis 2016).

Digitalisation is a term corresponding more to what this research is exploring. Digitalisation is referring to the processes when using the digitised data. It’s the adoption of the digital within an organisation, industry or nation. In this case it’s all the above gathered under the discipline of archaeology. The aim of the digitalisation can, for example, be to increase revenue, improve workflows, replace systems or transform business. Digitalisation can be described as the changes in processes and business models happening through digitisation and more. In cultural studies or the humanities, the concept can be more problematised and processes involve, for example, human social life through digital communication (Lupton 2015; Brennen & Kreis 2016).
A Theoretical Approach to Digital Archaeology

In this chapter I suggest that digital tools, when put in the hands of archaeologists, are more than just tools. Within the theoretical framework presented below I examine which type of archaeology can be conducted with the help of the digital and investigate how it might change the archaeologist’s interpretation process, which is fundamental for knowledge production and the communication of it. I argue that digitalisation of archaeology is not about its tools and methods per se, it’s about the non-digital, the humans, and what they do with them. It’s about what these humans’ (or archaeologists’) agenda is when creating digital data, how that affects the interpretation of archaeological source material and how they use digital tools to communicate their vision of the past to the public. I argue that in the creation of, for example, a 3D model there is always a subjective process at play, the model being a result of the human input (Perry 2015:203), even though the advanced algorithms involved might suggest otherwise. Jeremy Huggett brings this reasoning further and calls the digital tools archaeologists use “cognitive artefacts” that, despite their technical complexity, work “[...] on our behalf to explore, reveal, capture, and characterise archaeological objects.” An external device (or method) is considered cognitive because it is an extension of the human intention (Huggett 2017:2f).

I will use the famous excavation site of Çatalhöyük as a foundation for building the theoretical framework of this thesis, by studying the project’s relation to digitalisation processes. Çatalhöyük is a 9,000-year-old site in today’s Turkey. It experienced its first major excavations in the early 1960s by James Mellaart. In 1993 the excavations were reopened and have been supervised by Ian Hodder for the past 25 years (Hodder 2003; Berggren et al. 2015; Taylor et al. 2018). I will begin this chapter by considering the theoretical approach of reflexivity and continue to discuss how it has worked in practice at Çatalhöyük and discuss its possibilities for future work. This theoretical approach is then used as the basis for perceiving the digitalisation of archaeology in relation to my research questions (see ‘Research Questions’). Throughout this thesis I want to deepen the theoretical discussion by exploring the approaches highlighted in this chapter and investigate how they can be used in ongoing work with digitalisation in archaeology. As part of the concluding chapters at the end of this thesis, I suggest an approach of how to engage with digital knowledge production and communication within archaeology (see ‘Digital Communication’ & ‘Alive’).
Reflexivity

Reflexivity can mean various things for different scholars but is mostly referred to within the discipline of sociology (Lynch 2000). I will here describe the theories concerning reflexivity that are useful for this research, to expand the understanding of the concept of digital archaeology. Reflexivity is not acknowledged as its own social theory, but merely an approach which highlights and critiques the surrounding context of knowledge creation, in this case digital data. The reflexive approach is though strongly connected to theoretical ideas deriving from post-processual archaeology and hermeneutics (Taylor et al. 2018). I found the approach useful within my research to illuminate different issues in creation and dissemination of digital data.

Anthony Giddens suggests that we live in a world changing more rapidly than ever, where trust and risk are factors humans always consider in their cultural reality. The “information age” has given us more “social reflexivity” than ever before, we must always reflect upon where we are and what we do. In ancient times this relationship was different, and one could rely more on religion and traditions to guide one’s life (Giddens 2006). At this stage it must be added that many people all over the world, archaeologists as well, still rely heavily upon religion and tradition to guide their life, even though one may be brought up in a secular society where other rules may apply. Giddens goes on to describe reflexivity’s importance for a positive knowledge production process to take place. There are different tools one might apply to increase chances of success. The researcher needs to constantly be reflexive about what is going on in the process, and think before he/she acts, to reflect on how his/her interpretation will be seen in the data, because all data is a construction made by a person (Giddens 1986, 1991; Bourdieu 1992). To have this mentality present when introducing new workflows, like a digital one, has been proven to be very useful in achieving a good result (Berggren et al. 2015). One can ask: what is my role in the whole and how do I affect the knowledge production taking place? This can then be applied to archaeological fieldwork.

Reflexivity is closely connected to the dialectical process that might take place between different agents, here dialogue and discussion is a natural part of the knowledge production process. Though it can let anyone in, the process needs its experts, they are the ones that drive the development forward and can give the process meaning (Giddens 1991:137ff). In Pierre Bourdieu’s sociological world, a dialectical process is described as the individual’s capability to manage her/his surroundings by being aware of their culture and how they express it, habitus. It is through human actions that habitus is created, constantly changing. This dialectical process does not choose between objective or subjective, instead it acknowledges the value of both through internalisation of the external and vice versa. They are dependent on each other to drive the dialectical process forward. He says that structures can be objective while the
human processes will still be subjective (Bourdieu & Passeron 1977). In the quest for knowledge development, the dialectical process becomes a centerpiece. Instead of choosing one specific method for research, the dialectics allow you to explore different possibilities and to discover other worlds outside one’s own in dialogue with others. Knowledge seeking therefore becomes a question of transparency and commitment to other agents, openness is a prerequisite necessary for the process to take place. In this setting, the relationship between subject and object becomes less relevant than the process of how interpretation is produced via interaction.

*The more you expose yourself, the greater are your chances of benefiting from the discussion and the more constructive and good-willed, I am sure, the criticisms and advice you will receive. The most efficient way of wiping out errors, as well as the terrors that are oftentimes at their root, is to be able to laugh about them together, which, as you will soon discover, will happen quite often...* (Bourdieu 1992:219)

**Hermeneutic Reflexivity**

Hermeneutics suggests that there are several ways to understand the world around us or a social event. Hermeneutics can explain the processes of creation, resolving and recreation of knowledge (Heidegger 1927; Palmer 1969; Gadamer 1972; Ricoeur 1990). Interpretation and understanding are constantly linked together, and humans always have preconceptions and their own versions of what truth consists of. One could argue that meaning, truth and belief can’t exist without the others (Davidson 2001:156). People can never take the position of being outside themselves and objective in a process of knowledge production, instead they are always a part of it, the process depends upon them taking it forward. One can argue that humans are slaves to their subjective minds, but that subjectivity is also dynamic and can change so new horizons might be discovered. Humans are part of history itself and cannot be freed from that stage (Heidegger 1927). Truth becomes relative and what Gianni Vattimo calls a “*rhetoric solution*” where truth is the product of an interpretation process (Vattimo 2012:50).

Within a reflexive approach there is often a view that there is a recursive movement in the creation of knowledge. This means that for every piece of knowledge created, feedback is received in a loop and new knowledge might be developed with the aid of this new information. The loop movement can occur in several ways: between the creator and his/her self-reflection, in a dialectic dialogue with other scholars or even with anyone else, who cares to answer. In this way knowledge can always be tested, be open for scrutiny and lead to new insights in the research discourse. What reflexivity will give or not give to the
process is depending on the agents involved and what they do. Such a recursive movement in knowledge production is closely interlinked with the hermeneutic theories, and the ideas of reflexivity can easily be combined with the ideas of the hermeneutic spiral. The combination can help in trying to understand the role of the different agents (in this case archaeologists) and digital technology’s role in the process of knowledge production. This so-called hermeneutic reflexivity is used to understand and describe the processes involved in interpretation, understanding and knowledge production (Lynch 2000; Taylor et al. 2018).

The Hermeneutic Spiral

The hermeneutic spiral was, when first introduced as a concept, depicted as a circle describing the reader’s interaction with texts. The concept expressed that there is a constant movement between reading and contextual understanding of the writer and the reader’s role in the understanding of a text. In social humanities, the hermeneutic circle has been used to understand interpretation processes in general (Lynch 2000), highlighting the process of knowledge production and the constant exchange between the parts and the whole (Palmer 1969; Radnitzky 1970).

Assisting in the analysis of knowledge production and communication in archaeology I prefer to picture the recursive movement of information exchange and knowledge creation in an upward (or downward) turning spiral instead (Hodder 1999, fig. 1). For every new insight, a new turn can be made upwards in the spiral, a spiral that is possibly never ending. It’s not necessarily so that the process of knowledge production is a positive one where the insights are productive. Poor information flows, a non-transparent process and poor interpretations can produce a non-productive course of events where a negative circle/spiral, “circulus vitiosus” is generated without producing any new knowledge of use (Radnitzky 1970; Gadamer 1972). A negative spiral can start turning if the inputs for knowledge production, like digital data, are inadequate. Then there’s a risk that the level of knowledge declines instead of increases. The spiral is helpful in visualising the processes involved in digital data creation, how data are used by agents and for what reason, which also gives guidance in how to work with it moving onwards.
Gary Lock suggests that the use of computers adds another layer to the reflexive process and that they are an important part of knowledge production in relation to the hermeneutic spiral and the process of interpretation. The process of asking questions of data and getting answers is dependent on the interpreter’s preconceptions has its own relationship to the human when the information is digital. During interpretation, some data will be disregarded by the human. The hermeneutic spiral becomes a communication channel between human and computer. Whatever knowledge that comes out from this process is “[...] open for constant re-evaluation, hence the never closing hermeneutic spiral.” (Lock 2003:7f). If such a relationship can be established between the archaeologist or other agents and digital data, the chance might increase for data to be re-used and its life prolonged.
Reflexive Archaeology in Practice at Çatalhöyük

I will now investigate how the reflexive approach can be carried out in practice in archaeology by studying the case of Çatalhöyük. What can be learned from a project that has been using reflexive methods and evaluating them for over 25 years? What might be said about digital data production and communication in that regard and can those results give guidance moving forward?

The reflexive approach implemented in the daily work at the excavation site of Çatalhöyük derives from the theoretical framework of post-processual archaeology, as developed by the manager of the project, Ian Hodder (Hodder 1982, 1986; Taylor et al. 2018). Hodder acknowledges a different focus of reflexivity within the discipline of archaeology compared to when used in its original setting in sociology. He states:

In archaeology there is less emphasis on autobiography, dialogue, self-positioning, and writing, although these are all relevant to archaeology and have been pursued. In archaeology the emphasis is more on finding ways in which the collection of material data can be opened up to interpretation as it happens (breaking down the distinctions between discovery and interpretation, and between description and interpretation), allowing a greater diversity of perspectives or ‘positions’ in the interpretive and analytical process, and allowing extra layers of documentation so that others can re-evaluate conclusions that have been made. (Hodder 2003:65f)

When it comes to the application of reflexive methods in field archaeology, Hodder recognises two main focuses: the importance of identifying the different stakeholders and their role in a project and for the archaeologist to work with the “[…] self-critical awareness of one’s archaeological truth claims as historical and contingent.” (Hodder 2003:56). The reflexive approach suggests that the interpretation process during field archaeology is dynamic and that new knowledge can always be produced with discussion between agents and the implementation of new methodologies in the trench. In Çatalhöyük, much of the excavation workflow has been standardised and linked to the single context method, still with an understanding that data produced reflects individual archaeologists’ personal and professional backgrounds. Hodder expected the reflexive methodology, with an ongoing collaborative process between researchers and their perception of the site, would create a better understanding of the archaeological remains and come closer to comprehending their complexity (Farid 2015:63; Taylor et al. 2018).

In order to implement the reflexive workflow, the research project came up with a 12-point plan during the 1990s (that has developed over the years) with
different methods for making the excavation process more reflexive. In the beginning the digital was not in focus (Hodder 1997), but over time it “[…] has become clear that many of the original aims can be enhanced by use of the new generations of computer-assisted technologies for visualisation, recording and planning.” (Berggren et al. 2015:434). On this list of 12 components, one can find various approaches like: on-site interaction, an intra-site database, diary entries, daily sketches, videos, and virtual reality. The project further aims for an open approach with for example a web-based database which is accessible online and open for scrutiny by others (L1), but also methods for communication with the public via media of different kinds (Hodder 2000; 2005; Berggren et al. 2015:435ff; Taylor et al. 2018). The 3D documentation has become central in achieving the possibility of recreating the excavation process virtually. One good example of how the project managed to do this is when the human remains team found it difficult to figure out the stratigraphy between different layers of burials stacked together. With 3D models generated from the field documentation georeferenced into the intra-site GIS, the team could recreate the sequences and make sense of it after excavation had been done (Berggren et al. 2015; Dell’Unto 2016; Taylor et al. 2018).

**Multivocality**

As a part of Hodder’s reflexive approach at Çatalhöyük, comes the idea of multivocality. One can understand it as a defined dialectical process where there is a clear idea of who the stakeholders are and what their contribution might be to the archaeological process of knowledge production. Stakeholders can be an array of different specialists contributing to the analysis of the archaeological source material collected in the field. If many different specialists work closely together at the trowel’s edge, the chance of new insights increases. Hodder took this a step further and wondered “[…] to what extent can non-specialists be involved?” (Hodder 2003:59). He meant that there are more stakeholders than just the archaeological community involved in the archaeological process and that it is the duty of archaeologists to invite them into the research agenda and get them to participate in shaping what an archaeological site can be. In Çatalhöyük, the public, tourism industries, and policy makers were all invited to share a common platform throughout the archaeological process. Hodder understood that inviting other people than archaeologists into the archaeological process meant that the archaeologists now needed to be more aware that archaeological interpretations are strongly coloured by the different individual backgrounds. With this in mind he set up an international team with people from many different backgrounds to reach a diversity and broaden the discussion (Farid 2015:59ff). This seems to be one of the project’s biggest challenges, introducing multivocality in the workflow. Even though there might be strength in having many voices engaged in discussion, it is a challenge to get everyone to speak the same language.
Digital Reflexivity

Over the last couple of years, the reflexive approach has contributed to the development of new digital tools and the excavation teams in Çatalhöyük have been using an effective digital workflow where 3D models from photogrammetry are combined with geographical data and so-called legacy data (older material, like journals, that have been digitised) in a GIS, directly in the field with tablet computers. The aim of the digital approach is to make the archaeological process virtually reversible (Hodder 2000, 2005; Forte 2014; Berggren et al. 2015; Taylor et al. 2018). While applying a digital workflow, focus has been put on making it function with the reflexive methodology and to improve it, with three goals in mind:

Ensuring no data would be lost in the transition from paper to digital records; Creating a workflow with a manageable learning curve that could be utilised by team members with diverse technological backgrounds; Ensuring an increased overall efficiency when compared with traditional paper drawings. (Berggren et al. 2015:442)

All data produced by different teams and methods has been linked together in a relational database which was made available for all on site (Farid 2015:74), later published online, also freely accessible for anyone outside the project. This intra-site database and how it can be used on site with mobile technology, is central in understanding how digital reflexivity has been achieved in the Çatalhöyük research project.

When it comes to the approach of digital reflexivity, other projects have been inspired and a new wave of digital reflexivists has emerged as well, with new critical views on the digitalisation of archaeology. One of the strongest trends of recent years might be the calls for a “slow archaeology” (Caraher 2016) or a “slow data” approach (Kansa 2016:466). Slow archaeology is a criticism of the focus on efficiency and speed that a digitised workflow might bring. Acquisition of 3D data through photogrammetry might be cost effective and the result a rewarding one, but there is need for understanding of the processes of that model being produced, the critics argue (Huggett 2017). The photos are taken by a human with a certain camera and the software generating the 3D model from these photos has a default value for the algorithm that needs to be understood. If these underlying processes are not understood and part of the reflexive thinking, there might be a belief that these 3D models are something objective in nature, when they are not. By using the adjective slow, the advocates want archaeologists to take a step back and look at their own role in producing this data and engage with the archaeological source material to a greater extent. What they suggest is no different than the reflexive approach, which I can
understand, but merely a re-boost of the concept in a modern context. “Slow archaeology” is a comment against the positivistic methodological approach of solely measuring and weighing the past where the contextual archaeology on the other hand is putting data in relation to other data collected from objects, trench or the landscape to be analysed (Caraher 2016).

The Gabii project defines a reflective design process affiliated with the theoretical framework of reflexivity together with the notions of slow archaeology. Their first-person 3D solution has been developed with these concepts in mind. Rachel Opitz and Tyler Johnson state:

\[\textit{Both emphasize a multi-vocal, fluid approach to meaning-making, as well as a recursive relationship between producers and users of knowledge and interfaces. While reflexive archaeology begins the interpretive process “at the trowel’s edge,” it also involves a closer integration of interpretation with data, and the critical awareness supported by reflective design can be helpful for achieving this. (Opitz & Johnson 2015:278)}\]

The reflexive approach is also acknowledged by the creators and users of the digital system ‘The Archaeological Recording Kit’ (ARK, see ‘Digital Workflows’). Andrew Dufton describes that:

\[\textit{Those of us who work with data often bear the brunt of criticism from post processual archaeologists. We have a tendency to work in a way that ‘scientificises’ and formalises what is essentially interpreted data. Especially in the field of site recording systems, our tendency is towards abstraction and removal of the voice of the excavator. (Dufton 2016:380)}\]

Dufton continues, stating that ARK aims to change that relationship between the interpretation process and data, if that criticism was ever true. With the reflexive method, he states, archaeologists can work against those positivistic traps that might cloud the interpretation process from being constructive and contextual. Dufton shows that ARK fosters multivocality by offering the possibility of adding different interpretations regarding the same data in the recording process. This can, says Dufton: “[…] empower the reader to become the interpreter and to contribute to the project.”. By ARK being web based it also enables for a larger reflexive approach when users of the system can engage in each other’s datasets almost in real time. Dufton says that the possibility for different interpretations to be recorded in the same data makes it possible to present multiple narratives from the archaeological source material, when documenting it (Dufton 2016:380). The digital workflow of ‘IDA- Instant field Documentation system and Availability’ (see ‘Digital Workflows’), has a similar
system as ARK, where data can be shared instantly between archaeologists but also with anyone else via web interfaces in real time. The IDA system is also mobile during digital field recording, dissemination and when viewed by a public audience, giving the discussion regarding digital reflexivity another dimension.

The one digital tool described to have had the biggest impact on the archaeological work at the Çatalhöyük site, is the PC tablet, a powerful mobile device that can be brought down into the trench for documentation, analyses and sharing. In other digital workflows like IDA or ARK the mobile solution might be a regular tablet or mobile phone instead. The project means that the PC tablet has transformed the analogue reflexive methods such as ‘the daily sketch’ or ‘the diary’, into being a part of the digital tool kit instead. The sketching was first done on printed photos but has since shifted to digital photos with sketches and comments added directly on to the picture. The information is then added into the intra-site database and becomes a resource in combination with other data, like digitised legacy data, contributing to the reflexive process. The PC tablet and the intra-site database enable a wide array of digital information to be shared throughout the project. When the tablet was introduced into the field the archaeologists soon realised they had access to many different types of data which made them see the potential of the tool and how it could be a reflexive one. PC tablets gave the opportunity to work with the digital data directly in the trench, boosting the interpretation process. In the use of a digital mobile documentation system, barriers between different datasets, and teams, were removed and now everyone with access to the recording system could make more elaborate analyses and interpretations of the archaeological remains. Editing information could be made directly and not separate from the daily work in the trench. This called for better research decisions and interpretations to be made and created a more transparent and democratic knowledge development, serving both the reflexivity but also the quality of digital data entries being made. The advanced software used in the PC tablet also created a challenge for the project. Not everyone had knowledge of how to use the programs and needed to learn. Even though courses were held, and efforts made to encourage everyone to participate in digital data recording, it remained a problem (Berggren et al. 2015; Farid 2015; Taylor et al. 2018).

The example presented above shows that a digital reflexivity is possible, the digital input might even enhance the tools of reflexivity and make them work better. The digital makes human collaboration and wider interpretations easier to accomplish. The view in the Çatalhöyük project changed from the perspective that digital tools would get in the way of a post-processual reflexive approach and instead the project acknowledges their importance. This has been possible because the digital workflow has been developed in response to the need of the excavation and not the other way around. The ARK system promotes the same
benefits of an approach focusing on the reflexive methods, for achieving a fruitful knowledge production (Dufton 2016).

**Knowledge Production and Communication**

The reflexive approach challenges the assumption that the archaeological research concerning the knowledge production process must be linear. The arguments expressed by e.g. Hodder, suggest that there’s always an “[...] interaction between data and theory; the relationship between these stages and aspects of an archaeological project is multi-directional and dynamic.” (Farid 2015:63f). This dynamic process is not the result of separate stages of archaeology where objective data collection is carried out in the trench during excavation. It acknowledges that the archaeologist is always interpreting and that this dynamic process is also essential for how the excavation process is carried out, affecting the outcome of which kind of data is produced. In the world of reflexivity, the archaeologist also has the agents of multivocality to consider and what kind of information they bring might also affect the knowledge process. So, one aim of a reflexive approach is to enable the archaeologists, as they dig, to have as much information as possible, so they can make a good judgement about what it is they are digging. From this viewpoint, digging is not just a technique; it is a highly skilled and difficult balancing act combining many different types of information (Hodder 2003).

The participants of the research project at Çatalhöyük are convinced that the development of digital methods interlinked with the reflexive approach has given them new, valuable insights and a knowledge creation on a deeper level, together with a holistic understanding of the parts being important for the whole, and that they are always attached to each other. The possibility to contextualise so much data on the tablets has:

 [...] inevitably had an impact upon the way in which we understand and interpret the site, even as we excavate, and this ultimately is a boon to a truly reflexive approach. It enables the excavator to make and simultaneously document well-informed interpretations, normally done during post-excavation, whilst in the field. (Taylor et al. 2018)

The reflexive approach is a good example of how the process of working in a digital workflow might change how archaeologists think while recording the archaeological remains in the trench during an excavation. With mobile documentation systems and the 3D visuals there can be an ongoing discussion connected to the instant information flow, the reflexive approach further on challenges the field archaeologist to think more intensively about what is happening and tie insights together with the greater context of the site. An important notion is that it’s not the digital tools that decide the way of approach
in the above-presented cases, they are merely the methods to help implement the theory of how field archaeology could be conducted to improve the archaeological interpretation work. The digital assets are a necessity to achieve the goals of the project and not the other way around.

Reflexivity, and all its different applications is there to make knowledge production more valuable, to extract the important stuff from the archaeological source material. But how does it ultimately become knowledge and who is the receiver? What stories do archaeologists want to tell and why? This work analyses the importance of communication in the creation of new knowledge on different levels. As shown in this chapter this can be true for internal self-reflection, in dialogue with other archaeologists and specialists with other expertise or in communication with different stakeholders outside archaeology.

Archaeologists must also think more closely about the receivers of stories based on archaeological source material and how they can create communication channels, like digital ones, so that a connection is made. Later, I will also make the argument that it’s just as important to communicate outside the project, not only to share results but also to gain new perspectives and inputs that have the potential to improve knowledge production as well (see ‘Digital Communication’). Advocates of reflexivity understand that the narratives archaeologists create by digging in the past all depend on who is telling them and what they want to convey. If more voices are added to the creation of a story, it might become more diverse and complex, not just the reflection of a single mind. The argument that archaeological knowledge production is dynamic will be further developed later in this thesis where it also extends to the statement that communication is not only a part of the process but a necessity for success. Communication is not only there to make better archaeology but also to make a better society.
The title of Andre Costopoulos’s article in the publication ‘Frontiers in Digital Humanities’ states that “Digital Archaeology Is here (and Has Been for a While)”. There is certainly nothing new in archaeology embracing technology. In fact, it’s been going on since the dawn of the discipline itself (Costopoulos 2016:1f). What’s new is the increased speed with which the digitalisation of archaeology has been developing over recent years. In several aspects, digital archaeology has gone from being a specialisation in the discipline to become more mainstream and part of most archaeologists’ daily work, to some extent. In the introduction of this thesis I refer to Costopoulos’s words that he wants to “[...] stop talking about digital archaeology” and “[...] continue doing archaeology digitally” (Costopoulos 2016:1f). What he wishes for can be described as a contemporary transformation of archaeology’s relation with the digital. In this chapter, I will look back on the digitalisation of archaeology to create a context in this thesis for further explorations in the subject and to create an understanding of what Costopoulos means.

This chapter illustrates what digitalisation, historically, has meant for archaeology, and for the different directions the discipline has taken because of it. The chapter relates to the research question of this thesis concerning what can be said about the level of impact of digitalisation in archaeology and how it can be related to knowledge production and communication (see ‘Research Questions’). In the second part of the chapter I present contemporary examples of projects engaged in the development of digital workflows. What unites them is that they have created these digital solutions with a theoretical mindset. To see what these projects have further accomplished adds to the greater discussion of digital knowledge production in this thesis. Jeremy Huggett states that: “One of the key transformations in archaeological studies in the past thirty years is the shift from analogue to digital.” (Huggett 2017). But maybe the most important transformation is not the digital, but the archaeologists’ perception of and attitude towards this transformation.

Calculated Truths 1930–1970s

Archaeologists have been using computing technologies since the 1930s and originally, these not-so-advanced computers could merely provide descriptive data, like statistics, for the user. There were machines that could sort, count or tabulate. Information was put in to them with so-called punch cards and calculations were performed which resulted in figures and tables being produced from them. These more quantitative approaches continued to be of
importance throughout the following decades, becoming increasingly elaborated over time (Zubrow 2006:14; Costopoulos 2016:2).

Some researchers suggest that the decade truly marking the beginning of a computational archaeology, is much later than these earliest machines in the 1930s. It’s not until the 1950s one can begin speaking about computers and the archaeologists’ use of them (Zubrow 2006:13; Djindjian 2015:1; Moscati 2015:10). During the 1950s several important events took place, such as conferences acknowledging the existence of quantitative archaeology, the publication of the first algorithm of seriation, and of the first statistical method for typometry. Furthermore, the first application for data retrieval was constructed and the CADA (Centre d’Analyse Documentaire en Archéologie) laboratory created the nine descriptive codes, marking the beginning of data banks in archaeology (Djindjian 2015:1).

Moving on to the 1960s the next important step was taken; quantitative statistical analysis could now be combined with geospatial data in a geographic information system (GIS) for the first time. Processualism meant that the quantitative analysis made archaeological remains measurable and in doing so also contributed to the important steps towards becoming a more empirically based and scientific discipline. The machines could create “objective” data that had been weighed and measured, figuratively speaking (Binford & Binford 1968; Lock 2003:9; Zubrow 2006:13ff; Wallrodt 2016:38f).

Figure 2. Lock’s description of the development of archaeological computing from the 1960s up to the 1990s. Figure showing the relationships between technology and theory (Lock 2003:8).
Although quantitative analyses of large data sets were now possible, the main use of computers during the 1960s and 70s was still focused on calculation of statistics from collected data (Huggett 2015:88). In the 1970s the first GIS software was developed and commercialised by the American software company Esri and its founder Jack Dangermond. During this period, GIS software thrived in archaeological research and flourished in the 1980s and early 1990s (Orengo 2015:64). Another event of note for computing archaeology in the 1970s was the first conference on ‘Computer Applications and Quantitative Methods in Archaeology’ (CAA) held in Birmingham in 1973 (Djindjian 2015; L2), and still running.

**Digital Archaeology 1980–1990s**

In the 1980s, the theoretical trend within archaeology was undergoing a paradigm shift and the post-processual school of thought emerged and grew stronger. Here, the individual was put at the centre of attention and the focus was upon the subjective instead of the objective, a focus shift that to a high degree affected the digital development (Zubrow 2006:14f). Another trend at the end of the 1980s was that publications went from using the term “archaeological computing” to the wider term “digital archaeology”. The digitalisation of archaeology now entered a more experimental realm and digital tools and concepts such as AI, advanced GIS, visualisation, agent-based modelling (ABM) and web-based technologies, were becoming a reality (Zubrow 2006:14; Huggett 2015:88). Many of these concepts still being important in present discourse. Another trend that is certainly active in today’s digital archaeology is virtual reconstructions of archaeological remains.

Moving into the 1990s, the trend of creating virtual spaces became increasingly common (Reilly 1990), one of the first being the reconstruction of the Roman baths near Caerleon, in the UK (Reilly 1992: Pujol-Tost 2017:3). These early projects set the groundwork for contemporary archaeologists to widely use these virtual techniques, such as 3D acquisition and reconstructions, today. Costopoulos states that virtual reconstructions since then have “[…] made it possible for anyone with modest computer equipment and an Internet connection to be in an imagined past, to manipulate it, and to help create it.” (Costopoulos 2016:2).

GIS became mainstream in archaeology in the 1990s, which was followed by a critical approach using GIS software. This new critical GIS was acknowledged in the mid-1990s and highlighted questions of e.g. hierarchy and criticised GIS as being undemocratic, among other things (Pickles 1995). After this rethinking of what GIS could bring to the table, new questions kept on coming. Theoretical standpoints were applied before the usage of the technology and issues regarding e.g. feminism and indigenous groups, were discussed with the aid of quantitative analysis made with GIS (Shurman 2000). Although Huggett also
states that “[...] relatively little of that attention has been paid to acquiring an understanding of how they may have affected archaeological practice.” (Huggett 2017).

**Not a Turn, a Leap 2000–2010s**

As we have seen, digital technology and archaeology have a long history together, but this rapid development of digitalisation during the 2000s and onwards is something new (Zubrow 2006). Literature calling it the “digital turn” which describes the feeling that everything during the 2000s was being digitised, and that the digital could provide a merger between a virtual reality and reality (Costopoulos 2016; Petersson 2018:70). Isto Huvila and others note that the referencing to the “digital turn” as something that marks the point of a digital revolution is excessive, they state that “Even if digital technologies have many evident opportunities of influencing archaeological and information work, it might not be altogether clear where the ‘real’ change takes place.” (Huvila et al. 2018:143).

In this post-digital-turn era I choose to describe what has been going on for the last decade as a digital leap instead. I think the term better describes what has become a more rapid development of the digitalisation of archaeology, but not something new that archaeology has made a turn towards. As has been shown in this chapter, archaeology has always co-existed with technical development. This leap that digitalisation is taking right now is rapidly changing how archaeology is being conducted, the archaeological interpretation process and the possibilities for archaeology to be of use for society through communication. With archaeological computing being more focused on the archaeological analysis, the opportunities for digital tools currently available are vastly larger and the digital is used both internally in the discipline but also for communication externally, sometimes with the same data used.

Over the last ten years, there has been one important change that has made this leap possible. The fact that smartphones, tablets and laptops are now in almost every human’s (or archaeologist’s) possession, has made it possible for information to flow in new ways. Digital technology has been made more accessible at a reduced cost and mobile units have become powerful enough to be used as tools for documentation and communication within archaeology. In other words: digital tools have become mainstream (Dallas 2015:178; Taylor et al. 2018). Roosevelt, with others, amplifies the importance of this infrastructural change: “This digital infrastructure shifts the way archaeology is practiced by leveraging an ever-expanding set of recording, analytical, and communication tools.” (Roosevelt et al. 2015:326). The digital leap also creates new social structures, whether it’s in the trench, in archaeology or in society. These new structures can be described as “digital villages” with their own rules and norms. Creating a digital workflow for an archaeologist has never been easier or at the
same time more complex. Digital tools for online GIS, Image Based Modelling (IBM) or 3D modelling can be accessed, free to use for anyone (Richardson & Lindgren 2017:142) and digital specialisation is now becoming common knowledge. But when implementing a digital workflow, more than digital tools are needed. Human relationships are at the centre of digitalisation and it might be said that both archaeologists and the public are among the stakeholders.

The World is 3D – Virtual Realities

One of the strongest trends within the concept of digital archaeology is 3D. The modelling of virtual worlds has been around for a long time but the infrastructural changes, with affordable and mobile technology for the majority, made it possible for the work to take a digital leap into the mainstream during the 2010s. This development has created a lot of 3D artists present at many archaeological institutions within both contract archaeology and academia. Archaeologists can create 3D models with free software such as Agisoft Photoscan (L3) or MeshLab (L4), which are much more cost-effective than for example the use of laser scanners. Working with these programs for documentation is relatively simple and they create realistic 3D models of pictures through Image Based Modelling (IBM) techniques like Structure from Motion (SfM,) with smart algorithms (Roosevelt et al. 2015:327; Wilhelmson & Dell’Unto 2015:2). But it takes an expert to be able to be critical about the algorithms transforming those point clouds into models and to understand how they affect the result. Some argue that archaeologists rely on these algorithms too heavily (Huggett 2017). 3D models are a product of a decision chain made by their creators. They decide what kind of tool to use, how to use it, how collected data is processed and presented as a visualisation (Dell’Unto 2018:56).

3D has become mobile and moved out of the office and into the field, in some cases even to the trowel’s edge. Advocates of the so-called “3D Digging” see these techniques as great tools for reflexivity in archaeological field practice by augmenting the experience of digging. But also, to recreate the excavation virtually post field campaign, which allows more intricate spatial analysis to be made (Forte 2014; Forte et al. 2012, 2013 2015; Taylor et al. 2018). Nicolo Dell’Unto states that:

One specifically prominent strength is the extremely high degree of precision available using the 3D models as a geometrical reference and, at the same time, a very time-efficient process (compared with traditional drawing/ GIS documentation of the bones). These characteristics make this approach applicable to all field investigations, whether research-based or rescue excavations. (from Wilhelmson & Dell’Unto 2015:15 referring to Dell’Unto 2014)
Apart from the arguments supporting 3D documentation as an important part of the digitisation of archaeology, there are also many that argue for the communicational benefits of creating virtual worlds for others. Archaeological reconstructions have not only always been an important tool for research but also for communication. Virtual reconstructions are nothing new and as we have seen, the discipline embraced the techniques in the 1990s, which has made it possible, for users since then, to be part of the created past and even to create their own pasts (Reilly 1990; Costopoulos 2016:2). In the 2010s, virtual technology is to be seen everywhere. These virtual worlds can be experienced on a screen but more effectively through virtual reality (VR), augmented reality (AR) or mixed reality (MR), which are predicted to take up more and more space in the daily lives of people and in many different parts of society. Angus Mol with others states that: “[… even if the past cannot be experienced in actuality, interactive media present an opportunity to re-live it, which appeals on both an instinctive and emotional level.” (Mol et al. 2017:8f). Laia Pujol-Tost has identified the change as:

 [...] the introduction of two interrelated elements acting at different levels: on the one hand, the adoption of new theoretical concepts, such as storytelling, gamification, and Virtual Museum; on the other hand, the incorporation in the interdisciplinary teams of specialists in communication, interactive visualization, and/or computer games. (Pujol-Tost 2017:3)

The earlier so-called “dead worlds” in virtual reality came to life and became more oriented towards user experiences, a clear example of this trend being the V-MUST project (Pujol-Tost 2017:3). I will take a closer look at these virtual realities and their relation to communication of archaeology in the chapter ‘Digital Communication’.

Digital Workflows
The research sector and international projects in particular have been leading the development of digital tools used for documentation, analysis and dissemination of archaeological data. Projects such as the Kaymakci Archaeological Project (KAP) (Roosevelt et al. 2015), the Say Kah Archaeological Project (SKAP) (Jackson et al. 2016) or the Çatalhöyük project have been known for introducing and experimenting with digital workflows (Berggren et al. 2015:442f; Taylor et al. 2018). Later in my text I explore more of those examples. The Çatalhöyük project is presented elsewhere in the thesis, and therefore it receives less attention in this section (see ‘A Theoretical Approach to Digital Archaeology’).

When it comes to the archaeological research projects, they are united by an experimental driving force in the quest to find new approaches that not only
make the archaeological process more efficient, but also create new perceptive places for theoretical engagement. Knowledge development, reusability and open data are all important for the academic contribution to the digitalisation of archaeology. However, there is not one single, agreed-upon method with which the academic world approaches the development. Each project has developed its own digital solutions according to its specific constraints of time and budget as well as its own way of doing archaeology (Wallrodt 2016:33).

In the contract archaeology sector, the adoption of digital tools had not been something unusual, but what happened in the 2000s was that the archaeologists were now able to take things to the next level. This new infrastructure, with affordable hardware and software, encouraged the industry to increase their usage of the digital. During this time, Lock saw opportunities for commercial archaeology to benefit from these developments including the creation of:

*Integrated Information Systems where information flows seamlessly from excavation, through post-excavation to publication and archive, offering an efficient process that would give a competitive edge to any organisation managing to achieve it.* (Lock 2003:265)

He writes that there is still a way to go for the businesses to achieve this, and that existing solutions are products of their context and limited in their use. Lock argues that the problems arose from the commercial sector lacking the resources and expertise to make a seamless digital workflow a reality at that time (Lock 2003:265). Such an integrated information system was successfully developed in the research project of Çatalhöyük with others following (Berggren et al. 2015; Taylor et al. 2018).

Today, around 15 years later, things have changed, but home-made solutions and lack of resources are still a reality. Despite this, a larger spread of digital solutions can be seen, in e.g. Swedish contract archaeology, that are increasingly adapting to digital workflows. For example, GIS platforms such as ArcGIS (L5) and Intrasis (L6) are being adopted to field situations in different ways. With the GIS software directly accessible on mobile devices such as tablets or smartphones, the need for recording techniques with context sheets is reduced and can, in some cases, be fully removed from the equation. The most common workflow is still partly analogue though, with context sheets being digitised manually and transmitted to a geodatabase in the GIS software. In the case of a seamless fully digital workflow, like ARK, PaleoWay (Spigelman et al. 2016:399ff) or IDA (see ‘Sandby borg – a Case Study’) the archaeologist doesn’t need to be concerned about context sheets or paper maps and can instead use digital devices to create digitally born data. But no system has been set as a standard and many archaeological actors, both in the private and academic sector, aren’t using off-the-shelf solutions (existing software like apps), even
though it is the easiest way to become fully digital. Partly customised solutions based on Microsoft Access or Filemaker Pro are common both in academia and contract archaeology and fully digital workflows, with already existing software, are not as common (Wallrodt 2016:46) as one might think.

Increased efficiency of the archaeological documentation process is often mentioned as an effect of digital workflows. Not many projects have numbers to back up these statements, but they still stress its importance. One of the Pompeii projects (PARPS:PS) reports productivity as being increased by over 300%, but do not define what productivity means. More modest numbers come from a project where tablets were used in an osteology laboratory, they state that their efficiency went up by 16%. But digital workflows with tablet recording not only save time for a project, they might also reduce the influence of the human factor and errors being made (Roosevelt et al. 2015:340). These improvements in operability of the archaeological workflow are worth a lot, not least for contract archaeology, where it is important to consider time and money during the documentation process. Instead of slow digitising processes where context sheets are becoming digital by transforming the information into the database, a digital workflow can release time for other resources such as analysis.

Pompeii

The excavations at the famous site of Pompeii had already begun in the second half of the 1700s (Poehler 2016:201) and since then have produced a lot of important archaeology. An archaeologist involved with the digital might argue that the most significant change took place much later. The year 2007 marks the point where the digital development in the ‘Pompeii Archaeological Research Project: Porta Stabia’ (PARP:PS) began making the digital leap, arguably for the whole discipline. That was the year when the first iPhone was released, which began the development towards advanced archaeological mobile digital field recording. Over time the mobile technology improved and in 2010 larger iPad and Android based tablets were released which made it easier for archaeologists to adapt to the technology with more user-friendly interfaces in the tablets (Wallrodt 2016:43). PARP:PS was one of the first projects to use mobile technology and a fully digital workflow for field recording. They had the time and resources available for such a development. After using tablets for several years, the project evaluated the digital workflow and stated that: “[...] data collection became more efficient when it comes to how fast it was” and that “the data collected was better secured, data became more dynamic and the onsite access to information was largely improved.” (Ellis 2016:55f).

The PARP:PS has further contributed in how to make legacy data usable and relevant in research. In ‘The Pompeii Bibliography and Mapping Project’ (PBMB: L7), archival data such as pictures, paintings and written sources are combined with spatial information with the aim of creating a powerful research
tool where the library can be brought into the trench. A freely accessible GIS map contains thousands of these references outlined in the spatial environment of Pompeii. This is the first time a user is able to do research of the city, as a whole, in an interactive digital way (Poehler 2016:212).

The Swedish Pompeii Project (L8) has also made important contributions to the development of digital workflows. When initiating excavations of a full city block (Insula V, 1) in Pompeii, a mixed method approach was undertaken, opening up for new ideas to be implemented to find the best workflows. In 2011 and 2012 the Insula was documented through acquisition of 3D data from laser scanners in combination with IBM. This allowed the team to generate 3D models of the whole Insula and a virtual interpretation of different contexts could be presented and imported in a GIS environment, creating a 3D GIS (Dell’Unto et al. 2015; Landeschi et al. 2016:103).

**ARK – Archaeological Recording Kit**

A system that has been an active part of the development of archaeological workflows since the mid-2000s, years before digital data recording became mainstream, is the *Archaeological Recording Kit* (ARK). ARK is developed and maintained by L-P: Archaeology, a commercial British organisation (L9), and has been used in projects within the sectors of both contract archaeology and academia.

ARK is web-based and can be used for both recording and storage. The online capabilities also make dissemination of archaeological data achievable. The system combines different open source tools, with code freely available. This opens up the possibility of a project tailoring the system for their own solutions without additional programming. The system works in a variety of operative systems and creates a local server on a computer which enables the sharing of data with other units like smartphones, laptops or tablets through a network connection (Dufton 2016; L10). Dufton, one of the creators, holds that this function of the system is one of the most important and states:

*ARK’s ability to eliminate the gaps between data collection and online dissemination has always been a major strength, and it is no surprise that those projects best deploying the system with mobile technologies include a substantial public-facing component.* (Dufton 2016:391)

**iDig**

An interface for field recording that received some positive response from the archaeological sector during the mid-2010s, is the *‘iDig’* (L11) application created for Apple by Bruce Hartzler from ‘American School of Classical Studies at Athens’ (ASCSA). Through the ‘American Athenian Agora project’, Hartzler developed a native app for iPad. A review of the app by Martin Uildriks in
Internet Archaeology (Uildriks 2016) sums up the experience of using the app, in a constructive way. He puts forward the positive aspects of the interface for field recording and the different functions that run smoothly. The archaeologist can for example choose between different base maps like orthophotos and look at plans of other trenches and images. Through the app the user can access the integrated digital repository of the ASCSA and its legacy data. While recording, the archaeologist can access measurements by the total station as soon as they are made and add information to features in the database and at the same time compare new data with legacy data from archives and digitised resources. The most impressive feature of the software is the way it transforms the data displayed on screen into matrices with just a drawing of a line over visible features. The contexts are then displayed in matrices explaining their stratigraphic relations to each other. The combination of an entry in the database, where the archaeologist states the relations between contexts, and this kind of smooth graphical interface has not been experienced before. When digging with a contextual method, this tool can be an asset for a reflexive process at the trowel’s edge, where the documentation process is constantly evaluated. Uildriks states that:

*The options for visualisation and drawing relation diagrams on the fly are also impressive and the software looks slick. Certainly, these are exciting aspects that many archaeologists undoubtedly will find useful in the field and that without doubt could save precious time. In addition, the pencil tools, filters, and organisation of data are exceptionally well executed and usable, within the scope of the Athenian Agora Excavations project.* (Uildriks 2016)

And he further says that “iDig provides a stronger visual interface and workflow” than other comparable applications for archaeological digital data collection.

Even though the app and its usefulness are acknowledged, the reviewer also identifies several issues that he thinks need further attention in future development. Uildriks states that there’s a need for clearer instructions and explanations about some of the functions related to documentation. Another aspect is that iDig is a product developed for the Athenian agora excavations and it is hard for other projects, with other specifications regarding finds or features, to implement the system without some adjustments. Further on, he feels that not all projects will have the same financial resources to buy all the necessary hardware. (Uildriks 2016).
Gabii Project

Gabii was an important town in the Roman Empire with close connections to the city of Rome, located just 18 km to the east. Ongoing excavations of the site are conducted by the University of Michigan. The Gabii project has been engaged with the digital for a long time and been using a structure from motion (SfM) technique to record stratigraphic units in 3D since 2009. The project developed their workflow and in 2012 they began using a customisation of the web-based system ARK where they combined different modules like Unity (L12) and GIS in one platform (Opitz 2015:74f). The trend for using advanced 3D modelling for field recording has become common-place, what the Gabii project accomplished was to combine this data with other graphics and levels of information to create powerful graphical user interfaces (GUI). Opitz and Johnson express that highly realistic 3D models and reconstructions of a house in a game-like surrounding with integrated information elements like pop-ups, databases or descriptive texts with the archaeologist’s interpretations, create a user experience with reflexive possibilities. They argue that digital archaeologists should be engaged in a theoretical discourse concerning the role of the GUIs in archaeology and be reflexive while creating them and evaluating the impact of these interfaces (Opitz & Johnson 2015).
Concluding Thoughts

This chapter illustrates that the digitalisation of archaeology is vast and occurs on many different levels in many parts of the discipline, with the largest impact observable in academia. At larger research funded excavation projects like Pompeii, the environments are, in one sense, much more suitable for the development of new workflows, since research projects can have a long-term plan. PhD students and researchers, who have their own agenda, might also be assisting and through synergies one helps the other. The limitations of contract archaeology make it harder for a digital development to take place. In a contract archaeology project, the reality is that there is a constant feeling that there is never enough time or money. These facts need to be considered when approaching issues of digitalisation in this thesis.

The examples of projects presented in this chapter all have aspects closely related to theoretical concerns, which are a part of their creation and how they evolve. The theoretical approach is almost solely a reflexive one and the combination of making data flows transparent together with contextualising it with legacy data tie these projects together. Digital data is there not for its own sake but for answering research questions or creating new ones. There are, though, still some traces left where the belief in the digital to create objective knowledge exists. Processualism in the 1960s and the belief in computational archaeology to collect “objective” truth is still present and re-actualised in today’s context. Even if this thesis focuses on the human part of digitalisation, those who advocate an objective knowledge production exist. A TV show entitled ‘Time Scanners’, first aired in 2014 (L13), highlights this trend in some way by being proof that a belief in machines and their ability to create objective truths is still widespread. The show used mobile laser scanners to, as they put it in their trailer: “for the first time allow(ing) us to understand some of the old mysteries of the engineering world”. Even though the technology is fantastic, the sometimes almost supernatural belief in point clouds can shadow any criticism regarding the individual’s subjective creation, collection and analysis of that point cloud.

In this chapter I have stated that the most important part of the digital leap is the mobilisation of digital tools and their affordability. But mobility is more than just having the ability to take a tablet down into the trench and create digitally born data, the connectivity and online access is just as important. The research projects in Pompeii, the ARK workflow, iDig and the Gabii project all stress the importance of legacy data (or archival data) being part of the archaeological interpretation process. Different information sources in combination also contribute to the interpretations of archaeological source material. John Wallrodt states that with data being born digital in the Pompeii project, there was improved access to information. It also made it possible to connect information in new ways and generate greater knowledge in the process.
of doing so. When different technologies like digital born data and legacy data could talk to each other due to their digital nature through linking and relationships e.g. between databases, it made management of the excavation much more effective (Wallrodt 2016:35). Wallrodt also reflects:

> When archaeological data are unbound from their analogue predecessors, they no longer exist as discrete pieces. In digital form, through data connections and transfers, we move away from multiple pieces of disconnected individual observations and toward a singular dataset. (Wallrodt 2016:45)

Within the framework of Pompeii, Steven Ellis also argues that accessibility further enabled intricate collaborations between different teams when a dialogue between for example bio-archaeologists and conservators could take place more actively. Now, a more useful interpretation process could occur and a research process that produced better results was achievable (Ellis 2016:56). But he also goes on to describe the challenges in implementing a new workflow and Ellis states that: “[…] it is one thing to convert a paper-based project to a paperless system, but it is another to convert all of the project’s team members to that system.” (Ellis 2016:57). Here is a good example of seeing that the digitalisation is not only about the digital tools, but that it is also about the humans and their relation to the digital that determines the digital development’s fate. With the rapid pace with which the digitalisation is happening: “[…] it is not where the technology is moving that is important, but rather where the archaeologists are moving.” (Zubrow 2006:9ff). So where are the humans, the archaeologists, moving? Lock’s book ‘Using Computers in Archaeology’ gives us a snapshot of more parts of the digitalisation of archaeology in the early 2000s. He can identify the change as ongoing but understands that several steps need to be taken before digital archaeology can be something more than a sub-discipline. Lock states the importance of collaborations within digital development work, which I argue is still true today:

> The increasing use of computers is one of the few activities that unites a very diverse range of people and interests which constitute archaeology and it will be beneficial to the discipline if change based on IT is mediated and managed within a discipline-wide dialogue. (Lock 2003:268)
The Digitalisation of Contract Archaeology

In this chapter I investigate how the framework of contract archaeology affects the digital development and how this differs from the research sector. This chapter mainly deals with the research question regarding what can be said about digitalisation’s level of impact within archaeology and especially contract archaeology and how it might be further problematised when it comes to knowledge production and communication (see ‘Research Questions’). I approach the sector with the aim of studying how the processes of digitalisation affects the industry and how business is affecting the digitalisation in return. I will start out by giving a short background to contract archaeology (for definitions see ‘Terminology’) in Europe, the USA and Sweden, with an emphasis on the latter. Focus will then be put on Sweden from where I present three minor case studies to illustrate some observable trends within the sector. Data acquisition for these minor case studies has been made through six qualitative interviews, online surveys and literature studies. The result from this analysis is further used, together with the other results, to shape a discussion involving knowledge development and communication in archaeology, from the three perspectives: in the trench, in archaeology and in society (see ‘Digital Communication’ and ‘Alive’).

Contract Archaeology in the Global West

Since the Valletta (1992) and Faro (2005) conventions there have been great changes in the way that different European countries approach contract archaeology (Webley et al. 2012). The “polluter pays” principle, which means that the developer responsible for the exploitation pays for the archaeology connected to the project (United Nations 1992; Demoule 2012:614), has had a different impact in various countries. In France it is activated through a development tax, in Greece the price is negotiated with developers and can range to up to 10% of the whole development cost. Spain, Italy and Ireland have an open market for archaeological services (Thorpe 2015:185ff). In the 1990s the UK adopted the principle that archaeology is a part of the land-planning process, following publication of Planning Policy Guidance 16: Archaeology and Planning (PPG16) by the UK Government. This led to an increased awareness of ancient monuments and more sites being avoided or archaeological investigations carried out before exploitation of the area. Even if much has improved there are still concerns that the system is under heavy pressure, with it receiving less funding (Everill 2009; Everill & Irwing 2015; Cooper & Ralston 2015:10ff). Another issue has been the increasing possibility
of contract archaeology being managed, and decisions taken, at a local administrative level. In some cases, this has led to the developer being able to choose the archaeological contractors for the job and to some extent control the costs. For example, it can be hard for the archaeological company to receive funding for analyses after the field project has ended (Cooper & Ralston 2015:11). In the USA, larger archaeological undertakings prior to land-development were commissioned by the state right from the 1930s and 1940s. After the Second World War, several countries, such as England and Sweden, experienced larger land exploitations as well, meaning that archaeological undertakings grew with this societal development (Börjesson 2017:33).

Contract Archaeology in Sweden

In the early days of Swedish contract archaeology, excavations were mostly conducted by the Swedish National Heritage Board (NHB) but also by regional museums and archaeological departments at universities (Ambrosiani 2012). Since the 1950s and 1960s there was a slow but gradually movement towards market principles in society, but it wasn’t until the 1980s that the first private actor ‘Arkeologikonsult’ (L14) was established (1988). Today there are around 55 organisations active on the market of contract archaeology in Sweden, divided between a governmental consultant, various foundations like museum departments, incorporated business and sole proprietorships (Börjesson 2015, 2017:34; Törnqvist 2015:10). In 2005 the government inquiry ‘Uppdragsarkeologi i tiden’ (SOU 2005:80) stated that contract archaeology should produce more than documentation and analysis of the archaeological remains. The inquiry proposed that contract archaeology should increase its collaboration efforts with society, something that Anders Högberg and Fredrik Fahlander say: “[...] were never fully realized, however.” In the bill that followed (Kulturmiljöns mångfald 2013), words about the societal impact of contract archaeology became more carefully expressed sentences about that “some” public outreach should be a part of an excavation project (Högberg & Fahlander 2017:15). Since 2016 the Swedish legislations regarding cultural heritage contains a phrase including the term mediation of archaeological results, stating that a popular summary is to be included in the publication of results (KRFS 2015:1).

The Swedish market of contract archaeology can be described as semi-regulated where companies compete in getting contracts, but where the regional County Administrative Boards (CAB) decide who gets the job. The market can be said to be less regulated than some European countries such as France and the Netherlands, but not as free as the markets of UK and the US (Börjesson 2017:35; Börjesson & Huvila 2018:16). CABs play a central role on the Swedish market and all building planning must be approved by them and they are responsible for the protection of ancient sites and monuments. If it is decided
that an exploitation is of such large benefit for society that the ancient sites remain can be removed, CAB can decide that archaeological documentation of the site must be conducted before the removal of it. The archaeological efforts being made are depending on the site’s complexity, they can consist of a field survey, preliminary excavations or full scale archaeological excavations. The polluter pays principle applies on the Swedish market as well and the developer must include the cost for archaeology into their budget (KML (1988:950); Larsson 2017). But it is not up to the developer to choose the contractor, which means that the CAB can control projects and ensure that documentation and reports keep good quality. An important difference between Sweden and other European countries is that the price is just as important as the scientific value in a bidding process and where: “[...] all contract archaeology must be based upon current research, because its main goal is to produce new historical knowledge.” (Kristiansen 2009:645). Contract archaeology is supposed to produce good scientific data that has the potential to contribute not only to a knowledge production, but also to knowledge development (Riksantikvarieämbetet 2015:10; Börjesson & Huvila 2018:20).

As Högberg and Fahlander stated, this outreach to society has not come the whole distance and there is still a way to go for contract archaeology in the quest of making it relevant for society (Högberg & Fahlander 2017:15). Mikael Eboskog, head of the dept. of archaeology at Bohuslänns museum, thinks there are problems concerning the current system with museums detached from part of the process of knowledge production when for example data is collected during field work. Museums could take a larger part in creating long-term solutions for knowledge building. Eboskog states, if only the system of contract archaeology would allow it. In the present system, museums are only involved in the archiving of results and finds. Archaeological departments concerned with contract archaeology are supposed to have an economy set aside from public funding, which excludes them from the rest of a regional museum (Eboskog 2017:30). Eva Skyllberg (at the time at Swedish NHB) identifies one part of the problem as being the project focused on knowledge production, not grasping a bigger picture. She thinks that contract archaeology is not living up to its full potential of being a valuable contribution in writing history connected to relevant subjects. Skyllberg means that there is need for more research on topics and not only publication of the location of the current site being excavated (Skyllberg 2017:71f).

Digitalisation of Swedish Contract Archaeology

In this section I present three minor case studies illustrating various parts of the ongoing digitalisation in Swedish contract archaeology. The text is made up of the results from a combination of literature and statements made by officials and individuals active in the sector. I’ve met with representatives from the
government agency, NHB, responsible for cultural heritage management in Sweden. I’ve further approached a large excavation project that has tried a fully digital workflow and met with an individual who could be identified as a digital archaeologist, working at an organisation engaged in the digital development.

**Minor Case Study 1: DAP & Digisam**

Following several decades of development of a competitive system within Swedish contract archaeology, it can be said that it isn’t without problems. One of the main issues is that the archaeological information isn’t fully open to access and to too large an extent stays within the organisations that have collected it (Löwenborg 2018:42). The Swedish NHB has recognised this problem, among other issues, and initiated the DAP programme (Digital Archaeological Process) as a countermeasure. DAP has made it a priority to work for the creation of a new structured archaeological digital workflow supposed to make the civil process more effective (L15). In 2007, the Swedish market of contract archaeology produced over 90% of all new archaeological data, which is supposed to relate to and be used in research (Riksantikvarieämbetet 2010; Börjesson 2018). This number is probably higher due to many large infrastructural projects over the last decades, but no up-to-date statistics exist as at the time of writing (2018).

**DAP (Digital Archaeological Process)**

Marcus Smith works as a development officer at NHB and has been involved in the development of DAP. Smith has a background as an archaeologist in the UK where he e.g. worked with the Archaeological Data Service (ADS), a digital repository for heritage data that has been in existence for c. 20 years, ensuring long-term archiving of archaeological digital data and dissemination. He also worked for the Council for British Archaeology for six years, arranging sector-wide collaboration between government agencies and commercial fieldwork units. Smith initiated a Swedish pilot study in 2012 regarding digital information within the cultural heritage system where shortcomings in data flows between different actors in the sector of contract archaeology could be detected (Krantz 2012). The first step, towards what later became DAP, was to take the result from the report forward, which led to the establishment of a collaboration between the NHB and the CABs around Sweden. A three-part project was initiated concerning: an internal system for streamlining data flows, development of the administrative process and issues regarding archaeological data. The third project part resulted in a suggested approach to move forward with a new digitised archaeological process. It was expected that this would eliminate several issues with information being both unavailable and not being transferred in an effective way, and with the amount of unnecessary duplication work that was being done (Krantz & Smith 2012). In 2013 there was a government mandate to proceed with these issues and funding was received. It
all ended up in a five-year governmental programme called DAP that started in 2014. It was thought initially that DAP would involve a close collaboration between NHB and CABs which would improve the effectiveness of the administrative processes of contract archaeology, with digitisation as a resource for accomplishing that. The workload was supposed to be divided roughly equally between the NHB and the CABs, but it ended up with the NHB taking most of the responsibility and work, according to Smith. CABs were not able to commit the time and resources required to develop corresponding IT services in parallel with the DAP development at NHB, Smith continues (Interview: Smith 2017).

The DAP Programme

With the DAP programme starting, a five-year operation began to create a more seamless process for storing and sharing digital information generated through archaeological surveys and excavations. DAP aims to increase data availability and make it more useful for agencies and contractors within a variety of different fields which are affected by contract archaeology and heritage management. They could be development planners, builders, industries or contract archaeology organisations. Even though they are not the main target group, the research society and the general public are also thought to gain from this development (Larsson et al. 2017; Interview: Smith 2017).

Tord Klafver is an experienced project manager who has worked as a consultant with IT-related development before getting employed at the NHB. When this interview was conducted (2017), Klafver was responsible for the DAP programme. He describes the programme as a mix of different projects aiming for the same goals. It is Klafver’s belief that over the course of the DAP programme, from its start in 2014 up to the interview in 2017, the project moved from visions to goals, with prevailing conditions meaning that certain deliveries were possible while others were not. What DAP is has changed over this period and not all the original visions were realised in its delivery (Interview: Klafver 2017). The programme has around 25 to 30 employees (several consultants) from various departments at NHB currently involved in the different projects in one way or another. Klafver explains that focus now, at the end stage of the programme, is on the technical development of the IT platform. There are, generally, two competences represented within the DAP team: knowledge of archaeology and the contract archaeology sector being one and technological expertise being the other. Klafver explains that DAP doesn’t need to have all expertise within the programme, but merely know where to find it. In the beginning it was also hard to know which skills were needed and it soon became clear that contract archaeology is a complex sector with many perspectives, making the recruitment of the right personnel a challenge (Interview: Klafver 2017).
The Swedish NHB has acknowledged several major problems in the current analogue system that they want to change with a digital, more effective approach. Today, only analogue primary source material such as artefacts, drawings and photos are delivered to museums by the contractor. Once stored at the museum, artefacts are not necessarily connected to their context more than there being a reference to a database that exists somewhere. Without access to field information and an understanding of the context, possible research on archaeological source material becomes limited. With more data being born digital, not all information is being stored for the future (Larsson et al. 2017). Even though very few contractors have a plan for a long-term preservation of digital data they still, to a large extent, have their data stored on local servers. A study conducted in 2015 also concluded that, although limited, there were still a variety of formats for GIS data (Törnqvist 2015; Larsson et al. 2017). A problem though is that when the report was published, a great deal of the material which led to the interpretations being presented was lost or not presented, according to Åsa Larsson, operations developer at DAP. Also, information can be held by one contractor and when another contractor is meant to take over work on the same site it can transpire that not all information is accessible, or it is time consuming to locate, especially when, sometimes, it isn’t digitised at all (Interview: Larsson 2016; Larsson et al. 2017).

DAP’s vision is to make the civil process more effective and archaeological data more useful (fig. 4). Larsson says that authorities need a better basis for decision making and the system also needs to be legally correct with the same administrative processes in all the Swedish counties. DAP’s vision also contains a greater aim, connected to the idea that cultural heritage sites and ancient monuments will give new knowledge to society for generations to come. With open digital data there can be a better archaeological knowledge production for society; and museums, associations, schools etc. can find archaeological information more useful as well (Interview: Larsson 2016). Larsson further wants to “[...] emphasise that the guiding principle on digital data for the National Heritage Board is openness”. All archaeological documentation (as far as possible) will be published with open licenses in the Cultural Environment Register (KMR). KMR will work as a portal that links to reports and primary data stored in the new digital repository, the E-archive (see ‘E-archive’). Both reports and digital field records will be licensed as open data under Creative Commons (Larsson et al. 2017). Larsson states that the new systems will eliminate time-consuming processes such as duplication of work, contributing to a more efficient process for the archaeological actors. In this new national digital system, KMR, archaeologists will be able to create data posts directly into the register and the local CAB has the responsibility for data retaining good quality when published. Larsson states that there might also be better information flows between contract archaeology organisations, with digital data, such as geodatabases, accessible for reuse (Larsson 2016). Organisation
databases isn’t something that will be shared at this stage though, but the aim of continuing work moving forwards after DAP is finished (Klafver 2017). Another solution DAP has come up with is a digital system of unique identifiers (UID) which makes a contract archaeology project or a find identifiable and traceable all the way from data recording to archiving, and this is supposed to eliminate problems with artefacts being out of context in museum collections (Interview: Smith 2017).

Figure 4. The vision of DAP (from Larsson et al. 2017: Link to original figure).

DAP and the Future
As has been shown above, not all that can be achieved is done within the framework of the DAP programme. Even though much is accomplished, much needs to be taken further so that the development on a governmental level doesn’t end with the DAP programme. Klafver and Larsson assure me that this
will not be the end and state that DAP is producing a to-do-list which the
government can pick up on (Interview: Larsson 2016; Interview: Klafver 2017).

DAP is a clear example that working with digitalisation means that you work
with processes and change of workflows. The most important work here is not
the technological solutions, even if they are a necessity, but DAP leading to new
regulations and guidelines for the actors in contract archaeology to follow
whether they are governmental agencies, contractors or museums. DAP must
therefore work in collaboration with these different actors in both the
development stage and the implementation phase (Larsson et al. 2017). One
special regulation will stipulate the relationship between NHB and the CABs,
regarding the question of responsibility for cultural heritage information
(Interview: Klafver 2017).

After the DAP programme concludes in 2018–2019. Smith hopes for a
continuation of the work related to regulations regarding standards in datasets
where a lowest common denominator can be set, so data looks the same
wherever it derives from. One improvement that will follow DAP is an update
of the most basic list of ancient monuments, this is mostly useful in surveys and
doesn’t represent all the remains found at an archaeological site. This list will
also be comparable to other countries lists, according to Smith (Interview: Smith
2017). Klafver also agrees that more must be accomplished when moving
forward with digitalisation work in Swedish contract archaeology. The
programme succeeded in looking at the civil process but not so much with the
dissemination of data and how it can be more beneficial for society. New
mindsets need to be developed together with new strategies. Therefore, one of
the new departments at NHB (‘Department of Digital Mediation’ Swedish:
‘Enheten för digital förmedling’) is now engaged in those kinds of issues. The
KMR is being implemented at the time this text is being written, in the third and
fourth quarter of 2018 (Interview: Klafver 2017) and it remains to be seen how
it will all turn out and what the different stakeholders will think of this new
digital archaeological process. A future evaluation of the implementation of
KMR would be valuable for research, also for discussing approaches onward.

Digisam

In 2017 the secretariat for National Coordination of Digitisation, Digital
Preservation and Digital Access to Cultural Heritage (Digisam) became a part
of the Swedish NHB. Previously Digisam had been a part of the Swedish
National Archives (SNA), established in 2011 as a part of SNA due to lack of
competence within many parts of the cultural heritage sector as regards
digitisation. Digisam works for long-term solutions for digital cultural heritage,
focusing on state authorities and institutions in Sweden. They work on bringing
forward strategies for digital cultural heritage management, something that is
constantly changing. Management is focused on the digitisation, availability of
source material and long-term preservation of digital collections. They also
work with guidelines and training for institutions and agencies (Interview: Summanen 2017; L16).

Digisam is not directly involved in Swedish contract archaeology but is still of interest for this research because it is engaged with questions concerning long-term preservation, management, creation and dissemination of digital data. DAP will launch an e-archive (see ‘E-archive’) where contract archaeology will be able to archive their data and it is notable that Digisam hasn’t played a more active part in this process despite their expertise within these matters. Klafver says they adapted the Digisam guidelines to their own and further states that the collaboration between the two has been very limited because of the different approaches, where DAP is primarily working with the civil process of contract archaeology and Digisam’s primary work concerns the whole GLAM sector (galleries, libraries, archives and museums) and issues regarding e.g. archiving matters (Interview: Klafver 2017). Another reason for the lack of collaboration is that the DAP programme is about to finish and Digisam has just become a part of the staff at NHB (Interview: Summanen 2017).

To gain a better insight into what Digisam thinks about the development of DAP and archaeological digital information in general, an interview with Digisam’s Henrik Summanen was conducted. He’s an archaeologist who has been working with contract archaeology for around 10 years, at a museum for another 10 and for about 10 years at the NHB. He also presents himself as a linguist interested in information flows and language (Interview: Summanen 2017).

DAP states that openness is a guiding principle for their work, but what is meant by open data can differ considerably depending on who you’re speaking to. Summanen for example takes the concept a step further and states that open data means more than just transparency, it means structural changes for an organisation, the archaeological discipline and potentially society as a whole. When moving from analogue to digital there must also be a change in the approaches to information management, Summanen states. What has been learned regarding archiving and long-term preservation so far must be re-evaluated and the same principles as before won’t do digital data many favours. Summanen says that digital information should be thought of as a living entity where text/information needs to be activated and not just be a representation of the analogue. Information needs to be searchable and linked to other relevant entities. In this way information becomes contextual and more valuable. What has been part of the librarian’s know-how might be replaced by a machine in the future, but this transition can be hard for the humans of digitalisation to cope with (Interview: Summanen 2017).

When discussing archaeological information, Summanen states that it is complex and hard to manage, since data often just consists of fragments of knowledge and can represent no more than 20–30% of an ancient site. He further states that archaeological documentation represents an ongoing
interpretation process that the recording archaeologist tries to formalise for the sake of the report. What are relevant research questions today might be very different tomorrow. What archaeology should prioritise in the present is hard to know but is defined by the system’s demands on publication, dissemination and preservation set up by the CABs for the contracts. Summanen continues to reflect that if information were to be collected digitally it would be more useful and more objective in its creation. A laser scanning tool for example could help in recording larger areas and capture another scale more objectively than if many archaeologists were doing the same thing. If data was born digital, more useful analyses on a larger scale could also be carried out with big data, but these analyses won’t be “big” if data is too varied though. By data being born digital and structured for machines to interpret, rather than humans, new narratives that we don’t know as yet, can be created in the future, thinks Summanen. In today’s system, the narrative is created by the current archaeological project conducting the excavation. This becomes the main narrative and it might be difficult to create a new one or build further upon the published results in a report. If both primary data and the report were equally important for publication, archaeology could benefit. Summanen goes on to say that through, for example, digital cloud services, data could be shared directly from the field and a new transparent archaeology could emerge, with an opportunity for the public to contribute to knowledge creation (Interview: Summanen 2017).

In the previous chapter I’ve shown that such possibilities exist (like IDA or ARK) allowing a more transparent archaeological process and potentially a real time multivocality with different stakeholders. The technology is there but it is the cultural aspects of contract archaeology that might be the biggest challenge. The mindsets of the archaeologists in the business, regarding how things should be and not be done, sometimes make it hard to try and transform a competitive sector into a more open one where information can flow in new ways. The collaborative nature of digital data might be challenging for the experts who are not prepared for competition in the processes of interpretation and knowledge creation. Summanen thinks that this cultural change will take at least a generation and that there is a need for new positions within companies, requiring skills oriented towards the digital (Interview: Summanen 2017).

E-archive

This section focuses on the so-called E-archive that will be an important part of the new digital infrastructure that the NHB sets up through the DAP programme. That is because it sets the standard of Sweden’s strategy for digital archiving of digital archaeological information moving forwards. Information about the E-archive is important as regards understanding the discussion around the research questions on what digital is and how it is perceived by the Swedish system of contract archaeology (see ‘Research Questions’). With the creation
of a digital repository, there are questions that need consideration so that the e-archive will be of value in the infrastructure currently being created by DAP. These might be:

- What will be saved?
- How will it be saved and for how long?
- Which information might be of value for archaeology, for society and for the future?
- How can this digital information contribute in new ways to knowledge development in an unknown future?

Larsson states that there is no national digital archive today for archaeological data that everyone uses (Interview: Larsson 2016). The Swedish National Data Service (SND, L17) exists, but the archaeological data stored there is limited and mostly consists of data from research projects. One exception is the datasets produced by a project aiming to clean and share the GIS datasets from contract archaeology projects carried out in the county of Östergötland. The project was conducted at the request of the CAB with the aim of gathering all data in one place, before a large infrastructural undertaking called Ostlänken was to be carried out in the region (Löwenborg 2014:16ff, 2018). With contract archaeology producing over 90% of all new data (Riksantikvarieämbetet 2010; Börjesson 2018), only a fraction is delivered to the repository of SND. Because of that, this data has very limited value when it comes to extracting information important for the civil process or for big data analysis. Larsson says that a digital archive should consist of more than digitised reports and other documents. It should also include archaeological source material such as geographical and contextual information about features, samples, finds, photos, drawings, GIS-data etc. Her point is that this data is very important to preserve for the future because it’s often the only thing that is left from an archaeological site (Interview: Larsson 2016).

Even though DAP thinks it is important to save the original records, primary digital data in this case does not mean that it must contain every event recorded in the database, a cleaned database approved by the CAB is enough (Interview: Smith 2017). The priority so far has not been to get into details regarding primary data, but instead to get the infrastructure for the digital repository in place. Furthermore, DAP has prioritised the digital reports which are looked upon as the most important sources of information to be archived. In a later stage (unknown when) this will be followed by the digital datasets such as GIS geodatabases. Klafver further states that the visions of the DAP programme as regards the E-archive have not been fully reached. DAP had to compromise and create a solution within the timeframe of the programme that could work in the present and be implemented at short notice. For example, DAP has not realised the vision of creating guidelines for contract archaeology regarding how digital
data should be structured e.g. a database and in which formats. The E-archive will receive digital data in its current shape, delivered by the various organisations within contract archaeology, which all have different strategies for collection and management of digital information. DAP acknowledges that digital data produced by contract archaeology looks different depending on the actor. Some are semi-digital, and others have fully developed digital workflows where data is born digital. Klafter says that other standards, like what specific archaeological contexts should be named, are something the business of contract archaeology must sort out, but in collaboration with the NHB, which should have a coordinating role. Who would pay for such an undertaking is unclear, but it will not be DAP (Interview: Klafter 2017). The archaeologists’ visions of what a common database structure should look like differ and it would take a huge effort to get everyone on the same page, says Smith. Following implementation of KMR and the E-archive, organisations will send in their digital data, such as reports and databases, for archiving, using the individual workplace’s existing conditions regarding formats and database structures. Many will send in digital data in different formats and in varied quality and quantity (Interview: Smith 2017). Larsson is critical about how things are working in the business and states that:

*It is remarkable how poor we have been at making sure we use the same terminology in even very basic documentation, which could ensure computer-based analyses and statistics without extensive re-digitization. We are focusing so much effort on using digital tools during excavations that we rarely stop to ask how to make sure product will be usable in another context. We still mostly think in an analogue manner, leaving vital information out which would ensure that data can be related to each other.* (Larsson 2017:58)

Whoever wishes to dive deeper into or reuse the digital data will download it from KMR and will then need adequate software (and hardware) installed to be able to analyse the data. Smith says that the quality of digital data delivered to the E-archive will mostly depend on what the organisations of contract archaeology produce and what the CABs accept, having the final word deciding whether data is ready to be published. There will be no regulations regarding formats or database structures or demands that data must be traceable, at this stage (Interview: Smith 2017). The E-archive won’t be open for changes or add-ons in the data. A living archive, such as the one in Çatalhöyük (Taylor et al. 2018) and the concept of living data with the possibility to add new data and narratives onto datasets might have been possible to accomplish but won’t be. Digital data will be downloadable and can then be altered or built upon, but the sharing of those results must be done elsewhere outside the national E-archive,
in the SND, for example. This new data post can then be linked to the original one in the E-archive (Interview: Smith 2017) which makes it possible for a living discussion of the results at least.

Questions about the life length of data in the E-archive are harder to answer. Formats will be updated so data can be reused, but whether the knowledge archived can survive present terminology and frameworks for knowledge production that aren’t even the same on a national level, can’t be answered at this stage. Smith further explains that there are more national E-archives on their way when it comes to other state agencies and there seems to be a national archive for all agencies in Sweden under development. If this is the case, it is unclear whether the E-archive for archaeological digital data will be a medium-term archive, or whether the long-time preservation assignment will stay at NHB despite other national E-archives (Interview: Smith 2017).

Summanen thinks there is a risk that the E-archive that DAP is establishing, might end up being a temporary solution that must be remade in a decade or so. It’s hard to make digital data valuable and reusable when structural changes within the digital infrastructure are always in motion. Summanen says that a more beneficial solution for long-time preservation of archaeological digital data would be to create and collect data that is more objective instead of highly subjective data which is descriptive in nature. He further thinks that the structure of datasets created needs to change so data can be separated into different segments and created for machines instead of people (Interview: Summanen 2017).

Now, I will switch the perspective and present two case studies of digitalisation work within contract archaeology, taken from one of the biggest excavations in Swedish history and a smaller organisation engaged in digitising their workflows.

Minor Case Study 2: New Lödöse – a Contract Archaeology Project

The project ‘New Lödöse – The town below the Old Town’ (my translation, Swedish: ‘Nya Lödöse – staden under Gamlestaden’) in Gothenburg, Sweden, is and has been one of the largest contract archaeology projects in the country since its start in 2013. The project has had a turnover of around 200 million Swedish kronor (c. 20 million Euro) and is a collaboration between three contract archaeology organisations: ‘The Archaeologists’ (Swedish: ‘Arkeologerna’, L18), ‘Rio Göteborg’ (L19) and ‘Bohusläns museum’ (L20).

In February 2017, I conducted an interview with the archaeologist Caj Carlstein, employed at ‘Rio Göteborg’. He has been the project’s GIS coordinator and technician, responsible for import/export of data and for making sure that data retained good quality. This means that he was both in the trench as a field archaeologist and (mostly) in the field office managing digital data (Interview: Carlstein 2017).
A Digital Work Flow

Before the beginning of field work there was time set aside in the budget for preparation of the digital workflow developed by the team behind the GIS software Intrasis (L6). The on-site personnel participated in courses to learn the workflow consisting of several solutions with the client software Intrasis3 in focus, a fully operational GIS system with a desktop interface. This meant that there was a terminal server in Stockholm and that all digital field recording was conducted with tablets linked to this system. The workflow had been tested beforehand, but not on-site. The motivation behind the decision to try out a digital workflow was the assumption that it would save time in the field and reduce the amount of duplicate work connected to an analogue workflow. Meaning that an archaeologist had to digitise a context sheet paper into a post in the database, a second registration post-excavation on a daily basis. The project also had ambitions to create a more effective interpretation process and to make the documentation process swifter, Carlstein tells me. Expectations differed among project members, he continues, and field personnel had several preconceptions that were both positive and negative, but the majority thought that the digital workflow would be an asset and that issues such as slow work elements would be eliminated. Others thought that this method would not work, and rather than saving time it would become time consuming.

Although the system was up and running smoothly at the start of the field project, after just a short time several negatives could be identified. The workflow contained more parts than originally anticipated and together with the fact that there were too few tablets for digital recording this meant that problems soon emerged. The continual log-on/log-off for each archaeologist into the system with a terminal server, combined with a bad Internet connection, did not make the use of tablets an altogether positive experience, says Carlstein. Another challenge was the frequent staff turnover, meaning that newcomers needed to learn how to use the digital workflow. Even though instructions were written down in manuals this still took time and effort. The biggest issue for field personnel was the user interface provided by the software, which was the same as for a desktop solution, but in this case, they only had a tablet with, by comparison, a greatly reduced screen size. This made it hard for the user to be able to see what to do on screen and mistakes could easily be made by pressing the wrong buttons. Carlstein states that the complexity of the system created a technical hurdle that the user had to overcome before it could work. Carlstein thinks it’s important to point out that there was no budget for the development of an app and that the solution was the best the IT crew could come up with in these circumstances.

Even though there weren’t tablets for every archaeologist, everyone on site had access to the digital recording system and could document and analyse. One person was designated to verify that data was of good quality and if an individual had missed something they had a chance to correct it after scrutiny.
These people were important, states Carlstein, and for his position as the one responsible for the GIS, they were vital. Those individuals became an important link between the field office and digital recording at the trowel’s edge (Interview: Carlstein 2017).

The Abandoning

Carlstein says that different problems connected to the digital workflow had been piling up for a while and issues with wireless connection, the client software, the interface and the slow process in the field made archaeologists increasingly inclined to use their note books instead. When it was hard to see the benefits of using digital tablets, they were perceived as redundant. In the summer of 2015 after around 7–8th months of usage in the field and development of the concept before that, the fully digital workflow in ‘New Lödöse’ was abandoned and before the summer ended it was decided by the project management that digital recording with tablets should cease. The double registration part of the documentation process was once more a reality, but the personnel were keener on using the computers to register their notes in the database than to do it with their tablets (Interview: Carlstein 2017).

Lessons Learned

Carlstein states that it would have been better with a more user-friendly interface, such as an app could potentially have provided, but within the framework of this project, it became too expensive to develop one. The project learned a lot from implementing the fully digital workflow and changed their process of how to work with teams and different levels of responsibility, leading to better documentation and follow-up processes. Carlstein says that another useful discovery was that they could have a unique ID for every archaeologist recording data. This was valuable because one could trace the events in the database and see who had done what, where and when.

Carlstein says that he would have liked the workflow involving the tablets to work, as he thinks it was a good idea and that the quality of the documentation improved with this system. He goes on to state that the archaeological workflow and the project’s needs must steer the development of digital methods, and not the other way around. Carlstein sees a danger in the development of digital tools not being related to the requirements of archaeology, which he sees might lead to archaeological documentation and interpretation suffering as a result. If the digital development is going to be able to move forward within contract archaeology, the CABs have to, in the future, start asking for digital approaches in their specifications, Carlstein states. Today there is no room in budgets for the development of digital applications in contract archaeology projects, but he hopes for a change where the archaeological process can become more transparent and accessible through digital solutions (Interview: Carlstein 2017).
Minor Case Study 3: A Digital Archaeologist

Below I present the results from an interview conducted with an individual having a typical job at a contract archaeology organisation: the digital specialist. He or she is typically an archaeologist and at the same time the person responsible for technology and an expert in a variety of software. The role of this specialist is still much the same as the GIS specialist but is slowly changing, and these individuals are receiving more attention at their organisation as digitalisation is moving forward at an increasing rate with new solutions constantly emerging.

Patrik Hallberg is an archaeologist and a GIS specialist, he is further self-taught when it comes to digital methods of photogrammetry, 3D reconstructions, and game engines. He works at the organisation ‘Heritage Halland’ (Swedish: ‘Kulturmiljö Halland’, KMH), part of ‘The Museum of Cultural History in Halland’ (Swedish: ‘Hallands kulturhistoriska museum’). The company takes contracts both within archaeology and within the sector of building preservation. The organisation has around 20 employees divided into these two departments. Hallberg explains that KMH has an outspoken digital approach within the organisation and that he has been given the opportunity to work with a wide range of digital methods such as GIS, laser data, 3D GIS, drones, photo scanning, 3D reconstructions and virtual reality. KMH has set the goal of eventually being fully digital (although without setting a definite date), because of the limitations they see with analogue workflows and the many possibilities with digital ones. KMH has had the opportunity to invest in the digital due to a generated surplus from previous years’ work. The organisation also had a management willing to invest in this development (Interview: Hallberg 2017; L21). This might be one of a few ways to have an organisation engaged in development of digital methods, as a surplus makes it possible to invest in hours for co-workers to do this.

Hallberg continues by explaining that the organisation, management and colleagues are not afraid to try out new directions and engage with the digital development, but also states the importance of a specialist within the organisation to be able to move forward. Colleagues are positive about including digital work but worried that there won’t be enough project hours and want the specialist Hallberg to do the data processing as fast as possible, so they don’t have to. In Hallberg’s own experience there hasn’t been a big technical hurdle to surmount when implementing different tools into the workflows of field archaeology. Archaeologists have for example been able to learn the basics in digital field recording with digital cameras for photo scanning. Although he sometimes experiences communication challenges with the project managers, when they do not necessarily know what they want or how to accomplish it. In the use of several of the digital methods there is a certain amount of planning needed. Project managers do not often have very high expectations of the results produced by the digital work but are often very pleased with the results and
want to include digital methods in their next project. Hallberg describes the project managers as being quite independent and the technical department does not have the authority to simply tell a project manager that a certain method will be included in the workflow from now on. Hallberg states that it would have been better for the development if the decision process of how and when to use digital methods had been controlled by organisation management, then they could have easily decided that everyone was to use this software (Interview: Hallberg 2017).

Even though the personnel might be positive, Hallberg describes limitations within the system of contract archaeology and budget constraints as a bigger problem. When engaged in bidding processes they have tried to create budget posts regarding digital methods in the applications a couple of times, with the aim to try and change the situation. In these cases, the posts were accepted by the CAB and included 3D documentation and/or 3D reconstructions. Hallberg thinks that the CAB and developers all think e.g. 3D is very interesting and useful, but they are not accustomed to paying for it. Hallberg does not know if the public think that 3D models published online are of interest or not, as no dialogue with the public about this issue has taken place. (Interview: Hallberg 2017; L22). To not know how the general public receives digital outputs or who the relevant public actually are, is, in my experience, a very common situation at contract archaeology organisations.

Hallberg states that the most positive effect with the implementation of digital methods is how more powerful analyses can be achieved. With well-structured databases archaeologists can perform GIS analyses in many useful ways with powerful applications creating new possibilities as compared to an analogue workflow. Digital information further creates opportunities for more open data flows which might support cooperation with other organisations and researchers in new ways (Interview: Hallberg 2017). If contract archaeology organisations published their data open and left all the traces from the interpretation process available for scrutiny, then other professionals, or anyone with the right skills, could create their own interpretation process and maybe discover something new. The technical conditions are already there, shown with the IDA workflow for example (see ‘IDA-Instant field Documentation system and Availability’), enabling the creation of an infrastructure where everyone could have access to each other’s data within the archaeological discipline. Hallberg points out that this is something that could have positive effects in the process of knowledge development. The obstacle in achieving a positive development is not technical, but cultural. The sector of contract archaeology does not want to share everything with their competition even though it could create “better” archaeology, Hallberg continues. Open data also creates new opportunities to share information and create new narratives addressing the public which don’t need to wait for the report to be published. With digital tools the archaeologist might share the interpretation process and preliminary results
with anyone through digital media. The archaeologist doesn’t have to, if he/she does not want to, work with the journalist as an intermediary between the expert and the public, often leading to the mediation of misleading information via newspapers, radio or TV. Furthermore, digital data presentations through VR products or 3D reconstructions could work as a complement to the published report and give added value to the receiver. Hallberg states that we could give so much more than a report, if only the conditions were there (Interview: Hallberg 2017).

Hallberg sees a negative aspect with a digital approach, this being that digital data is sensitive to the human factor, mistakes are easily made. Another big issue is the question of how digital data is to be preserved, how it can survive into a distant future. Hallberg sees it as a big problem that no national plan for digital data exists when it comes to database standards and doubts that DAP will solve everything, expectations are low. It is not good for archaeological knowledge production that different actors in contract archaeology have different ways of doing things and do not all use the same software, hardware and standards. It’s not at all certain that digital data produced can be comparable if it is delivered from different companies in various ways, says Hallberg. He states that a standardised collection of data would ultimately give better analysis, where data could be comparable across county borders. This large data analysis could make archaeological digital data more useful and reusable. He also thinks that the business of contract archaeology could collaborate more to drive the digital development forward. Actors could for example hire each other for different digital projects and strive for a common standard of how to do things (Interview: Hallberg 2017).

Concluding Thoughts

After analysing these interviews, I have made several observations. I see the DAP programme as a possible success in several ways, certainly when it comes to making archaeological information more useful in the civil process. The digital archaeological process will be a benefit for e.g. forestry companies extracting information regarding ancient sites to avoid inflicting damage while de-foresting an area, it will certainly make the cultural heritage management of CABs more effective, create a more effective administrative project management within contract archaeology organisations and improve communication with the developers. DAP’s digital infrastructure will probably create a more transparent relationship between digital data and contract archaeology actors, where it will become easier to extract data from a competitor. Future research needs to be done in evaluating whether all these changes will be of benefit for the Swedish market of contract archaeology and in what way. DAP has also highlighted that there are questions that need dealing
with in the future, and that the digitalisation of contract archaeology is just at
the beginning of its development (Interview: Klafver 2017).

But will DAP make contract archaeology better? In one way yes, as discussed
above, but my analysis also shows that it’s not in any way certain that this
development will contribute to increase the value of knowledge production,
coming from contract archaeology, and make it more relevant to society, other
than for the civil process. The system might benefit the civil process, but it can
also be argued that it is only a way to make the process of contract archaeology
a little less uncomfortable for society to handle. The risk here is that the new
system only improves contract archaeology as a cog in the industrial machine,
building a modern society and not considering its role as a knowledge producer.

E-archive

Smith says that the quality of digital data delivered to the E-archive will mostly
depend on what the contract archaeology organisations deliver and what the
CABs accept. Larsson describes that in the new register KMR the CAB holds
the position of deciding whether data can be published or not, if the quality of
data is good enough. There will be no regulations regarding formats, database
structures or demands that data must be traceable, aimed at the contractor
(Interview: Larsson 2016; Interview: Smith 2017).

I don’t think it is a major problem that data must be approved by the region’s
CAB before being published in KMR, it’s good that someone works for high
data quality so that the knowledge production coming from contract
archaeology can be secured. The issue here, lies in the question of transparency,
or lack of, when it comes to the history of that data: the context surrounding its
creation in the trench, all the editing being done after field work and the
representation of it in the report. If all these events, in the life of data, were to
be documented and traceable, then interpretations could be challenged, or a
future researcher might be able to take them further. Digital data has the
advantage of being traceable if we want it to be. The database could contain all
the editing steps leading back down to its birth, if we created the database in
that way and the narrative that is the report could still exist, but not as the only
narrative.

In my view it is noteworthy that Digisam has not had a larger part in the DAP
programme so far, as they have particular expertise when it comes to issues
regarding long-term preservation. Digisam would probably have been a great
resource in the work with the E-archive and it’s a valid question to wonder if
the E-archive would not have been better formed if the long-term strategy for
preservation of digital data had been made in cooperation between DAP and
Digisam. One can argue that the principles for handling digital information are
the same whether it is art or archaeology (Interview: Summanen 2017), and that
Digisam might be an important asset in the work with the digital E-archive
moving forwards.
Primary target groups for DAP are governmental authorities and archaeological companies. Others, like academia or the public, are not prioritised, but DAP believes that they will benefit from the new systems as well (Interview: Larsson 2016). I hold this statement questionable when it comes to academia seeing KMR as a useable resource. It will be easier for researchers within academia to get hold of data, that’s true, but big data analysis, that could make the digital development take a huge leap in interpretation and dissemination of archaeological results, is not easily achieved. That kind of research needs structured information (Löwenborg 2018:41). No advanced big data analysis, with for example a research question concerning the finds of Neolithic pottery in today’s Sweden can be done if data is not comparable. This limits the potential of digital data to a large degree and sends little hope to the future consumer of archaeological data. Summanen is also critical of the fact that DAP hasn’t included the research sector in the work with the digitalisation of contract archaeology. By doing so, they would not only have had a more theoretical perspective in the development but also the possibility to build networks for future development (Interview: Summanen 2017). Future solutions for archaeological digital data would benefit by taking these issues into consideration.

3D data
What is not included in the DAP solution, at this stage, is all the archaeological 3D data (Interview: Larsson 2016), produced at an increasingly higher rate than ever before. 3D data comes in many shapes and the sector of contract archaeology is experimenting and learning much about it (Börjesson & Huvila 2018:24). Photo scanning, photogrammetry, laser scans of objects or landscapes, 360º media and virtual reconstructions of interpretations are frequently used, but the question remains what will happen to all this data and who will take care of this vast amount of digital data produced. For a field archaeologist today, this data production is a natural part and a large asset for analysis, a method for field documentation just as any other data recording, such as geodatabases. 3D data is also more often a part of the geodatabase, like in Çatalhöyük (Berggren et al. 2015; Dell’Unto 2016; Taylor et al. 2018), and will probably be even more so in the future. The E-archive is supposed to take care of and secure field data, but no solution has been presented for 3D data yet. In fact, there are no public archives currently accepting 3D data and the kind of data archaeology produces “[...] is by far exceeding what the archival institutions are capable of accepting.” (Börjesson & Huvila 2018:24, 29). There is a real danger here that vital information about archaeological contexts might be lost, and that an information gap will be noticeable in the future when looking at this period. There is a hope that contract archaeology organisations will save their own 3D data. Contractors are mostly saving data on their own servers for future use, but not leaving any archive guarantee for a long-term preservation
(Törnqvist 2015). What will happen when the servers are full? There are no national guidelines of how to take care of 3D data or raw data like photos or point clouds, used to produced it.

What the future holds for the digital data for contract archaeology is unclear, but these case studies show that no sufficient strategy for the repository and conservation of digital data exists at this stage. Who will be the recipient of data and what measures can be taken so that data is not forgotten, are unanswered questions. NHB wants to make the system for managing Swedish archaeological digital data as general as possible but states that there is no possibility to build a system for every possible scenario. One cannot know how data will be reused and by whom. Smith says that the most important measure, at this stage, is to secure the preservation of data and see that data is properly managed on an ongoing basis. Primary digital data is society’s replacement for cultural heritage sites destroyed during excavation (Interview: Smith 2017; Larsson et al. 2017).

Challenges
The challenge for the Swedish sector of contract archaeology is first and foremost not the technical side of digitalisation. There are many digital professionals on every level doing a great job with building infrastructure, guidelines, workflows and developing digital methods. What seems to be the biggest challenge for the industry is the cultural change in attitudes that must come before digitalisation can take a real leap into a relevant future with society included. This is something that all six interviewed individuals touched upon and see as an issue that needs more work. The contract archaeology actors also recognise cultural challenges within their organisations, such as establishing good communications and getting everyone on the same page. There’s also often a technical hurdle to be overcome for a project and its archaeologists or for the colleagues within the organisation (Interview: Carlstein 2017; Interview: Hallberg 2017).

Limitations to Change
The processes of digitalisation can be viewed as being revolutionary and, in archaeology, digitalisation is often described as a “digital turn” (Costopoulos 2016; Huvila et al. 2018; Petersson 2018:70) that is changing (or has the possibility to change) the discipline to its core. When looking into these matters, a picture manifests itself where this might be more of a truth for large international research projects, than for the sector of contract archaeology. The same description looks a bit different for contract archaeology and it’s true that organisations incorporate a wide range of digital methods into their workflows, but the possibilities to go all the way look very different due to the infrastructure of the system. In a research project the possibility for development projects can be greater and a natural part of research, here issues and concerns can be sorted
out between individuals with different responsibilities and aims. Even though this might be a complicated task in itself, it’s not a regulated system with laws and guidelines that need to change for digitalisation to flourish. Here, it must be acceptable for the CAB and NHB that contract archaeology actors create, share, analyse and store digital data in certain ways. For the companies developing digital solutions they also need to find money for it, whether it derives from a company’s revenue, budget posts in a project application or through research funding.

In short, a regulated industry doesn’t automatically promote the freedom needed for digital development work. It might be true that the capitalistic system of a market-based contract archaeology “[…] dictate(s) the form and means of archaeological work undertaken in most countries of the Global West, and, by extension, their digital archaeologies as well” and that the system

“[…] have an effect on the types and locations of digital work that can be done, the modes in which digital communications on archaeological subjects can take place, and the long-term sustainability of digital archaeology in general. (Richardson & Lindgren 2017:144)

But I suggest that a semi-regulated capitalistic system doesn’t mean it can’t be changed from within. As seen in the example of KMH, digital approaches might be included in the project application and the costs for it accepted, the archaeologists just need to do it.
Sandby borg – a Case Study of the Digital and Virtual

The aim of this case study is to approach the research questions of this thesis regarding how digital data might be understood within the context of knowledge production and communication in archaeology. But also, to explore where the potential in digital communication lies and how archaeology can make use of it (see ‘Research Questions’). How might archaeological knowledge production interlink with communication and what are the possible consequences of doing so?

To accomplish this, I use the archaeological site at Sandby borg as a forum for experimentation, applying digital methods and evaluating them. With the applied research method, I can collect data concerning digital processes of archaeological documentation, interpretation and communication. These results are used to suggest an approach moving forward, working with the development of digital methods and new perspectives on the uses of archaeology. The aim is to develop methods and ideas in the context of a research project, to eventually implement them in the sector of contract archaeology.

Sandby borg is an archaeological site with a special history connected to it, and a research project (L27). ‘Frozen in time – histories of life and moments of death at Sandby borg’ (2016–2018) included two parts: archaeological excavations and theoretical research on the theme of “difficult heritage”. Managed by the Dept. of Museum Archaeology (MA) at Kalmar County Museum (KCM), the Sandby borg project is a vital part of the organisation’s digital development as well as of the research attached to it.

The case study of Sandby borg consists of two parts where several digital applications are put to use, some of them represent digital development before this PhD project started as well as present undertakings with direct relevance for this research. The first part, ‘The Digital Sandby borg’, presents a case focusing on an organisation’s development of digital documentation workflows and communication through dissemination, within the context of this research project. The second part, ‘Sandby borg – A Virtual Connection’ deals with more specific questions aiming at communication through emotional storytelling. The case explores how archaeological source material might contribute in making an impact by using VR and directly relates to the part of the Sandby borg research project dealing with issues concerning “difficult heritage”.

Background to the Archaeological Site

Sandby borg constitutes the remains of a ringfort situated on the island of Öland, just off the south-east coast of Sweden. Sandby borg is one of Öland’s ancient
ringforts of which there are remains of at least 15 scattered around the island, many dated to the Swedish middle Iron Age, c. AD 300-600 (Stenberger 1933, 1966; Näsman 1997; Fallgren 2009). Sandby borg is the only ringfort situated next to the seashore of the Baltic, on the island’s east coast (fig. 5). The Öland ringforts are of a circular or oval structure with stone walls surrounding houses within (Stenberger 1933; Borg et al. 1976; Alfsdotter et al. 2018:424). At site today, there are no visible stones from these house foundations above ground. Research suggests that these forts were raised as a collective effort by families/clans, living on farmsteads in the surrounding area. The houses within were probably not meant to be used as permanent living quarters all year, but primarily during times of crisis or when there were official and possibly religious matters to attend to (Fallgren 2009:40, 49).

Several spectacular discoveries have been made in Sandby borg, making it a unique archaeological site. It all started after the discovery of looting pits in 2010. This led the CAB of Kalmar commissioning a metal detector survey on site to retrieve and protect any valuable artefacts still underground. The campaign resulted in the discovery of several extraordinary finds such as five treasure caches containing exclusive gilded silver broaches as well as beautiful beads and finger rings. The treasure finds, dated to the Migration period (AD 400-550), seem to have been carefully hidden inside the houses of the ringfort (Victor 2015b; Alfsdotter et al. 2018:424). Since the discoveries in 2010 and up until 2018, MA has conducted archaeological excavations of c. 9% of the area inside the outer wall of the ringfort (Dutra Leivas & Victor 2011; Victor 2012; Victor et al. 2013; Victor 2015b; Papmehl-Dufay & Alfsdotter 2016;
Apart from treasures, something completely unexpected was also found during the first field campaigns, human skeletons. The archaeological traces suggest that Sandby borg was mainly used during the Migration period and that there in the later part of 400s or early 500s, a massacre took place that killed the inhabitants, leaving them where they fell. Remains of at least 26 humans (mostly young males but also children), have been found on the floors in the houses and in the streets (Alfsdotter 2018), but there are probably many more to be discovered. Around a couple of hundred people could have been in the fort during the massacre. No one ever buried the dead or came back for them and the archaeological results suggest that no one could or wanted to dwell on the site after the massacre, for any sort of extended period. When the massacre occurred, there were troublesome times all over the European continent due to the fall of the Western Roman Empire (AD 476). On the island of Öland there seems to have been a power struggle which, in the case of Sandby borg, had a violent outcome and it’s possible that the ones responsible for the massacre became the new political elite (Victor 2015, 2015b; Papmehl-Dufay & Alfsdotter 2016, Alfsdotter et al. 2018:433).

House of the Dead

The first house to be fully excavated within the ringfort was House 40, this is also where the archaeological data has been processed the most. This means that the focus on many of the digital products coming out from the project has been on the archaeological material from this house. For example, the house has been virtually reconstructed in 3D, based on the archaeological remains unearthed during excavations (Gunnarsson et al. 2016).

House 40 was excavated in different phases during the period 2011-2015. Artefact finds include, among many others: loom weights, pottery, a roman gold coin, a large millefiori bead, a lancehead and a treasure cache with e.g. a gilded silver broach and beads. The finds suggest an influence from, and even direct contact with, different parts of the European continent (Dutra Leivas & Victor 2011; Victor et al. 2013; Victor 2015b; Alfsdotter et al. 2018).

Apart from the features and artefacts, there have also been discoveries of human remains of 9 individuals in House 40 (fig. 6). The osteological analysis shows traces of violence from sharp or blunt weapons, such as swords, axes or clubs, which led to the individuals’ deaths. Those killed were all young at the time of death, the oldest in their early 20s and the youngest being just an infant between 1.5–3 months. Another young child was only 2–5 years when slain (Wilhelmson 2017; Alfsdotter et al. 2018:428f; Alfsdotter 2018).
A Difficult Heritage

The term “difficult heritage” is often used when heritage sites can be linked to human-created horrific events like deaths or other catastrophes. Events that can be difficult to understand or reconcile with (Logan & Reeves 2009; Macdonald 2009; Lehrer et al. 2011). Places related to difficult heritage may not only be restricted to modern conflicts, but might also include prehistoric sites like Sandby borg, where violent deeds have left a scar on the heritage (González-Ruibal & Hall 2015; Wollentz 2017:218). The events that took place at the Sandby borg ringfort qualify as such a “difficult heritage” with the topic of a massacre as the main narrative. It further challenges the ethical aspects and decisions concerning how this story should or should not be communicated. How to visualise and create storytelling with archaeological evidence of a massacre in Sandby borg with relevance for present audiences?

The Digital Sandby borg

The Sandby borg project has been a forum for field experimentation and development of digital tools since the project began excavating larger trenches in 2013 (Victor et al. 2013). Before that there was also underground mapping of the fort structure done digitally, with ground penetrating radar (2010–2011). The aim was to determine the plan of the fort, where the house remains might be located more precisely (Viberg 2012; Viberg et al. 2014). The result from
these campaigns became an important asset while planning excavations in the following years. In 2016, this interpretation could be further updated by analysing pictures taken with a drone. The very dry spring and summer Öland experienced that year made it possible to detect the stone structures underneath the turf, which had dried out the grass to a higher degree than the surrounding area, making the house structures visible to the naked eye (fig. 7).

Figure 7. A dry spring/summer season made the house structures in Sandby borg visible for to naked eye. The orthophoto was taken with a drone. Photo: Kalmar County Museum.

The first digital experiments in the trench were conducted in collaboration with Lund University (LU) and archaeologist Nicolo Dell’Unto, during the field campaign 2013 (Victor et al. 2013). The work included the use of photo scanning techniques and IBM in the field, where photos were taken from all angles and post-processed to high resolution 3D models that were integrated in a GIS. This 3D-GIS became a powerful new digital analytic tool and the 3D models were e.g. used by osteologist Helene Wilhelmson as an analytical tool, studying the taphonomy of the individuals. This method called “Virtual Taphonomy” had never been used in this way before and marked pioneering work. The 3D models produced in the trench represented not only separate features but also the whole excavation at different stages. This made it possible to contextualise the osteological results with spatial data, creating opportunities
for a reflexive method leading to new interpretations of the archaeological record (Wilhelmson & Dell’Unto 2015; Wilhelmson 2017:139).

IDA – Instant field Documentation system and Availability

IDA is a concept developed in 2014 by MA at KCM, and this has meant that the workflow for archaeologists documenting in the field is now totally digitised (Video pres. 2016: L24). Together with my colleague Nicholas Nilsson, I had the task of finding a suitable solution that could be used to establish a fully digital workflow. At that time, the ArcGIS platform (L5) was expanding with many new products, including apps for smartphones which were connected to cloud services. It soon became clear that these products could be adapted to an archaeological workflow. The first step was to transform existing databases for features and finds (Intrasis, Access) into a new geodatabase that could be used in the application Collector for ArcGIS for data collection. The need to become digital derived from MA’s contract archaeology projects, where the wish was to become more efficient in field recording and to save time during excavations. It was decided that Sandby borg could be a good place to test the system, before gradual implementation within contract archaeology projects could take place.

Since the creation of geodatabases, IDA has expanded to include more than digital data registration in the field. IDA is today a fully digital workflow where data is “born digital”, collected with a smartphone or tablet. Data can be instantly shared through a cloud service, giving all personnel on or off site the ability to view data and follow the progress of the excavation. The cloud service (ArcGIS Online), also enables data to be shared openly online for anyone to view in real-time. This encouraged the team to develop the A (Availability) in IDA and the creation of online products for external use, exploring how archaeological data could be combined with storytelling. The aim has been to create interactive interfaces for different target groups, such as, for example, archaeologists, the CAB, the developer or the public.

Much of the IDA workflow is an off-the-shelf solution based on the ArcGIS platform, but also includes photo scanning methods and software like Agisoft Photoscan (L3). Drones are also becoming a natural part of the workflow, with aerial photographs building a mosaic, analysis of the topography by creating 3D models or picture analysis can be achieved (fig. 5, 7).

Digital Communication

The IDA workflow made it possible to create a new type of digital communication, which for the last couple of years has been the focus for development of the system. Explorations of how IDA could be a digital communication tool, among others, began with several collaborations. Following on the methodological development of digital field recording 3D-GIS and IDA, there were a couple of co-operations with the Swedish Exhibition Agency. One project enabling the gathering of intelligence, from Sweden and
abroad, regarding how digital outreach was perceived within the cultural heritage sector. The results were used to develop a strategy for the continuation of digital communication of cultural heritage sites in general and Sandby borg in particular (Gunnarsson et al. 2015).

A Three-Part Concept
The strategy for digital communication in Sandby borg has three main parts interlinked to each other: the site, the museum and the web (fig. 8). It was acknowledged that a visit to the site itself could be enhanced with the help of digital tools, but that tools could also benefit from being interlinked with an exhibition at the museum, in contact with the site, and online resources. This was an important alternative for those not able to visit Sandby borg or the exhibit at the museum. The three parts work under slightly different conditions and can be valuable for user experiences in different ways, attracting a diversity of visitors with various expectations. Some might not be able to visit the site at all, for them the museum might be more accessible. At the exhibition they will still be able to come closer to the site and what’s happening there, through digital media in combination with the exhibition. If the visitor doesn’t have the chance to visit the site at Öland or the county museum in Kalmar, they should still have the opportunity to experience the site closely online (Gunnarsson et al. 2015). On site there was a so-called “info station” installed that offered analogue and digital displays with Wi-Fi connection through a system which powered the screens and the Wi-Fi from two solar panels on the roof. In this way, tourists with no local Internet connection could still make use of the online mediation tools (L25). At KCM, an exhibit displaying Sandby borg and its story was created, including a computer with online resources available, such as the Sandby borg website, 3D models and web apps. The same products also worked
on visitors’ computers or smartphones and made the site available from anywhere as well.

Figure 8. A three-part concept for digital communication of Sandby borg where the elements Site, Museum and Web are interlinked with one another.

Web Apps and 3D reconstructions
In a following project, in collaboration with the Swedish Exhibition Agency and KMH, web applications were produced, partly to solve the problem of poor information being mediated on-site. These were position-based digital mediation tools consisting of a native app, where a visitor could experience a map-based tour of the site, with the visitor’s own position being given in relation to the archaeological data. Another presents Sandby borg and its relation to the European continent (apps not up and running). Within the same project the whole ringfort was virtually reconstructed. 3D documentation from the field through IBM had built a good base of 3D models which became important resources in the creation of a 3D reconstruction of the whole fort, in upcoming projects as well (fig. 9). There was also a separate 3D model created for House 40 of which there is (in 2018) a stylised version, available online (L26) (Gunnarsson et al. 2016).

Opening the Archaeological Process
Important arenas for dissemination of archaeological results and also the digital products are the Sandby borg project’s social media platforms and its website (L27). In 2013 both a website and a Facebook page were launched, today the Facebook page has more than 4000 followers. These and other forums such as Instagram and Twitter have become part of the daily communication with the
public. The website worked as an online portal with information about the project but also links to other locations on the web. The visitor could now access and download the published reports and view digital interactive elements like web apps (Papmehl-Dufay & Söderström 2017). One of those web applications was a presentation of a 3D reconstruction of the fort in a GIS environment (fig. 9, L23). ‘Sandby borg in 3D’ combined a virtual reconstruction of the site, positioned in its surrounding landscape, with archaeological source material coming from the excavation data of that year (2016) and some previous results. The user could see the geodatabase for field recording or discover what archaeologists thought the fort looked like. The 3D reconstruction is also a GIS database with data editable when new results emerge, which might change the look of the reconstruction. Data posts like the individual houses could hold additional info like text and photos or links to other online information.

![Sandby borg in 3D reconstruction as a GIS tool. Screenshot from Sandby borg website L27.](image)

As part of the work with online tools, an idea emerged that the archaeological process could become more transparent and data shared externally in real-time with the IDA system. Discoveries of finds could be displayed, interpretations shared, and preliminary results open for anyone to look at. The users wouldn’t have to wait for the report to find out what had been found and the hypotheses regarding those findings. In 2016, the Sandby borg project produced its first live map where archaeological finds and features were shared as soon as they were recorded in an online interface embedded in the website. The output consisted of the archaeological database, which was combined with some additional info like daily ortho drone pictures, explainable icons, the excavation plans and more
(Papmehl-Dufay & Söderström 2017). The year after there was a second live map produced for the field campaign of 2017. Building upon what had been learned and using the same concept as in 2016, developing it further, the product ‘The Explorer’ was produced (fig. 10, L28). The information flow was refined from the previous year and included more archaeological results from previous excavations, legacy data born digital. Many elements were the same as in 2016 like the open database and daily drone pictures of the trenches. A part where additional info was interlinked with the database and the map was also included. These “mini stories” were manually added and contained the latest news from the trench presented in video clips, text, pictures or 360º panoramas. The content was published elsewhere, for example on Instagram, or attached directly to the database. The “mini-stories” were supposed to add some value and give the archaeological data a voice in the creation of a narrative. All the different functions of the live map created various layers of information, where users could decide how deep they wanted to dive into it.

![Figure 10. ‘The Explorer’. User interface (smartphone) created and shared live during the field campaign 2017. The database is viewed as yellow dots, but also polygons marking layers can be seen. The “mini-stories” are highlighted with larger white icons. A base for the map is the daily drone picture, making the remains visible. Screenshot from L28.](image)

During the excavation, ‘The Explorer’ had just under 200 views a day (fig. 11). The user statistics show an interest in this kind of product and it also becomes clear that the peaks in the graph correlate with the marketing of the product through social media and the website. When the map was updated, the traffic in
the web app also increased. It was further observed that when interesting new discoveries were shared on social media the number of visitors increased.

![Graph showing views of 'The Explorer' during excavations in Sandby borg 2017. 184 views/day in general and 487 views at most in a day. In total there have been more than 7000 views and counting (Edited screenshot from ArcGIS Online user statistics).](image)

The live concept and other web apps have also been implemented at projects within contract archaeology, where the database is viewable for anyone online and combined with additional info and storytelling. The web products in general are perceived as a complement to other communication channels like social media, physical guided tours on-site and other uses of additional media such as TV, radio or newspapers. Information coming out from this open concept might be valuable for off-site supervision by archaeologists, the CABs, developers or the public, if developed further. An open archaeological documentation and interpretation process might give opportunities to involve a third part in the reflexive process (Hodder 2003). Even if target groups, in these cases, are not more specific than “the public”, the value consists of showing other professionals or the public, that these channels can be open, even in contract archaeology. Third parties could make spatial observations of data before archaeologists themselves have had the chance to do so and discover new patterns. Representatives from the public could be able to contact the project through e.g. social media or, telling them of their discoveries. Even better would be an interactive tool where they could add data themselves, which could be interpretative in nature and open up new ways for dialectical processes, that were not there before. With an open database, archaeologists could also ask for help with for example searching the Internet for styles of pottery that the field archaeologist hadn’t defined yet. The archaeologist could point the direction if needed, “– Would you mind searching in this online database for pottery or check this literature?” This kind of crowd sourcing could be engaging and the participation of the public rewarding for the project, without interfering with the professionals’ results but merely adding on more layers of alternative knowledge to it, parts adding to the whole.

Further research stresses the need to investigate how these new digital infrastructures can be used to create interfaces that people want to use. A
qualitative investigation of the user’s perception and usage of online interfaces and live products would be valuable. If a product like ‘The Explorer’ for example could be combined with a questionnaire, information about the users and their experience could be collected, this would be valuable basic research for further development of such products.

In sociology there has been a call for a “live sociology” which could study living data, when data flows and not afterwards. This enables new innovative ways to study processes of digitalisation which can be open, critical and public. In this way, lifeless descriptions of life, with quantitative or qualitative analysis tending to dehumanise data, can be challenged (Back 2012; Back & Puwar 2012; Lupton 2015:46f). A similar approach could be applied by projects within digital archaeology to study the effects and possibilities of digital live communication with the public.

Sandby borg – A Virtual Connection

Here I present the second part of the case study. ‘The Digital Sandby borg’ was about the archaeological documentation process and how this could be opened, this part is about how archaeological data can be used for creating an impact, within the user, through digital communication.

This part of the case study could be conducted through funding of the project ‘Sandby borg – A Virtual Connection. Creating a Relevant Dialogue Through Cultural Heritage with Virtual Reality’. Carried out in 2017, the project was a collaboration between MA at KCM, RISE Interactive C-studio (L29) and Linnaeus University (LNU). Using the Sandby borg narrative, the project studied how communication through archaeology and with the use of VR might be conducted. The aim was to convey knowledge through emotional storytelling but also to initiate dialogue with the public via their experiences in the virtual world (Gunnarsson et al. 2018:10).

When it comes to emotional storytelling using digital solutions, some pioneering and inspiring work is being done by the ‘Emotive Project’ (ongoing 2016-2019). They aim to change the impact a visitor gets from heritage locations, where they feel that the narrative told can often be narrowed down to meditation performed by experts explaining facts. The Emotive team states that the emotional part is often concealed in storytelling coming out from heritage management. Their approach “works from the premise that cultural sites are, in fact, highly emotional places.” Cultural heritage sites are not just preserved memories, with knowledge of the past connected to them, these places are also strongly interlinked with human emotions both from the past but also in the present. Emotive want to create drama-based narratives that combine information about the site with emotional storytelling (Roussou et al. 2017; L30)
The project ‘Sandby borg – A Virtual Connection’ had a similar approach and aimed to study how communication of difficult topics in the present could be actualised through the story of the Sandby borg massacre. By creating a drama-based narrative, the project used storytelling through VR to create an immersive user experience that could potentially make a connection with the user on an emotional level. The VR experience could be used as a catalyst for thoughts and discussions on difficult topics in the present in relation to “difficult heritage”. As a result, the project produced a VR demo that was presented to the public at KCM in October 2017. User testing was performed and completed with the specific aims of narrowing down possible future target groups for further development of VR experiences, and to find out how digital storytelling could be developed, if emotional storytelling were to make an impact. The VR demo can be downloaded for free from the Sandby borg website (Gunnarsson et al. 2018; L27).

The project observed that what is currently lacking in VR products coming out from the archaeological sector is human-centred storytelling. Virtual reconstructions of the past tend to be without humans, and these “dead worlds” make it hard to connect with the heritage or data presented (Pujol-Tost 2008). A virtual reconstruction does not necessarily encourage the user to interact with the environment. If not part of a story, there’s nothing to relate to, nothing to memorise, nothing to connect with on an emotional level. In this project the virtual reconstructions of houses or artefacts were not the main event, but merely the backdrop. The project’s research questions were (Gunnarsson et al. 2018):

- How can VR be used as a communication tool and work as a link between difficult heritage and today’s society?
- Can the user’s level of understanding and empathy be increased through such an experience?
- Which target groups is the VR experience suitable for?

**Archaeological Source Material**

Today 3D visualisation is a natural part of the archaeological documentation process, where image-based modelling and virtual recreations are common, giving the modern archaeologist new powers of interpretation (Börjesson et al. 2016:6) and communication. This data production also opens for possible reuse in other applications such as VR. The Sandby borg project has produced an amount of data including 3D models and GIS-data, some imported into the VR environment.

Much of the material used to create the VR demo had already been produced in previous projects. Either as part of the documentation process during excavations in Sandby borg or as virtual reconstructions of the site and its contexts (Gunnarsson et al. 2016, 2018). This was a great advantage and the
reuse of data models took the VR demo further than would have been possible otherwise within the frameworks for this project. Focus could now be put on the user experience instead of time-consuming 3D modelling, even though some features had to be created from scratch (fig. 12).

![Image](image.png)

Figure 12. A lancehead as seen in the VR Demo created from scratch shown here as an example of artefacts visualised with 3D modelling. ‘In game’ screenshot.

**Demo Event at Kalmar County Museum**

In October 2017 the finished VR demo was presented to the media and then tested on volunteers (fig. 13). After they tried the experience, each participant of the VR event was asked to fill in a user questionnaire, which helped us gather data about who they were and what they thought of the VR demo. Thirty-three volunteers participated in the event and in completing the form afterwards. They were invited through social media and traditional media, some of them had also dropped in during the day. The questionnaire had both quantitative and qualitative questions where they could grade their answer according to a scale with five values and another section where one could elaborate in text (Gunnarsson et al. 2018:36ff).

One of the project aims was to see if new target groups could be attracted with the use of VR technology, people that don’t visit museums on a regular basis. Most of the participants were over 50 years old, an age group also well represented in visitor numbers at the museum. But the VR event also attracted people between the ages of 18 to 50 (41%). This is regarded as a positive result since many in this age group took time off their daily work/routine to come and try out the experience. The many older people could more easily make time
during working hours since many of them were retired. A total of 70% of the participants were female and 30% male. (Gunnarsson et al. 2018:38).

The answers to the qualitative questions gave more information regarding who the test persons were and what they thought of the experience. Most of the participants visit museums now and then and have some knowledge of the Sandby borg story. Many are fans of the project and wanted to participate in this new experience for themselves. But there were also participants who didn’t know that much and wanted to learn more. In each case most of the test persons felt that they learnt something new, to some extent, and felt a greater understanding of the events that took place in Sandby borg, than before. With a few exceptions, most of them had not used VR equipment before. Even so, almost no one felt the effects of VR sickness or found the hardware difficult to use. The majority also thought that there was an added value in using VR compared to other media because of the interaction and immersive experience (Gunnarsson et al. 2018:38).

**Sandby borg VR demo Scenes**
Here follows a presentation of the scenes in the VR demo that the volunteers experienced at Kalmar County Museum (to download the demo see L27)
• The excavation
The user finds themselves at the archaeological excavation of House 40 and can see the ringfort remains surrounding them and hears sounds from working archaeologists. Standing in the trench, the user is given a tutorial showing them how to use the VR equipment in the game. After a while a portal transports the user to the next scene.

• House 40: Remains of Daily Life
The user finds themselves, once again, in House 40, but this time not as part of the excavation but in an alternative reality where the house is still in use, virtually recreated. The user’s hands have become light particles, just as the objects which the user can interact with have. There are various items available for the user to discover, including a standing loom, a shelf with different ceramic pots on it and a coin. The soundscape is a mix of a background music track, environment sounds such as fire crackling and interaction sounds. The scene gives clues to the daily life in Sandby borg, without the living attending.

• House 40: The Battle/Massacre
The environment and the soundscape mood become darker. There is banging on the door. Interaction with objects stops and the user checks what is going on. When approaching the door, the light fades out and the sound changes to a battle alarm. Turning around the user sees silhouettes of standing human figures. Frozen in position a scene is played showing the inhabitants being slain by the attackers. Strong emotional sounds play, a female voice screams louder and louder until everything stops. When the user approaches lights in the inner part of the house, skeletons from the excavation become visible on the ground and a narrator’s voice describes the cause of death and age (in Swedish). The user can then explore the archaeological remains for themselves.

• The Revelation
When the interactions with the skeletons are finished, the front door opens, and the user is encouraged to walk outside. Finding themselves on a street, in a ringfort, the user sees other human silhouettes appear with light particles moving out from them. It’s raining, and the music has changed to a more ambient track. The perspective has now shifted, and the realisation dawns that the violent deed in House 40 was not isolated, but part of a larger event.

• Final Scene
The user is starting to levitate off the ground and is soon hovering over the ringfort. Scale is shifting once more, and the user can now see the whole fort from above and observe many human figures representing the dead everywhere. A massacre has taken place.
The strongest emotional impact was made by the battle scene/massacre (21%, fig. 15) and the following realisation that there were so many victims (14%, fig. 16). Flying evoked strong emotions of it being real for many users (18%, fig. 17) who felt that they were really flying, some even experiencing the feeling of vertigo. Also, elements like music, the sense of discovery, being part of a different reality, the skeletons and the rain were mentioned as reasons for heightened emotions among the users. About 4% didn’t feel any emotional response at all from the experience (Gunnarsson et al. 2018:40, fig. 14).
Figure 15. The battle scene/massacre. ‘In game’ screenshot.

Figure 16. Some of the users felt emotions of melancholy/sadness over the SB inhabitants’ fate. ‘In game’ screenshot.
A Virtual Connection

The idea of this project was not solely to tell about the past, it was to try and make a connection with the users in the present through the past, in this case the Sandby borg events. The idea was that if an emotional connection could be made, the visitor would not only have a valuable learning experience about the past, but more importantly it would create something for the visitor that could potentially have an impact in their own lives and have value for them in the present. It might also give resonance for how the audience will engage in the heritage site onward. Sara Perry through others states that:

*When audiences connect with sites individually or intimately, lasting remembrance (Park and Santos 2017), personal restoration or transformation (Packer and Bond 2010; Smith 2015), and care for protecting and preserving the heritage record can manifest (McDonald 2011).* (Perry 2018)

Laurajane Smith has conducted almost 4500 interviews with visitors of museums, heritage sites and exhibitions. For her, it has become clear that a visitor experience can not only be explained as just a transfer of knowledge. Emotions are always a part of the equation and affect how the heritage experience is perceived (Smith 2014; Smith & Campbell 2015:2). One of the most important and frequently recurring emotions for many visitors is empathy. The feeling of empathy is often connected to the feeling of “being there”, being a part of the heritage, to hold a real artefact or to visit a heritage location. Smith and Campbell state that empathy made visitors reflect upon the stories and their
own connection to them (Smith & Cambell 2015:5f). This sense of presence (Riva et al. 2009; Pujol-Tost 2017) might be key in achieving a virtual connection to heritage. There is a challenge in reaching a high level of impact or presence in a virtual world even if the digital tool of VR is powerful. Giuseppe Riva and others state that:

1) To induce maximal presence, a mediated experience has to include recognition of the specific purpose of the user. If the developer is not able to identify the specific objective of the user it will fail in supporting his/her action, reducing the level of presence. 2) To induce maximal presence, a mediated experience has to identify and support the specific tools that mediate the activity of the user. Most of the activity of the user is mediated by physical and social artifacts. The developer has to identify and embed in the virtual reality system features to support the action of the user effectively. (Riva et al. 2009:10)

In Sandby borg the emotional relationship to the site is special. Gustav Wollentz conducted interviews with elderly locals from the vicinity of Sandby borg, asking them of their relation to the mythification of the site. The research wanted to investigate whether the massacre could have left a memory that lingered in people for over 1500 years. Results show that they mostly have pleasant memories in relation to Sandby borg, growing up, and that the site became a place for avoidance seems to not have survived to present time, within these individuals. Another interesting observation Wollentz made was that the elderly was not necessarily emotionally attached to the story at first but were instead intrigued by the mystery and their possible genetic relation to the inhabitants of Sandby borg. But after a more tangible storytelling, getting into the fate of the murdered individuals, they react with emotions of empathy or horror. Wollentz also observed that it seems to be easier be become emotionally attached to the events when visiting the site. The emotions connected to the stories of the events within people are two-fold. They are intrigued by the mystery and want to help solve it, like a murder mystery of some crime novel. This excitement often co-exists side-by-side with the “difficult heritage” of Sandby borg (Wollentz 2017:215f).

With this example I have been able to show that digital storytelling and a VR experience can connect to users on different levels. Many of the answers coming from the user questionnaire show that an effect of feeling a “physical” connection to the actual site is possible in a virtual world as well, many felt that they “were really there” (Gunnarsson et al. 2018). In the creation of the VR experience, both moments of detective mystery solving and emotional storytelling about the massacre were included, following the observations made by Wollentz about the mixed emotions connected to the site. My study shows
that a mixed connection to both of these emotional triggers created an effective storytelling tool, for some of the individuals, which connected to different parts within the user. Another interesting observation I made, was that for many of the participants, the VR experience was an intimate one and they didn’t want to follow up the experience by discussing it in groups, something that the project management had initially thought could occur. Most of the users wanted to discuss things with a friend or contemplate on their own. This intimate feeling didn’t seem to encourage a sharing of the emotions that emerged during the VR experience, which might be related to the fact that individuals are just that, individuals. They are not users, subjects or participants with one mind that reacts the same way to the same experience. Most of them have agency over their emotions and can control how feelings are expressed. How they react outwards themselves and facing others, depends on who they are and which context they are a part of (Smith & Campbell 2015:18).

The project was a success in terms of how it could make an emotional connection with many of the users. How strong this connection was varied among users, some felt almost nothing, and others were very affected after the experience, showing emotions of empathy and sadness (Gunnarsson et al. 2018). Several people were grateful for the experience and how it made them feel. It can be argued that a part of this success was due to the immersive experience, where the feeling of “closeness” to the place, finds and the dead individuals was effectively achieved in the situations where the user felt empathy. VR was a powerful digital tool when it came to increase both the level of understanding for the Sandby borg events and empathy. The VR experience could affect the user both physically and mentally in several ways, which created a virtual connection to the story and possibly a lasting memory.

**Concluding Thoughts**

What the case study of Sandby borg and this chapter has illustrated is that there are many different approaches to the digital and depending on the specific need and/or question the researcher has, the digital tool and the result of using that tool will differ. If the aim of the archaeologist/project (as in ‘The Digital Sandby borg’), is to collect data that will strengthen the analysis and to spread information about the excavation, one approach is needed. The potential impact of a transparent archaeological interpretation process and digital tools for multivocality like crowd sourcing, could not be established at this stage but might be part of further research. The VR project gives another perspective and fuels the discussion of how archaeological source material can be used for a relevant dialogue within society. By interlinking the results from archaeological knowledge production like databases, 3D data and theories, with powerful communication tools like VR, a connection with the user/visitor is achievable. This case study shows that such a connection is a possible consequence of
activating archaeological digital data in a new manner. The research further suggests that another consequence of doing so is that the individual feels closer to the archaeological site and becomes a resource that is willing to contribute.
This chapter is a reflective one where I build my discussion upon earlier chapters and the results presented there. Sir Mortimer Wheeler once wrote: “It is the duty of the archaeologist, as of the scientist, to reach and impress the public, and to mould his words in the common clay of its forthright understanding.” (Wheeler 1956:224). Wheeler’s words resonate with the kind of thinking illustrated by several cases presented in this thesis, but also represent the perfect opening for this chapter where I will build my argument that digital communication is key to achieving an archaeological knowledge development. I suggest an extension of the word communication to include dialectical processes between archaeologists in the trench but also between other experts inside and outside the excavation situation. I argue that it’s the archaeologists’ responsibility to produce digital data, which is not only of value in itself, but something that both the public and archaeologist can make use of. This chapter relates to the whole theme of this thesis and the research questions regarding how digital data can be understood within the context of knowledge production and communication in archaeology, what can be said about digitalisation’s level of impact within archaeology and most definitely to the question of where the potential lies in archaeological digital communication (see ‘Research Questions’).

In this chapter I suggest that communication is not only an important factor to consider in digital archaeology, but a necessity for the discipline’s development into something that might live on and evolve using digital data and interfaces, making archaeology relevant in the present society. I build my argument by examining the potential impact of communication from the three perspectives: in the trench, in archaeology and in society. This chapter connects to data presented and conclusions made in previous chapters but also widens the analysis with help from the study of communication theories and strategies. By showing how digital communication can be a tool for archaeological knowledge development, I create the narrative needed for the concluding chapters ‘Alive’ and ‘Conclusions’.

Usually when referring to communication of the archaeological record, there’s a common view that it’s about archaeologists’ or communicators’ (such as pedagogues or heritage interpreters) engagement in the mediation of archaeological results to non-specialist audiences (Perry 2018). The transition of knowledge from the expert to the people is the service that archaeologists offer society in exchange for its funding of archaeology. Sometimes the divide between archaeological field work and communication is wide. The field campaign is often organised outside the context of e.g. a museum where results can be communicated with close connection to archaeological field work (Börjesson et al. 2016:13). In this chapter communication is used to describe
processes active in the creation of archaeological knowledge and as a resource for these processes to evolve into an archaeological knowledge development. The case study of Sandby borg has shown that digital communication with the public can be approached in several ways, addressing different people in a variety of different manners. Some activities encourage participation, others interactive knowledge discovery or immersive personal experiences.

**In the Trench**

One of the most important communication processes for archaeological knowledge production, with the potential to create knowledge development, is the one happening in the trench between archaeologists (fig. 18). As shown in earlier chapters (‘A Theoretical Approach to Digital Archaeology’ and ‘The Digitalisation of Archaeology’), there are several examples of how to use digital tools together with a reflexive approach within archaeological workflows, showing that it is possible to be successful in meaning-creating efforts concerning archaeological source material. At this stage, I find it important to acknowledge that: "Archaeological reflexivity is not formed at the trowel’s edge, but in conversations at the edge of the trench, a form of knowledge production that includes discursive representation." (Morgan & Wright 2018:11). It is the communication between people that makes the recursive movement of reflexivity an ongoing process.

![Figure 18. Archaeologists discussing in the trench with the aid of a digital tablet in Sandby borg. Photo: Daniel Lindskog, Kalmar County Museum.](image-url)
Reflexivity at the Trowels Edge

When it comes to the situation of the archaeological interpretation process in the trench, it’s crucial that what is unearthed is being discussed and that the reflexive approach is activated. If interpretations aren’t challenged by others, there’s a risk that the results presented by the few will be viewed upon as the only truth. At an excavation, it’s not certain that the archaeological information recorded, or the interpretations are shared with other archaeologists on site and discussed. Data can, in the worst-case scenario, be manipulated to fit expected results, and the critical view from the diggers is not heard during the process or presented as a part of the results (Everill 2009). The use of e.g. tablets in the field, where every archaeologist gets access to digital data and interpretation of it, can open for a reflexive methodology. A transparent digital field process, involving everyone on site, can become a more democratised one, challenging the top-down structures and avoiding problems with unchallengeable interpretations (Conkey & Gero 1997; Dallas 2015:197). I suggest that a more democratic approach in the trench also has the possibility to improve the interpretation process.

The examples of Çatalhöyük, Gabii and ARK have shown that the reflexive approach can be useful as an archaeological method when it comes to the application of digital tools into workflows (Opitz & Johnson 2015; Dufton 2016; Taylor et al. 2018). Çatalhöyük also experienced some issues in getting all the different teams of experts to collaborate so that the workflow could become reflexive. What’s been the main challenge is described as a communication problem. The very different kinds of experiences and levels of expertise made it hard to “speak the same language” and reach a good reflexive approach. Often switching personnel contributed to the problem, leading to tensions between different teams and isolation instead of collaboration (Farid 2015:65f). The implementation of a digital workflow contributed to solving some of these problems and creating a more democratic environment which somewhat improved communication between teams and reduced the feeling of isolation. But the human-computer relationship wasn’t solely the conflict solver here, the human-human interaction was also a necessity in getting diplomacy to work.

The implementation of digital recording systems such as ARK, PaleoWay, 3D-GIS or IDA, can not only open the archaeological process, but might also create possibilities for a reflexive process to take place at research excavations and in contract archaeology as well, if there are human agents aiming for that goal. The argument that the reflexive process needs time and the calls for a “slow archaeology”, that have been heard (Caraher 2016; Kansa 2016), do not fully describe a solution for contract archaeology, where the constraints of time and money are even more present than in academia. The use of fully digitised workflows must become a natural part of daily work and integrated in every
archaeologist’s toolbox for interpretation, just as e.g. the total station has become over time.

With an open digital archaeological process, reflexivity can be integrated in the daily documentation and interpretation processes, not having to be added as an extra task. I suggest that the ”slow” part of interpretation better suits the post-excavation phase rather than field work, especially within contract archaeology projects. The Gabii project has experimented with digital interfaces suitable for a reflexive interpretation process during the post-excavation phase. The interface aimed to be intellectual and create a platform open for critical studies through an embodied experience in 3D, engaging the user in exploration and a reflexive process. Opitz and Johnson state that:

In our case, in order to provide a “slow” and reflexive post-excavation experience with digital data, our archaeological interface must not only provide an accurate model of the dataset in question, but also interpretations generated throughout the excavation process. (Opitz & Johnson 2015:277)

The post-excavation phase in the digital workflow becomes important not only for the increased possibilities in elaborated interpretation processes off-site, but also invites more reflexivity into the trench. One example of how digital reflexivity might work with self-reflection to make the spiral of knowledge development turn upwards, is the work with the online video game ‘Second Life’ at Çatalhöyük (Morgan 2009). Its creator Colleen Morgan acknowledged the change that took place in the interpretation process when making the virtual reconstruction of the site. Realising that the primary data available wasn’t enough for a full reconstruction, she ended up changing her own way of how documentation was carried out. When recording in the trench, she already had the end-product in mind, what the data could be used for, making the documentation more elaborated than before (Perry 2015:201). This example shows the importance of communication channels in pursuing the quest for new interpretations. Here, the creation of a virtual world as an effort of communication not only gave an audience outside the project a meaningful digital arena for engaging with the past, it also gave insights into how field documentation and interpretation can be carried out in new ways. This hermeneutic reflexive recursive movement as an interaction between documentation and communication processes made the hermeneutic spiral turn upwards and added new knowledge that otherwise would have been impossible to gain.

There are fairly easy technical solutions for achieving the above-mentioned advantages, such things as digital work flows with integrated communication channels and contemporary off-the-shelf-solutions for digital workflows like IDA or ARK. Here one can combine the strength of a shared digital field
recording with legacy data and off-site post excavation analysis in for example 3D, but also open the process for anyone to scrutinise if they wanted to (see ‘Digital Workflows’ and ‘IDA - Instant field Documentation system and Availability’). These digital infrastructures enable wider communication between archaeologists in the trench and invite collaborative acts, a deeper interpretation process through new data engagement and help in making well-founded decisions while digging with additional data available at the trowel’s edge.

**In Archaeology**

What I call the “digital leap” describes the change of the digital infrastructure (see ‘Not a turn, a Leap 2000–2010s’). Digital mobility and access has changed the rules of engagement for how archaeology might be conducted, not only in a limited context like the trench, but also in the archaeological discipline at large. Archaeology is a highly diverse scientific field dependent on interdisciplinary collaborations to reach a high level of knowledge production depending on more than the theories of one archaeologist’s mind. But for such a scenario to be further developed within the sector of contract archaeology, the need for sharing digital data within the archaeological community and a change in attitude towards openness is most important.

**To Share or Not to Share**

I make the argument that data is subjective in nature and that one way to create good knowledge development is to be more transparent and to communicate with colleagues in the trench, other professionals and externally. As I have shown in previous chapters, there are great possibilities with digitalisation, the methods and theoretical approaches that can be applied, but these opportunities cannot be fully realised if the information flows of digital data do not become more open. Hodder states that:

> As much as one can attempt to bring as many different voices to the trowel’s edge in order to create a range of perspectives (and thus to do better science), in practice it becomes important to open up the process of enquiry so that other groups at a later date can re-interpret the evidence. (Hodder 2003:60f)

Before one can get to that level of reflexivity, archaeological projects within academia or contract archaeology need to answer the question of whether they are ready to share their digital data at all. My standpoint is clear on the matter, but there are also voices supporting non-sharing, especially within contract archaeology. To share digital data is not a technical issue, it’s a cultural one. I
will now make the argument of why sharing is so important for knowledge development and communication of archaeological digital data.

One useful definition of open data is: “A piece of content or data is open if anyone is free to use, reuse, and redistribute it – subject only, at most, to the requirement to attribute and/or share-alike.” (Edwards & Wilson 2015:1). I further argue that there are levels of how archaeologists use the term open. I, for one, often use the expression “more open” in this thesis, and that is because many archaeological projects whether in contract archaeology or academia, have a long way to go before their data is fully open. Tim Berners-Lee has created a useful scheme for how to become more open and eventually reach the level of fully open data (fig. 19).

![Figure 19. Tim Berners-Lee’s 5-star deployment scheme for open data. 1 star: make your stuff available on the Web (whatever format) under an open license, 2 stars: make it available as structured data (e.g., Excel instead of image scan of a table), 3 stars: make it available in a non-proprietary open format (e.g., CSV instead of Excel), 4 stars: use URIs to denote things, so that people can point at your stuff, 5 stars: link your data to other data to provide context. (from 5stardata.info, L31).](image)

In the case of Sandby Borg for example, the archaeological data in the live map concept is open for scrutiny by anyone with Internet access, but data cannot be downloaded and reused for other purposes which would be the better alternative. On the other hand, the data links to other locations on the web and is combined with legacy data, which makes the digital information contextual, relating to the 5-star level above (fig. 19). This is a huge step for contract archaeology, where sharing preliminary results and letting others into the interpretation process itself isn’t the everyday approach. Primary data is mostly not accessible because the companies keep that data on local servers (Interview: Larsson 2016; Larsson et al. 2017). And this is just the first rung on the ladder of which most archaeological projects have several to go.
It’s not common for the archaeological companies in contract archaeology to share their data. The system does not encourage it, in fact it’s a grey area as to whether it’s in order to share preliminary results at all. But it’s not only a question of regulations, it’s also a cultural issue with a competitive market that doesn’t encourage companies to share with other actors in the business, probably because there’s a view that information might give them an advantage compared to others. To not share digital data leads to a certain amount of data hoarding, which is a problem traceable throughout the whole discipline of archaeology in both academia and contract archaeology where information in some cases can be “[…] retained by an individual for a lifetime.” (Huggett 2015:9). I suggest that data hoarding, analogue or digital, does not contribute to a development of archaeology. It is not only of little benefit for the scientific discourse but also for the development of new methods and thinking.  

Data sharing allows for the sort of broad-brush, inter-site comparisons that can increase understanding of some of the greatest concerns of humanity more so than can single datasets: climate change, social inequality, and urbanism, for example. If archaeologists argue that their work provides such public benefits, they must be willing to provide full access to their complete and original data as well as to their analytical results. (Roosevelt et al. 2015:342) 

With open data, the authorship of digital information can be reconsidered. Traditional publishing, with a report as the end-product, especially for contract archaeology, is a result of the interpretation process done as a team effort at best, but usually just the project management or the site manager. The report is their conclusions based on the source material, in written form. Hodder explains that “[…] the many participants are mentioned by name in the report, but the personal contributions are not identifiable.” (Hodder 2003:62). This means that narratives coming out from archaeological source material are more often told by the few, making it an undemocratic process (Perry 2018) in part. With a digital workflow, the individual accounts in the archaeological record can be shown as traceable data in the database, which enables the possibility of including different interpretations to show the complexity of an archaeological documentation process and open for post-excavation re-interpretation. 

The Swedish Research Council has brought forward ‘Proposal for National Guidelines for Open Access to Scientific Information’, ordered by the Swedish government. The basic principle is: research data which is the basis for publications and publicly funded, must be open access. These guidelines are based on prevailing legislation and state that it’s not a question of if data is going to be open access or not, but how. Research data is regarded as a public document according to Swedish law and research data therefore belongs to the
authorities such as universities and through them, society, where every citizen has the right to claim access to research data produced (Swedish Research Council 2015). This represents a global trend towards shared scientific data, funded by both EU and national research councils all over the world. The call for governmental demands on contract archaeology has been made by researchers who recognise the need for a new set of rules for the sector (Kristiansen 2016; Börjesson & Huvila 2018:17).

Even though there are still problems with data hoarding, there is also a positive trend towards a sharing culture internationally. Many archaeological excavation projects, associations and government agencies, share their results in different ways (Kansa 2015). The Digital Archaeological Record (tDAR) or ADS in the UK are supplying infrastructure for sharing of archaeological digital data. They archive digital data in repositories and make it available for reuse, enabling new syntheses and hypotheses to be made (Costopoulos 2016:2). The Swedish counterpart, DAP, are setting up (in 2018) a similar infrastructure with an E-archive where the whole sector of contract archaeology in Sweden, in the future, will be obligated to share their databases and digital reports (Törnqvist 2015; Interview: Larsson 2016; Larsson et al. 2017). The goal is to create an archaeological process more open to other actors involved in the civil processes, like developers. When a landscape survey is conducted, documented findings will soon be available for anyone to view and use for planning (Larsson et al. 2017). To upload field documentation for everyone to see, like databases or scanned drawings, will probably be a big adjustment for Swedish contract archaeology and many actors will need to adapt their workflows to be more digital and open in order to fulfil their obligations, something that not all are fully accustomed to yet.

In dialogue with Larsson at the NHB working with DAP (see ‘Digitalisation of Swedish Contract Archaeology’), the question regarding openness in Swedish contract archaeology came up and Larsson stated that she doesn’t think data should be open too early in the process. Preliminary data is a work product and not something ready for scrutinising, she says. Digital data provided by the business will have to be approved by the CABs, before being uploaded to the new digital register (KMR) and the E-archive that NHB will provide. But after that, Larsson says, data will be open and open APIs will further give new opportunities to re-use data in other outputs than the one brought by NHB (Interview: Larsson 2016), resonating with Tim Berners-Lee’s suggested approach (fig. 19). I do think that this is a good approach even if there are several issues that should be subject for reflection. The ugly data, the cracks, the not-so-nice raw data or primary data that were the basis for the analysis from the beginning, will not be visible in this system (unless the actors themselves want to show it by having traceable data in the databases). This means that databases will not give full insight into the process that led up to the publication.
of the results, which is still a problem when this partly un-transparent interpretation process means that data, in worst cases, can be manipulated.

For me, the benefits of open data in the archaeological discipline are obvious. In their research, whether it’s for the contractor’s report or for an academic paper, archaeologists want access to existing data for consultation, comparison and reuse. An open data approach has already had proven positive effects leading to more effective research and reduced costs for acquiring data. It’s been shown that reuse of data from e.g. ADS increases when more data is available and a survey in the USA shows that almost everyone would use digital data more if only it were accessible (Richards et al. 2013:316). In the global trend of open access and shared databases, contract archaeology must share their data on an open access basis in the near future. Kristian Kristiansen states that: “[...] full digital access to results in a trans-European database or interlinked databases, providing Big Data” is an important tool to “[...] secure a more sustainable, long-term production of archaeological knowledge in contract archaeology.” (Kristiansen 2016:11).

Digital Democracy?

Studies (for example Everill 2009) have shown that in worst case scenarios, archaeologists can feel that they are just part of the machine digging trenches and collecting information. The task of analysing the results and publish it, is a luxury limited to a selected few from the project management. For those standing on the lowest rung of the hierarchy, this can create a sense of exclusion “[...] from the products of their labour and from archaeological experience overall” (Hamilakis 2015:726f).

The developers of the digital concept PaleoWay report that previous introduction of technology into the field was “guarded by the crew chief”, which contributed to the hierarchic structure where the leadership could use technology to strengthen its position by taking the pictures or measuring the features. This way of working was not only seen as undemocratic, but also insufficient. The development and implementation of PaleoWay was more than just introducing technology, it was a change in thinking about the archaeological recording process. Spigelman and colleagues state:

Our goal, instead, was to put technology in each crew member’s hands, giving everyone a job to do in parallel to one another, thereby increasing efficiency in the process. This approach was directed at all stages of the archaeological process, replacing the traditional archaeological toolkit with a digital one. (Spigelman et al. 2016:406f)

In the case of ‘New Lödöse’ (see 'Minor Case Study: New Lödöse–A Contract Archaeology Project’), Carlstein states that digital data recording with the
possibility to view data through tablets at the trowel’s edge, created an increased
democratic process, including more archaeologist participation in the
interpretation process. At the same time, he emphasised the importance of the
control function given individuals in the trench to secure data but also of his
own role in securing that data held an overall high standard (Interview: Carlstein
2017).

Digital workflows are able to create more democratic processes in the trench
and in archaeology at large, but they also give authorities new tools to control
the situation at hand. Just to share archaeological digital data won’t necessarily
make all the problems go away. It’s naïve to think that the archaeological
process will be fully democratised by changing the digital infrastructure, it will
help, but there also has to be a change in mentality regarding the process of
digitalisation. The system might change the rules regarding authorship of
information. Data might be produced, not by the few, but by the many. But there
will also be new ways in which one can manipulate archaeological information.
With open and free data, one can reuse data, not only for good, but also to fit
specific purposes, even if they might be populistic or even un-democratic in
nature. Sharing and online communities have given rise to new ways in which
one can manipulate and present false information for various purposes.
Therefore, an openness is also dependent on transparency into the process of
that data’s creation and the creator’s intention for its use, in order to ensure that
there will always be ways to critique the source. In this way, decisions can be
questioned, and knowledge development increased.

An open archaeological process can challenge the top-down hierarchy of
field projects and avoid problems with unchallengeable interpretations (Conkey
& Gero 1997; Dallas 2015:197), making it harder to manipulate data. Without
this awareness about theories and purpose embedded in that data, reused digital
data can also be subject to misinterpretation (Gramsch 2011:62; Huggett
2015:18f) or even misuse. The use of e.g. tablets in the field, where every
archaeologist receives access to data collection and interpretations of it, enables
the reflexive methodology to be activated. A digital field process involving
everyone on-site might be a more democratised one than the pen and paper
scenario where only certain people get to digitise, have an overview of the data
being produced and control how it flows (Hodder 2005; Berggren et al.
2015:444ff). Hodder explains that for reflexive archaeology to work, where
more people can take part in the archaeological interpretation process they

[...] need to be provided with the means and mechanisms for
interacting with the archaeological past in different ways. This is
not a matter of popularising the past, but of transforming the
relations of production of archaeological knowledge into more
democratic structures. (Hodder 1992:186)
In Society

This thesis holds the importance of digital knowledge production and communication equally high, in fact I make the argument that if knowledge production is to become knowledge development, communication as a dialectical process between colleagues inside and outside the trench, but also as an established dialogue with society, must be a part of the process. Not all archaeologists are known as being very audience oriented. Ezra Zubrow states that: “[...] it is commonly assumed that being field focused, adventure-focused, travel-focused, and technology-focused that archaeologists tend not to be particularly people-focused.” (Zubrow 2006:22). The problem is not primarily that no one wants to communicate, but that it’s hard to integrate archaeological work with communication, often making it a separate effort beside the regular work (Hauptman Wahlgren & Svanberg 2008:252). The scientific jargon is another language making it possible for researchers to talk to each other but not necessarily to others, outside this context.

Since June 2016, the Swedish legislation regarding cultural heritage, authored by NHB, has contained a phrase regarding mediation of archaeological results (KRFS 2015:1), which shows that it is being regarded as something important. But the voices speaking up for archaeology to be of more use for society have, in Sweden, been raised for a long time. The investment in “Agenda kulturarv” in the early 2000s (Agenda K 2003) and the debate that followed were important for the coming development of Swedish contract archaeology. An inquiry into what contract archaeology could look like in the future was made in 2004, commissioned by the Swedish government. The inquiry stated, among many other things, that; “ [...] if the "legitimacy" of contract archaeology is to be maintained, it is important that its results are made available in various ways to the recipients: to academia, to the citizens, and to the planners.” (Gruber 2009:117). Through the DAP programme all these target groups are affected, but arguably only the third will be met in a satisfactory manner (Larsson et al. 2017). Data will be available for all three but as my case study has shown, there is more to be done before the needs of academia and citizens can be met. After the inquiry there were some concerned voices pointing out the danger in transforming archaeology into something that would be too far from “real” archaeology (whatever that is) and in the end, lose its purpose as a discipline (Baudou 2007:174f). In today’s discourse there are still the same concerns, but also many new voices stress the importance of archaeology making a larger contribution to society, like GRASCA. To increase the significance and status of what archaeologists are accomplishing, there needs to be an explicit reconnection of archaeology and cultural heritage to big issues occupying people in contemporary society, like climate, conflict, globalisation and origins (Paludan-Müller 2015:7). One could argue that without “Agenda kulturarv” and other voices raised in the early 2000s, there
wouldn’t have been changes in legislation and the transformation of Swedish contract archaeology visible today. If archaeology is not for the present, what is it good for? Even though there is a different situation today, I agree with the statement that: “The communication of archaeological knowledge has been systematically undervalued, as opposed to the production of archaeological data and knowledge.” (Richardson & Lindgren 2017:146), and that this can still be claimed to be a part of the archaeological world view, but I would also hold it true that communication through archaeological knowledge is even more rare.

The Public
Who are the public and what do they want? are questions constantly asked in the discourse within the cultural heritage sector, including archaeology. The subject is raised in relation to issues regarding dissemination and communication of archaeological results and/or source material through digital interfaces. Bodil Petersson states that: “It is necessary to adapt to the fact that out there is an audience expecting interpretations to be communicated in a format and in platforms that are a part of their everyday information habits and behaviours.” (Petersson 2018:83).

There have been, and maybe still are, tendencies in heritage management towards a view that the government knows best and that learning institutions are there to educate the nation’s population about their heritage. The voice of the public is still very much silent though and the public is told, from the top down, what they want from cultural heritage. Cornelius Holtorf has stated that:

Significantly, even when Riksantikvarieämbetet emphasises how its activities foster democracy, it describes how citizens can take part in implementing state policies concerning the preservation of cultural heritage rather than how they can actively be involved themselves in relevant decision-making processes themselves. In short, Riksantikvarieämbetet graciously offers its expertise so that citizens can contribute to what the state tries to achieve. (Holtorf 2007:13f)

In this case, the NHB (Riksantikvarieämbetet), held (1) the educational approach in high regard, which is one way to communicate with the public, or maybe one should say mediate. Several researchers suggest that communication with the public can be divided into different approaches, and adding on to the above, one can also use: (2) the public relations approach suggesting that archaeologists should lobby for changing the outside perspective of archaeology. (3) The critical approach focuses on whose interest is at heart in a communication process and will gain from a specific presentation of the past. Lastly, (4) the multivocal approach invites the public to initiate a dialogue with the experts and acknowledges different interpretations as part of the knowledge
production. How to know which of the approaches to use when engaging in archaeological communication depends on that specific context is surrounding a project or a site (Matsuda & Okamura 2011:5ff, Arnberg & Gruber 2014:162).

I suggest that certain communication efforts need one of the approaches above for the other to work successfully. In some cases, an *educational approach* must create a foundation before engaging with multivocality for example. It also depends on the target group; a middle school class might need a fresh perspective on what archaeology is before they can engage in a pedagogical exercise about source criticism. Lorna Richardson argues that the expert will always be favoured over the general public even though digital data is freely available (Richardson 2014:251). The archaeologist will work as a leader of this digital tribe and set the agenda. Even if digital forums, like social media, are open for comments, it doesn’t automatically change the relationship between the archaeologist and the public (Richardson & Lindgren 2017:145). I suggest that there is a scale to work with here and although a fully democratised process might not be achieved, one should still aim for that, and something valuable will come out of that process, even if it only reaches half way.

Summanen thinks that the focus on target groups is the wrong direction in the creation of digital data. Archaeologists should instead create data for machines, because it is they that will do the analysis of material in the future. A large part of the data created today won’t survive into the future, archaeology should aim to change this and try and save as much as possible, future AI systems will probably be able to handle almost all types of information, but only if it is saved (Interview: Summanen 2017).

**Digital Participation**

There are tools within digital archaeology suitable for all the above-mentioned approaches to communication with the public and these can be taken to a new level, challenging the relationship expert/public by letting the public into the archaeological process through digital participation. In the design process of VR experiences or in the creation of games, there are several examples of co-creation projects where users have also acted as co-designers in the design processes of digital narratives (Copplestone 2017; Pujol-Tost 2017:2). Theoretically this is a great way to involve the public, on the other hand, there might also be challenges in incorporating everyone’s wishes into the mix. With the help from the Internet and the possibility of sharing, GIS has in the latest decade been used as a tool for participation, where people themselves can contribute with valuable information. One example is the mapping of the emerging hostility towards Muslims after 9/11. With a combination of narrative analysis of oral histories and geospatial information, the results showed that the life pattern of Muslim women had changed and that they were staying at home to a larger extent than before 9/11 to avoid confrontation (Kwan 2008). These GIS tools could be used in a similar way, collecting information and stories
from the public, using them for interpretation of the archaeological record and creating a relevance in the present, connecting to people. Crowd sourcing is one way to use digital tools for participation, crowd funding another.

The Sandby borg project had to find additional funding for the field campaign of 2015 and decided to start an online crowd funding campaign, where money from the public could finance the archaeological excavation that year. In exchange, the funders received gifts ranging from a thank you on the website to the highest level where a funder could participate in the excavation. The project saw the opportunity to not only fund archaeology but also to find a new way to involve the public. In this case it didn’t only mean locals, or those Swedes interested in archaeology, but the aim was to reach an international audience by using an international website for crowd funding. There was more to it than an exchange of services and commodities, the people who helped with funding became engaged in a new way and felt a stronger connection to the project, as though they were a part of it. In this way, the project managed to build relationships not possible otherwise. The public further gave something back to the archaeologists, apart from money, they also co-created archaeology and to some degree the knowledge production, by funding the project (Papmehl-Dufay & Söderström 2017). In this case it became clear to all involved that the archaeology was for the funders and not for archaeologists themselves. Multivocality does not have to present competing narratives, and the archaeologist’s work cannot be easily neglected (Richardson 2014:255). It’s about finding new paths to knowledge where the archaeologists might get help from inputs outside the trench or the project. This might strengthen knowledge development, but can of course, if perceived in the wrong way, create more work or bring disruptive elements into the interpretation process.

**Interactive Narratives**

The power of being able to tell a story through archaeological source material is not to be undervalued. Storytelling is an exploratory process that, through the creation of stories, enables different theories to be tested, and new insights made (Perry 2018). Digital communication offers much more than simply digitising a source material and making it available, which archaeologists have done for a long time when mediating knowledge with an educational approach in mind. With the possibility for digital information to flow in new directions, new structures for narratives can be created where linear storytelling, such as the mediation process, can be challenged by a multi-linear, a non-linear or a hypermedia design alternative for an interactive learning experience (Copplestone 2017:85ff; Copplestone & Dunne 2017). In the digital world, such as within the use of VR or the creation of games, different media can be combined in various ways generating layers of information where the user themselves can decide how deep they want to go and user experience will differ between individuals. The difference in narrative creation between for example
an archaeologist or a game developer is that the former is used to producing a narrative in the form of reports, books or journals and that the latter writes for many different scenarios in which the gamer/user decides for him/herself how the story progresses (Copplestone 2017:86).

Different models for narratives have been summarised by Lock where a linear narrative is compared with other approaches such as hypermedia design by Liestøl (fig. 20). The models help in understanding a user’s acquisition of digital data. By combining different kinds of media, the storytelling has different outcomes: “Video and audio are good for capturing interest and for presenting quick introductions at a fairly superficial level, whereas text and still images are recognised as better for in-depth information.” (Lock 2003:223).

Figure 20. Compilation of different kinds of models for the creation of narratives. Liestøl’s hypermedia document at the bottom shows an exploratory layer in the centre that gives the user experience an interactive element where the user has the power to take the story onward. (from Lock 2003:224 after Gill 1996 and Liestøl 1995).
A hypermedia document is a static structure consisting of nodes of information with links between them and it is the user's discourse within the structure that creates a story [...] The major component within this, of course, the user, whose personal experiences and circumstances will influence the story created [...] The aim is to grab the user’s attention and encourage exploration of the next layer which comprises text and images and eventually leads to the third layer which is fully exploratory, producing a sequence of increasing interactivity with related increasing depth and richness of information. (Lock 2003:225)

The hypermedia design or the nonlinear narrative creation resonates well with the multivocal approach to communication. Such an example of a non-linear narrative created in a virtual environment is the Gabii project, where the user experience allows for different levels of data acquisition. In their interface there are longer texts that describe the archaeologist’s interpretations to create context to the visual. They state: “In this way, our interface facilitates two primary modes of exploration: free movement throughout the visualization and linear reading of a narrative with directed movement in the scene.”. The project sees a strength in combining the freer exploration of data in a first-person setting with the linear driven narrative and this means that it gives the creator of digital data a chance to present his/her story based on the data (Opitz & Johnson 2015:285). In the case of ‘Sandby borg– a Virtual Connection’ there was also a VR experience created. The storyline is linear but depends upon the user’s actions to drive it forward. The interactive and immersive elements are several and with the aim to increase the level of “presence” in the user experience, the goal was to reach out to the user and create an emotional connection to the story (Gunnarsson et al. 2018, ‘Sandby borg - a Virtual Connection’).

Copplestone points out that the video game media form, used as a tool for co-creation or in-game, allows for a system-based approach to be combined with the post-processual tools of multivocality and reflexivity (Copplestone 2017:94). The first-person view which sets the player at ground level and allows him/her to explore the virtual 3D environment in real time and at first hand, makes a reflexive process in digital data achievable. The user can get a sense of the spatial surroundings which is not possible otherwise, suitable for analysing during post-exavcation work (Opitz & Johnson 2015:279). Here as well, the feeling of presence makes the user engage with the archaeological source material in new ways, challenging the distanced relationship to 2D data. In an approach where one wants to reach a level of user interactivity, VR tools seem to be effective.

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Virtual Presence

VR offers the possibility to create immersive environments combining visuals and soundscapes with embodied interaction. VR has been seen as a tool that can revolutionise the future of communication by providing opportunities for 3D telepresence (Fuchs et al. 2014). As I have shown in ‘Sandby borg – a Virtual Connection’, immersive storytelling can be employed in a virtual setting where lighting, soundscapes and interactivity convey mood, empathy, but also information.

Within the cultural heritage sector, VR has been used for over 25 years (Barceló et al. 2000) and archaeology started to use 3D visualisation in the 1980s and has since mainly used it as a tool for analyses or recreation of archaeological remains like buildings, monuments, landscapes and even whole cities (Morgan 2009; Lanjouw 2016). The work with 3D reconstructions has been applied in the use of VR, but these models are not developed to the full potential of VR and often represent “[…] sophisticated interfaces to present discoveries or famous monuments.” (Pujol-Tost 2008). Just showing reconstructions does not necessarily enable an immersive experience. These virtual worlds are often lacking a human-centred approach and can be perceived as dead in that sense. There is still a way to go before the immersive experiences in the virtual are fully developed (Petersson 2018:97).

In research fields connected to studies of human–computer interaction, the term “presence” has, for a long time, been used for theoretical discussions concerning what this interaction can consist of and mean (Zahorik & Jenison 1998; Riva et al. 2009). Presence is used to describe many aspects of human-computer interaction but can in its widest sense, simply be described as the subjective feeling of “being there”, being in each environment. How much presence one feels depends on how personal actions are supported in the surroundings. ”Presence is tantamount to successfully supported action in the environment.” (Zahorik & Jenison 1998:78, 87). The term can also be described as a non-mediated communication where human intuition and the ability to move from intention to action is a reality (Riva et al. 2009:3). In other words, if a VR experience has a high but balanced interactivity, or the feeling of the experience is something which makes the user feel presence, then the conveyed story has a higher chance of creating an emotional impact within the user. To touch a user deeply can have positive effects and create a real connection to the heritage presented. When users make this emotional connection, the experience will last, and the memory become stronger. A personal attachment to cultural heritage further has the potential of increasing the engagement of the user with the monument, site or the conveyed message. (Perry 2018).

The theoretical approach of presence has been imported to the cultural heritage field, even if it’s still unusual for cultural heritage experts to take these processes into account. The term “cultural presence” emerged in the early 2000s and was defined as “[…] a culturally meaningful interactive environment in
which users could communicate and cooperate” (Pujol-Tost 2017:2). Erik Champion imported the concept into the cultural heritage field which has been developed since by other researchers like Laia Pujol-Tost (Riva et al. 2002; Spagnolli et al. 2003; Champion 2005; Pujol-Tost 2017:2). One example of this development within the cultural heritage field is the ongoing LEAP (Learning of Archaeology through Presence) project, which aims to take the concept of presence and develop it further within the archaeological context (Pujol-Tost 2017:3f).

**Concluding Thoughts**

In this chapter I have discussed how the implementation of digital tools in archaeology can be a game changer in the quest of making archaeology an accepted and active part of the societal process. Digitalisation is more than use of tools, it’s about opening doors that haven’t been opened before. It’s about giving the archaeologist at the bottom of the hierarchical structure a tool of power, the archaeological sector a deeper knowledge production and maybe most importantly, give archaeology new communication channels with society, which ultimately is the client of archaeological research.

The Swedish system of contract archaeology has its advantages, where one can argue that the competitive market has contributed to a more diverse archaeology than before, where it is not just governmental institutions that set the standards and norms for what field archaeology can be. There are still negative aspects though, one of them being the hierarchical system active during the excavation and report phases in the archaeological process. The information flow can be controlled by a few and the possibility for transparency is very limited. An excavation project, in a best-case scenario, can be a reflexive and rewarding humanistic process between archaeologists on-site where the hermeneutic spiral spins upwards and new knowledge is discovered. In a worst-case scenario it’s a top-down situation where the digger is a collector of data and not much more, the field manager decides what is right or wrong regarding the interpretations being made, without a developed dialogue. On larger projects the diggers are, more often than not, seasonal employees with low pay and with a weak voice in the power relations set up on site. I wouldn’t describe the situation in Sweden as bad as in the UK (Everill 2009), but it is still not ideal. During the post-excavation phase, the project management continues with this approach, that they are the ones that know best. Internal communication and dialogue is very limited and if any communication is made to the society outside the project it’s in the relationship between expert and non-expert. If a fellow archaeologist, client or the public want to look at primary data, it’s seldom possible, one will have to wait for the report where everything is cleaned up and it’s not certain that one will be able to scrutinise the interpretation process leading up to the results from a report.
The political goals for cultural heritage, have for a long time been to make the cultural heritage more democratic through participation and availability (Aronsson 2003:69). The sector of contract archaeology is not living up to these aims and is, to this day, subject to a partly closed interpretation process where only a few might take part in unfolding stories. There is an urgent need for a more transparent process in contract archaeology, not only for the sake of the invisible digger, but also in the name of science and in the end, society.

The digitalisation of archaeology provides a range of tools and approaches for helping contract archaeology in its endeavours to be an active part in the democratisation of society. With the concept of crowd sourcing and crowd funding, the public can contribute with their own funding or information to a project, the regular citizen can contribute to change regarding scientific results, a story about a site or how archaeology can be integrated and used in their societal context. Democracy is a culture that grows from deep but vulnerable roots that need cultivation at all levels (Paludan-Müller 2015:5), it needs us archaeologists to create long-term sustainable relationships with the surrounding society.

Digital solutions are a means to make archaeology relevant in our time and part of society’s changes and challenges. Changes are not to be expected to come only from the top though, because “Riksantikvarieämbetet’s work is characterized by a strong top-down attitude” (Holtorf 2007:13f). The actors in the sector of contract archaeology and academia are the ones who must lead the development together with society, in the quest to make archaeology and cultural heritage meaningful and of use in a close relationship with society’s needs today. By activating digital solutions with a new mentality, workflows including for example visualisation can contribute “[...] in building a more democratic, inclusive, critically engaged and truly reflexive network of media and people.” (Perry 2015:206).

In this chapter, I have been able to show that archaeological communication based on archaeological source material can be something more than mediation of information. Digital communication has the possibility to get beneath the skin of people and to make an emotional connection between archaeology and humans. Petersson states that:

The use of multiple senses to process information is part of being human. An empathically multisensory approach would be much needed both in museum exhibitions and in research. It would enhance the possibilities of letting experience and information go in both directions, from research to communication and from communication to research. (Petersson 2018:98)
A reasonable hypothesis is that it might be necessary for archaeology to tear down the walls built of old traditions and norms of how to do things, because they won’t help the digital development keep moving forward. Digitalisation needs visionaries, decision makers and action takers, not conservatives, non-doers or data hoarders.

**Rethink Publication**

This chapter has argued that there are great possibilities for communication to be a key factor in archaeological knowledge development and meaning making for people. The technology and pilot cases are there, but digitalisation has not yet changed the way in which dissemination of archaeological results and stories can be achieved in a way that meet the wishes and needs of society. In Sandby borg, we shared our digital archaeological data live to show that alternatives are possible where the archaeological process opens up and becomes more transparent. Such transparent platforms enable users to take part in the interpretation process and see that the science of archaeology is a product of a communication process, constantly ongoing, and that a public can also contribute to the knowledge creation and development.

The archaeological community, whether identifiable as government authorities, contractors or academics, could rethink publication in order to develop a digital communication of archaeological results, grounded in the society surrounding it. Brian Fagan sees the potential in digital publishing and states that:

> [...] the very nature of digital media means that your work, if properly presented, will foster comment and debate, contributions from others - fellow specialists, scientists in other disciplines interested in your work, students and the general public. Many of these comments will be trite, often useless, but among them will be gems from people with no connections to archaeology at all. (Fagan 2016:190)

Alternative publication strategies through digital media have been discussed for over a decade (Opitz & Johnson 2015:280), but it remains to be seen how this will develop. The great possibilities have not yet been realised as part of governmental legislation or research guidelines. Virtual publishing will offer more than text and pictures of the archaeologist(s) responsible for writing the report. A virtual representation of the archaeological record can create a story that is not possible otherwise. The combination of media like video, audio, primary data, images, 3D reconstructions and animations in an interactive environment might be a powerful communication tool if used with a clear aim. Several projects have published their data in a virtual interface where the interpretation process can continue. The Gabii project, Çatalhöyük, the Swedish
Pompeii Project and others have published a combination of databases and 3D models. This allows a user to have a new type of engagement with digital data, more closely linked to the archaeological source material, encouraging engagement in the reflexive process. If this data is experienced in a first-person mode, such as in a VR experience, the embodiment might create a stronger effect (Opitz & Johnson 2015:280).

User centred, emotionally based and qualitative communication is achievable and could be a reality for contract archaeology as well. The stories are always present in any archaeological project. In the plan for excavation, a hypothesis is presented, which the findings will confirm or challenge. This narrative is progressing along with the archaeological discoveries and after analysis, a story of the site can be created and presented in a report. The thing is, a report is not a very attractive tool for sharing stories. VR and games have been shown to have a greater impact, the report might be a good product for the archive, but the storytelling demands something different. How archaeology is being published and conveyed needs to be revised in a future where contract archaeology has greater meaning for society and its citizens.

If archaeologists rethink publication strategies and already produce high quality publishable digital data right in the trench, there can be a time of creativity following the report tradition. Publication can be something more, with new narratives created in new ways, by means of open access interfaces. The engagement with 3D data and the database as seen above, is just the start of a development where excavation results can be published with several layers of information combining archaeological primary data with multimedia. Narratives describing the archaeological recording and interpretation processes can be accompanied by 3D reconstructions presenting hypotheses (Roosevelt et al. 2015:342). The archaeological sector needs more research in the subject to determine future publication strategies for the communication through archaeology with relevance for society. How can such communication efforts and publication strategies be done and what does the society want or need?
In this chapter I take the discussion about digital knowledge production and communication within archaeology further. Here I discuss and suggest a theoretical approach for archaeologists to consider when engaging with the digital and its potential as a knowledge developer. The model for an archaeological approach to digital data and knowledge development, ending this chapter, sums up my conclusions from the investigations in the separate chapters (fig. 21). The results thus relate to all the stated research questions in this thesis regarding how digital data can be understood within the context of archaeological knowledge production and communication, the level of impact of digitalisation, the potential of digital communication and how archaeological knowledge production might interlink with communication (see ‘Research Questions’).

By answering these questions, I aim to enable further exploration of the digitalisation in relation to contract archaeology where new questions can be stated. How can contract archaeology make use of digitalisation where efficiency is not the biggest prize, but rather, what it can contribute to society in relation to what society wants from archaeology? Contract archaeology can increase its role as a producer of knowledge about the past and communication of it, but also create a knowledge development rooted in what concerns people in the present. Archaeological knowledge production must be more than production of data, just to keep the wheels in the large machinery of self-preservation spinning. In the previous chapter I have shown that communication is a key player in achieving this. Here I extend the argument and express that it’s also a necessity to keep data alive in the trench, in archaeology and in society.

With that statement I touch upon questions related to how to keep archaeological digital data actualised, relevant and of use for many. The opposite would be not to curate and manage the data, rather to “just” publish it and move on to the next data production. Digital data would risk being stored on a server at a museum or in a national e-archive, but not used in other situations than when a new excavation is taking place at the same location at a later stage. If the civil process of society does not want to make use of the digital data, then there’s a small chance that no one else will. Perhaps a researcher is interested in the data 10 years later, but then a poor reusability in data structure can limit the potential of that knowledge to be developed. Communication tools can be activated, not only to produce more usable digital data, but also to create narratives from that data relevant in present society through the past. These narratives, either presented in digital popular science texts, social media, film, interactive maps, video games or VR experiences, will have to actualise the
archaeological digital source material, to make it come alive, and on its way to reach people emotionally, also make digital data live on.

If no curation, no use of data is to take place, there is a real risk that digital data is being forgotten and consequently, knowledge dies with it. This is a natural part of archaeology where data is being produced regarding e.g. an artefact where its life is pre-determined by the archaeologist who registered the object. That artefact, let us say a flint arrowhead and the data attached to it, is after registration in the database, put into the museum depository. The information will be visible in the little box containing the artefact, in the published report and in the database that is kept by the museum. But for how long will the knowledge of that arrowhead, and more importantly the bigger story it represents, live on and will it ever have the possibility to transform into something else if new observations are to be made? I think that many archaeologists would agree that reports produced from an excavation conducted by contract archaeology, are not read by many, and the knowledge attached to that arrowhead has very little hope of having a long and prosperous life, if data isn’t being used. The knowledge needs to be activated in other ways through communication such as storytelling or interactive tools. One might say that not all artefacts from all excavations ever made can be activated all the time, and they would be partly right. But archaeology can do a whole lot better, at least build the infrastructure that enables such efforts, at least share digital data so that archaeological knowledge can be created by a bigger community, professional or public. Even if connections with people are not made through communication flows in a project, the possibilities to make them should be in place.

Life of Data

Huvila describes that archaeological information has the potential to live many lives, if it’s not forgotten. It is in engagement with the archaeological record that knowledge is produced if this engagement can be activated, kept alive, with several new life cycles (Huvila 2018:5). I will now illustrate how the life of data might look for archaeological digital data, to show how it might be kept alive. I will show that decisions made by archaeologists during the documentation process up until publication have a vast impact on which end-product is mediated. If communication is added during these processes, there might be another outcome and products coming out from that knowledge production in addition to the archaeological report can boost knowledge development.

Field archaeology is a very physical activity with sensory experiences affecting the interpretation process. The archaeologist first needs to remove the top soil, often with help from an excavator. When reaching the level of archaeological remains, the archaeologist needs to get rid of the soil blocking visual observation, an action that the machine is too clumsy to handle. Equipped
with a shovel or a pickaxe, the archaeologist now gets to clear the features, involving sweaty foreheads and dirty hands. This, for me at least, is seen as a rewarding business for the archaeologist, where the archaeological features now become visible for the first time. Usually, it’s also now that the documentation of the archaeological remains starts, with a measurement and the opening of a post in a database. As soon as data is “born” and the archaeological features excavated, the remains start being replaced by information about them, the physical object is used for further analysis during the post-excavation phase, but sooner or later, the only thing remaining during interpretation work will be the digital representation on screen. After this digital representation is born, more often during field work, the “life of data” can begin and the information used and transformed during the process of interpretation - including analysis and report writing (Lock 2003:265f).

The first step in the creation of data is to say that a specific dark-coloured stain in the soil could be something. When that has been established, measurement of the observation, using a GPS or total station, is done. The outline of the stain, its form and size will be the first modes of interpretation captured digitally. This will end up in geometrical data visible in a GIS program as part of a geodatabase. When the digging of the context is later being conducted, the first interpretation of the stain could turn out to be wrong and a correction in data is made. These first steps of data creation, where data is “born digital” are probably the most important and the starting point of a long chain of data corrections during the interpretation phase.

When the context has been documented and the archaeologist moved onto the next one, the collected data continues its life. The person responsible for on-site documentation often secures data and makes sure it has the right standard and that it is of high quality, this task is often viewed upon as an important one and even a necessity for conducting digital documentation (Interview: Carlstein 2017). If the geography from the measurement is a bit off, or if there is something wrong with the interpretation of the stratigraphy in the database, the documentation overseer alters the data, so it fits with the rules made for collecting data on that specific excavation. When the archaeological information collected in the field reaches the office, the interpretation of the site evolves further when a proper overview of data can be made. In the life of data, a small shallow pit where the field archaeologist hasn’t given the context a very high status can transform into a post-hole of an Iron Age longhouse if it is in line with other much more significant post-holes. Data is altered once more and by the time the result is published in an archaeological report, much might have changed.
Context and Transparency

Archaeological digital data is a result of a documentation and interpretation process. For the sake of every researcher that wants to reuse this data, it is important that this process is traceable, down to the first step where primary data is produced, and digital data is “born digital”. If digital data is to be reused it also requires some understanding of the context in which data has been collected, to fully comprehend what it represents (Naylor & Richards 2005:90; Huggett 2015:13). That is one of the reasons why it’s important that the archaeological documentation process be transparent and primary data accessible after the excavation project is finished. The user needs knowledge about data collected to understand it fully and for the possibility to challenge current interpretation. An insight into the data creator’s intentions and actions, while collecting and preparing digital data, is necessary to track the decisions been made during the interpretation process. John Swogger pointed out that the archaeological process where interpretation is made, like the lab, the veranda or the bar, is just as important to acknowledge as the results coming out from such discussions. With visualisation, snapshots and conceptual ideas can be captured and the creative process of archaeology known to others. Swogger also suggests that the visualisation of archaeology can be done in almost real-time and these “instant reconstructions” would visualise ideas and not results (Swogger 2000 through Perry 2015:199).

Eric Poehler states, within the framework of their archaeological project in Pompeii, the importance of secondary sources of knowledge for the interpretation phase. It’s common for the archaeologists to work with secondary resources in all archaeological projects, whether in academia or contract archaeology, and it can be useful to be reminded of its importance for how the result turns out.

So when do we think we would want to have access to and read secondary sources? Situations include: 1. Excavation: when discovering an unusual feature (e.g., a kiln or soil layer). 2. Artifact analysis: when discovering an unusual object (e.g., rare material or form). 3. Synthesis: when the combined data lead to a surprising result (e.g., when discovering your building is another building). 4. Writing: when making an argument supported by facts (i.e., all the time). (Poehler 2016:212f)

These resources, whether legacy data or source material from other archaeological findings, can be digitally available in the trench with tablets, incorporated into the databases. Without secondary sources being digitised and communicated, this procedure wouldn’t be possible. The point here is that context matters. If moving into the museum: digitised collections are not as useful without context as they are with. If data is not interpreted and put into a
context, one can argue that data has little meaning (Lupton 2015:63f). The archaeologists depend on the subjective interpretation process to be able to reach results and for this process to become a scientific one, the only way is to be transparent about one’s faults, theories and brilliance. It’s all about opening the archaeological process, a task that is possible with digital data flows, but a big challenge for the sector of contract archaeology.

In the paper ‘The Apparatus of Digital Archaeology’ Jeremy Huggett discusses (through Heersmink 2012, 2015) different approaches to digital archaeology and states that the argument can be made that digital tools used by archaeologists require training and understanding making them not so transparent in themselves (Huggett 2017). It’s a kind of know-how that only specialists have access to. It’s also a matter of how transparency can differ between various kinds of tools. He states:

So, for example, a total station plotting three-dimensional data points directly to an onscreen map could be seen as having quite a high degree of transparency, whereas a proton magnetometer that requires the data to be downloaded and processed in a separate software package would have low transparency (and indeed the interpretation of the resulting plots is often not self-evident). (Huggett 2017:5)

Huggett further argues for the importance of so-called “cognitive artefacts” in the archaeological interpretation process and how their level of impact can be evaluated through questions of: information flow, reliability of access, durability, trust, procedural transparency, informational transparency, individualisation, transformation. He argues that the process of turning archaeological remains into digital digits using the technical tool might be objective, but that the collection, evaluation of the measurements, and the use of data requires a human input, which is subjective (Huggett 2017:8). The concept of “cognitive artefacts” helps in understanding the concept of life of data and how the interaction between the archaeologist and digital data affects the outcome. Knowledge is not an objective truth that has simply been collected from the past to be displayed in the present, it is something that is alive, almost organic (Heidegger 1927).

This thesis has shown that archaeologists today rely upon the objectiveness of e.g. data capture, certainly the use of lasers is viewed upon as a tool for avoiding the human bias (Interview: Carlstein 2017; Interview: Hallberg 2017). When the archaeologist Hallberg looks into his crystal ball he imagines that drones will be equipped with laser scanning tools with RGB values enabling more powerful acquisition of 3D data. Lasers take away much of the human factor, thinks Hallberg, and enable more objective data recording. Huggett’s study shows that a culture has emerged among some digital archaeologists,
where algorithms are viewed upon as flawless almost holy entities which will save archaeology from human biases. Even if algorithms serve archaeologists well in producing for example 3D models, they are not to be easily understandable, which makes the level of transparency limited. The human-computer interaction is probably most tangible and fragile here, at the intersection between an overrated trust in the digital and the will to use digital tools. Some level of trust in the digital tools is necessary to be able to use them for all their positive characteristics, but also the importance of being critical in all aspects of the digitalisation, whether it is program, code, software, hardware, the design processes and not least their application within archaeology (Huggett 2017:10).

But to be fully critical and able to understand the full process in the creation of technology and the use of it, is almost an impossible task for an archaeologist, who is trained for something very different from being a computer scientist. But what the archaeologists can do is to reflect upon these questions and be as transparent as possible and constantly engaged in a reflexive approach, not only in relation to the archaeological remains but also to the digital. The faults need to be visible and described, if that’s a possibility. An archaeologist or an archaeological organisation can be critical, transparent and reflexive but if the standard regarding for example data quality and curation is going to be something that survives in an archive and can be fully reusable, the authorities, like NHB in Sweden, must take the leading role and apart from creating regulations they also need to be the creator of the digital infrastructure.

**Living Data**

The Çatalhöyük project shows examples of how data can come alive in the trench and be a part of the reflexive process. In the building of GIS databases there has been a collaborative effort from the start, where the database structure has changed according to the site need identified by the different teams: “[...] constantly reworked through archaeological practice.” (Taylor et al. 2018). This works as an example of a simple way of keeping digital data alive by constantly activating it in a reflexive process and always being critical about the interpretation, letting it be dynamic, organic, already in the trench. This approach also means that they’re working with the concept of “the living archive”. The idea is to share the digital data through the repository and online interfaces so “[...] researchers can constantly reassess and re-evaluate our very perception of the site as the primary repository of data.” (Taylor et al. 2018). A living archive, like the one mentioned here, is one way of ensuring that data lives on and knowledge is not forgotten. By creating this infrastructure, the Çatalhöyük project enables anyone to be part of the continuation of not only research, but also of the communication of the stories embedded in that digital data.
Interpretation + Communication = Knowledge Development

Open data, transparent processes and long-term curation of data are important steps in how to meet the challenges of digital archaeology today, but archaeology needs to do more. Not only other professional archaeologists, but the public too need to be invited to tour the data, so the visitor or user understands what he/she has access to. Digital data needs to be understandable in order to be reusable. Though access to the primary data is an important ingredient in the future process of archaeological knowledge production, it is equally important to offer the interpretation of the site in an attractive way so that society might gain from this knowledge as well. Successful communication of the digital archaeological record is key to getting data reused. In archaeology, there tends to be a divide between the flows of documentation and communication, which calls for new roles to be created to bridge this gap (Perry 2018), new agents, to coordinate between those flows so that one serves the other. These agents might benefit the hermeneutic process of knowledge development through the approach of digital reflexivity.

The archaeologists in the trench do not necessarily do archaeology for anyone else but themselves and why should they think about society and the public while documenting archaeological remains?

When using a reflexive hermeneutic approach (Lock 2003:7f; Lynch 2000; Taylor et al. 2018), a reasonable hypothesis is that there is a need for the two to work together in order to reach new academic insights. It’s true that communication can be used between researchers to gain new knowledge, but if the process is also open for others, the chances to gain more knowledge increase, as this research shows. Interpretation and communication can boost each other and should be part of the same knowledge development, the same movement forward. If the field archaeologist, even while at the trowel’s edge, reflects on how this data can be reused in the future or be understood by non-archaeologists through digital interfaces, the chances increase that there will be a better communication flow and at the same time an enhanced documentation of the archaeological record, that more people, including professionals, can understand.
For if we have few or mediocre skills in interpretation, if we marginalize its relevance, if we demean and undervalue its diverse practitioners, if we continue to produce endless reflections on art and archaeology or creativity and archaeology without real synthesis or systemic change to our standard textbooks, curricula, field schools, excavation manuals, commercial workflows, etc. (i.e., the architecture of knowledge-making in the discipline), then the profession of archaeology will forever remain stunted, unimaginative, and, so, trivial in relation to the world at large. (Perry 2018)

Interpretation

In the case of this thesis and the theoretical model presented below, I use the term interpretation to describe all the digital documentation done in the life of data described above. But also, to describe the human-computer and the human-human interaction that constitutes the process of interpretation of the archaeological record. When archaeological remains are transformed into digital information, the interpretation related to that process and the reinterpretation of digital data changes that information into something new.

The data flow of interpretation is used to extract knowledge from digital data produced during digital documentation. This is a process concerning the human-computer interaction where data has its own life cycle with defining moments, including decisions building upon observations made by the archaeologists, eventually ending up in a new registration in the database. Archaeological digital data is a result of observations and it’s important that this process can be traced, down to the first step in the documentation process which produces the primary data, to the moment when data is born digital. This is the strongest argument for why it is so important for the process to be transparent and that primary data is also accessible after the excavation project is finished. If data is also going to be reusable, the new user needs sufficient knowledge of that data to fully understand it (Huggett 2015:13). The possibility to challenge current interpretation must also be a reality. An insight into the data creator’s intentions and the actions involved in collection and preparing of digital data is then important in order to gain more insights into the decision making taking place during the process of documentation. How knowledge is acquired might differ depending on who is extracting it and of the research context of that time and place (Huggett 2015). The archaeological interpretation is also strongly influenced by the digital media that is used to document it and how that can change, depending on the digital tool (Copplestone 2017:87). The processes leading to knowledge extraction should be able to be reproduced, in that way there is the chance that new knowledge may be extracted using the communication flow and knowledge development starts its movement onward (fig. 21).
Communication

In this thesis I present arguments for the importance of communication in the archaeological process in the trench, in archaeology, and in society (see ‘Digital Communication’). I suggest that communication flows shouldn’t be separated from the archaeological process of digital documentation and interpretation. The model below shows how communication workflows are representations of knowledge gained from the interpretation workflow, a representation of that time and place, an important document in itself and a sort of window into the interpretation process (fig. 21).

The communication workflow could consist of e.g. interfaces like blogs, vlogs or homepages where it is possible to follow a dig through the web, containing different kinds of media such as text, pictures, video, 3D visualisations, audio or all combined in a VR experience. In the excavation project of Çatalhöyük and as a part of the project’s reflexive approach, they want to create these kinds of “windows” into the documentation and tell the story behind it. With components from the reflexive approach like VR, videos and teams working with communication, like the Çatalhöyük visualisation team, the site is opening up more than most to international audiences, mainly through its website (Hodder 2000; 2005; Berggren et al. 2015; Forte et al. 2012; L1).

My results also show that communication can be more than a window into the interpretation, it is the central tool for a dialectical process during the archaeological interpretation, it is the key tool to widen this knowledge production to include other professionals. With the establishment of a dialogue the communication becomes more than mediation of results, it becomes a conversation where the archaeologist might gain further insights by asking questions and getting answers to the source material with help from anyone.

My research shows that there are several challenges in combining these workflows into something new. To make this a reality, there seems to be a need for a new role in archaeological digital data management: an agent providing the service of bridging the gap between worlds. Being well-acquainted to both archaeological field work and digital methods for documentation and interpretation, in touch with the needs of the current society and have an insight into interfaces best suited for these needs. This agent, in order to engage the user of archaeology through narratives, has the possibility to transform the archaeological discipline.

A Model for an Archaeological Approach to Digital Knowledge Development

This model for an archaeological approach to digital knowledge development, is my way of illustrating the conclusions made in this thesis. It is also a call for archaeology and contract archaeology to start being aware of digitalisation’s
impact on archaeology and show how it might be used to create meaningful, relevant knowledge.

My model derives from the theoretical approach presented at the beginning of this thesis, where hermeneutics, and the model of a spiral, works as the basis for the use of digital reflexivity (‘A Theoretical Approach to Digital Archaeology’). There are other models describing digital archaeological knowledge production in a similar way, with feedback loops re-questioning the interpretations leading up to new knowledge. One of those focuses on the importance of visualisation in relation to digital data processing and interpretation processes. In this model, visualisation is not only important for communication to the public but also for research (Ch’ng et al. 2013:356, fig. 18.1; Petersson 2018:98).

What is significant in the model presented here is the hypothesis that the two processes of interpretation and communication can contribute to each other’s development moving forward as long as they are interlinked. I suggest that the two workflows depend on one another for the life of data to continue successfully. In short: if archaeological digital data is being activated by use and reuse, the extracted knowledge from that data has the potential to become part of a knowledge development and consequently have a longer meaningful life.

Figure 21. Model describing the potential life of data. The processes of interpretation and communication have the same point of origin where data is “born digital”. In this approach interpretation and communication is constantly in contact through a reflexive exchange of information leading to new interpretations and communication. This describes a knowledge production in constant movement towards a knowledge development. The flow of arrows illustrates that the interconnection between these workflows benefits from being dynamic and non-linear. Illustration by Daniel Lindskog.

This approach can boost the reflexive approach by interlinking the outputs and interfaces of the communication workflow directly to primary digital documentation enabling the user to have the alternative of accessing primary data from the same platform. For data to live on it needs these attractive interfaces, encouraging the user to use and reuse the digital data. If the archaeologist producing the information in the first place has an awareness of
the communication, the interaction between the two can be further developed: “It’s the combination of data and the purpose of data that is powerful and appealing” (Llobera 2011:215). When presenting results by, for example, visualising them in a 3D model, it is therefore vital to link the results to the primary data leading to the interpretations, so others can understand the process ranging from software use to algorithms and be able to challenge it. To use powerful communication tools, such as digital storytelling, in an earlier stage of the archaeological documentation process, where it’s linked to the story presented, can be a powerful way to encourage the communication resources at, for example, museums, to work together and more importantly to attract the user in new interactive ways (Börjesson et al. 2016:12).
Conclusions

Here I present a summary of the conclusions made in this thesis in relation to the research questions. In some cases, these answers lead to more questions which will be followed up and developed in the forthcoming doctoral thesis.

How might digital data be understood within the context of knowledge production and communication in archaeology? To understand how digital data affects archaeology and how it can be used, there is a need to understand what it is. My study shows that archaeological digital data can be understood as a product of the interaction, including different processes, between human-computer but also between human-human. With focus put on the digital tools themselves, some archaeologists reflect upon the technical as something free from human bias, but my research suggests otherwise. A digital tool is created by a person, used by a person and data is analysed by a person. If one accepts that digital data is affected by the human input, then one can argue that data and the processes active in the creation of it, must be transparent so the human factor in data can be scrutinised and evaluated.

With more and more digital data being “born digital”, it becomes the most important ingredient in future knowledge development processes, what future archaeologists will refer to when making interpretations and telling stories based on archaeological source material. Data needs to be open because of the individual preconceptions of humans, it needs to be dynamic in nature and not the creator’s single-handled truth and it needs to be viewed upon as a tool in a knowledge making process where data, without the human being, is useless.

Archaeological digital data flows differently than analogue information and can be accessible in real-time or connected to other digital information in an information network that is in constant movement. This gives the archaeologist opportunities but also challenges him/her to become more aware of digital issues because the digitalisation concerns the whole discipline and is no more, or shouldn’t be, only part of an expert’s skillset.

What can be said about digitalisation’s level of impact within archaeology and especially contract archaeology and how can it be further problematised when it comes to knowledge production and communication? The chapters ‘The Digitalisation of Archaeology’ and ‘The Digitalisation of Contract Archaeology’ illustrate that the digitalisation of archaeology is broad and occurs at many different levels throughout the discipline, within both contract archaeology and academia. In academia the possibility to take the digital leap has been greater. Research projects have to a greater extent, become digital and have evaluated their achievements while doing so. This depends on large, established research projects having both the time and money to do so, enabling a long-term approach.
The digital tools have made information flow in new ways and together with human agents they have created more transparency, analysis capacity and contextualisation of the archaeological source material. The openness and direct access to information have made most international projects, engaged in digitalisation processes, turn to the reflexive approach. With digital tools, the recursive loops of the hermeneutics become actualised in a contemporary context, making them vital in the process of knowledge production and communication. The last decade’s “digital turn” or “digital leap”, manifested by the mobilisation of digital recording units, their online access and their affordability is currently having a vast impact on contract archaeology as well. My case studies of Swedish contract archaeology show that the business finds itself in an experimentation phase exploring how tablets, 3D and online interfaces might be of use for their field projects, organisation or individual archaeologists. The eagerness for experimentation does not match the level of the digital infrastructure and organisations in contract archaeology are keeping one pace, the authorities another. One example of this is how acquisition of 3D data is widespread in Swedish contract archaeology but guidelines, research or archiving strategies regarding how to use these workflows are not in place yet. The digital development within the sector has many possible positive effects such as new information flows, open data and new ways of communicating with the public. But, the downside to all this might be that in the future there will be a knowledge gap where e.g. primary data used to create a 3D model is lost, making it hard for another researcher to recreate the scientific process behind the interpretation.

Another observation made is that the digitalisation of contract archaeology is not yet including everyone, even if this is changing rapidly. There’s still a workplace culture where the digital is viewed upon as something for the specialist. With the tools becoming more user friendly, this does no longer need be the case. These social constructions take time to change and are just as large a part of the digital development progress as the development of new powerful digital tools. My study suggests that digitalisation’s biggest impact on contract archaeology is about to happen or is happening right now, not yet fully observable in the research material.

The digitalisation of contract archaeology in Sweden is closely connected to the creation of a digital infrastructure developed by the NHB though the DAP programme. The decisions made in the creation of this infrastructure will affect how the industry will operate from now on. Though I see many of the steps taken as necessary and positive for the sector I can also see parts in the DAP programme with uncertain outcomes. The E-archive is a necessity for the digital infrastructure set up by the DAP programme. It will connect archived data with the interfaces of KMR, supporting the civil process. The interview material does not provide me with confident answers assuring me that this will be enough though. Data delivered from the contract archaeology organisations will look
different depending on who is sharing this data. Furthermore, the E-archive will not be able to receive all data produced by the sector such as 3D models or primary data for those models such as pictures or point clouds. This new digital infrastructure for archaeological data does not seem to fully live up to those standards of which the industry is currently working. Making not only the information stored in this repository limited in reuse, but also risking making archaeology eventually forget about data which is the source for much of the interpretations in today’s contract archaeology.

The impact of digitalisation might become greater if there were a number of changes in the business of contract archaeology. In a regulated business, much of these initiatives must come from the top through legislation and guidelines, but much can also be accomplished by the actors in contract archaeology themselves. They can collaborate with each other, with academia and with the NHB so that new steps in digital development moving forward resonate with what the sector identifies as needs that must be met. In collaboration with academic research into digital archaeology and other resources in society, strategies and systems might be developed that have a larger potential impact on archaeological knowledge development and communication, including more than just a beneficial system for the civil process.

Where lies the potential of digital communication and how can archaeology make use of it? This research has shown that the potential of digital communication within archaeology is promising and that it can be useful on different levels such as in the trench, in archaeology and in society. Digital tools have become a powerful aid in the reflexive process both within the individual archaeologist but also in a dialectical communication with colleagues and experts. In this way, open digital data flows have the potential to improve knowledge production coming out from the trench and make it open for additional information to expand the archaeological record. A digital reflexivity might alter the archaeological documentation and interpretation process, creating an archaeological record with greater value and relevance. A key in achieving a fruitful knowledge production is transparency and access to primary data. The digital infrastructure with all its possibilities in mobility and sharing won’t work efficiently unless data is being shared by the producers.

This study further shows the potential for contract archaeology to rethink publication strategies. The report is still a good way to account for the results from an excavation but limited in presenting narratives based on the results. The digital enables new ways of publishing the archaeological record and when data to a higher degree is “born digital”, field archaeologists have the opportunity to connect to a narrative at the documentation stage itself. Preliminary results of an ongoing project can be shared and establish a dialogue with the public, which might even help with the interpretation, not excluding the expert role of the archaeologist. The narratives created with the digital tools, when archaeology is being conducted, can relate to the surrounding community and what concerns
them in the present. Making archaeology and digital data relevant not only for a distant future but also in the present. Digital tools for communication like blogs, social media, video, interactive maps, computer games and VR experiences can activate the archaeological digital data, making it come alive by encouraging engagement with it.

If data is going to be reused and kept alive, the narrative interfaces need to connect to the primary data. In this way a user interested in doing analysis of data or who wants to be able to critique the narrative presented, might be able to do so. My research shows that, by creating a connection with the record, an engagement with it might be established and by doing so prolong the life of data. A virtual emotional connection can be produced with digital tools available today. Digital data representing the archaeological remains can be transformed through powerful communication channels conveying virtual narratives as an alternative to the archaeological report.

This research further suggests that archaeological interpretation and communication processes can boost each other with the digital as a resource. This might improve the archaeological knowledge production so that it becomes a knowledge development.

My research further shows challenges in reaching a level with a living data flow where the human agent is central to the digital knowledge development. This agent will need to have skills not so common in present-day contract archaeology. The new role needs to be well-accustomed to the processes of archaeological field work as well as using the digital for documentation and communication. Furthermore, the agent needs to be aware of present societal needs and have an insight into which interfaces work best in creating engagement.

Further Research

During the writing of this thesis I have identified several aspects that can be explored in further research.

To be able to create interfaces that offer an attractive output connecting to archaeological primary data, more research is needed to show how this might be done. What an attractive interface is, what the society wants and how archaeology defines target groups are important questions for upcoming research. Further research stresses the need to investigate how these new digital infrastructures can be used to create interfaces that people want to use. A qualitative investigation of the user’s perception and usage of online interfaces and live products would be valuable.

This research has shown how a more transparent archaeological interpretation process might be of benefit during excavation, in dialogue with the research community and society. But it remains to be seen how large this impact will be in the sector of Swedish contract archaeology. The digital
infrastructure of DAP will soon be up and running, and a future evaluation of whether this is making the archaeological process more open, remains to be seen. Can multivocality and crowd sourcing be a reality for contract archaeology as well?

The archaeological sector needs more research into the subject to shape future publication strategies for communication through archaeology with relevance for society. How can such communication efforts and publication strategies be made and what does society want or need?

I intend to continue working with these questions and others in the forthcoming doctoral thesis with the aim of bridging the gap between digital archaeology within academia and contract archaeology by introducing methods and tools valuable for archaeological knowledge development.
Swedish Summary (Sammanfattning)

Den här forskningen har studerat digitaliseringen av arkeologin med fokus på svensk uppdragsarkeologi. Målet har varit att öka förståelsen kring hur disciplinen förhåller sig till de förändringar som digitaliseringens innebär och människans roll i dessa processer. Avhandlingen är en studie av digitaliserings betydelse för de arkeologiska processer som berör kunskapsproduktion och kommunikation. Arbetet problematiserar förståelsen av digitala data inom dessa kontexter men visar också på digitaliserings potential och hur arkeologin kan dra nytta av den. Forskningen aktualiserar på nytt det teoretiska angreppssättet reflexivitet i ett digitalt sammanhang och kombinerar detta med kommunikationsteorier i syfte att utmana det arkeologiska arbetsflödet och knyta det närmare dagens samhälle.


Frågeställningar

- Hur kan arkeologiska digitala data förstås inom kontexterna kunskapsproduktion och kommunikation?
- Vad kan sägas om vilken påverkan digitaliseringen har på arkeologin och speciellt uppdragsarkeologin, hur kan detta problematiseras ytterligare när det gäller kunskapsproduktion och kommunikation?
- Var finns potentialen i digital kommunikation och hur kan den användas av arkeologin?

Slutsatser

Min forskning visar att digitala data kan förstås som en produkt av interaktion mellan människa – maskin men också mellan människa – människa bestående av flera processer. När fokus riktas på digitala verktyg reflekterar vissa arkeologer kring att technologin är fri från mänskliga fördomar, något som min forskning talar emot. Ett digitalt verktyg är skapat av en person, används av en person och data analyserat av en person. Digitala data behöver därför vara transparent så att granskning och utvärdering kan göras för att förstå vad den representerar. När allt större mängder arkeologisk information skapas digitalt, blir digitala data det viktigaste materialet i en framtida kunskapsutveckling, vad arkeologer kommer att använda sig av i tolkningsprocesser och


Mina fallstudier av svensk uppdragsarkeologi visar att sektorn till stor del är i en experimenteringsfas där många upptäcker görs hur plattor, 3D och gräsnitt på internet kan användas i fält, inom organisationen eller av den enskilde arkeologen på bästa sätt. Viljan att vara digital matchas dock inte av den digitala infrastrukturen för uppdragsarkeologi och organisationerna håller en fart och myndigheterna en annan. Ett exempel på detta är hur insamling av 3D data är väl utbredt inom sektorn men att föreskrifter, forskning eller strategier för arkivering av dessa data inte finns än. Den digitala utvecklingen i svensk uppdragsarkeologi har fått många positiva effekter som nya informationsflöden, öppna data och nya sätt att kommunicera med allmänheten. Men en framtida kunskapslucka riskerar att skapas när t.ex. inte primära data som använts till att skapa en 3D rekonstruktion finns tillgängliga, vilket gör det svårt för en annan forskare att återskapa den vetenskapliga processen bakom tolkningen. En annan observation är att digitaliseringen av uppdragsarkeologin ännu inte innefattar alla arkeologer, även om detta förändras snabbt. Det finns en arbetsplatskultur där det digitala uppfattas som en specialistkunskap även om de digitala verkygen nu blir mer användarvänligare och detta inte längre behöver vara fallet. Dessa sociala konstruktioner tar längre tid att förändra än tekniken och är minst en lika stor del av den digitala utvecklingen som nya
kraftfulla digitala verktyg. Synen på att det digitala är en separerad verksamhet från arkeologia i övrigt kan spåras genom hela sektorn, även om många ser det oundvikliga och att arkeologin idag till stora delar är digital. Min studie föreslår att digitaliseringen största genomslag på uppdragsarkeologin är på väg att håenda eller hålla på att hånda just nu, men att den inte än är fullt observerbar i forskningsmaterialet.


Digitaliseringens inverkan på uppdragsarkeologin skulle kunna bli större om sektorn gjorde flera förändringar. I en reglerad bransch måste många av initiativen komma uppifrån i form av riktlinjer och lagtexter, men mycket kan också åstadkommas av aktörerna själva. Till att börja med så behövs samarbeten mellan uppdragsarkeologiska organisationer men också med akademien och Riksantikvarieämbetet. På så sätt skulle nya steg kunna tas i den digitala utvecklingen som matchar de behov identifierbara av sektorn. I samarbete med forskning som rör digital arkeologi och samhällsresurser, kan nya strategier och system utvecklas som får än större påverkan på arkeologisk kunskapsutveckling och kommunikation samtidigt som den också gagnar samhällsbyggnadsprocessen.

Den här avhandlingen visar på potentialen i digital kommunikation inom arkeologin är stor och att den kan vara användbar på flera olika sätt i schacket, i den arkeologiska disciplinen och i samhället. Digitala verktyg har blivit kraftfulla hjälpmedel i den reflexiva processen både hos den individuella arkeologen men också i det dialektiska samtälet mellan arkeologer och andra specialister. Öppna arkeologiska data har på så sätt potentialen att förbättra
kunskapsproduktionen i schaktet och göra den öppen för mer information från andra källor för att utveckla den arkeologiska dokumentationen. En digital reflexivitet kan förändra den arkeologiska tolkningsprocessen och skapa arkeologiska data med större värde och relevans. En nyckel i att uppnå en givande kunskapsproduktion är transparens och tillgång till primära data. Den mobila digitala infrastrukturen med alla dess möjligheter för delning kommer dock inte fungera om inte data delas.

Agenten måste vara lyhörd och medveten om det omgivande samhällets behov och ha en insikt i vilka gränssnitt som fungerar bäst när engagerande narrativ ska skapas.
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L1. Çatalhöyük Research Portal
http://www.catalhoyuk.com/research

L2. CAA history
http://caa-international.org/about/history/

L3. Agisoft Photoscan
http://www.agisoft.com/

L4. MeshLab
http://www.meshlab.net/

L5. ArcGIS
http://www.arcgis.com/

L6. Intrasis
http://www.intrasis.com/

L7. Pompeii Bibliography and Mapping Project (PBMB)
http://digitalhumanities.umass.edu/pbmp/

L8. The Swedish Pompeii Project
http://www.pompejiprojektet.se/
L9. L-P: Archaeology
http://www.lparchaeology.com
L10. ARK – Archaeological Recording System
https://ark.lparchaeology.com/
L11. iDig
L12. Unity
https://unity3d.com/
L13. Time Scanners TV Show
http://www.timescanners.com/
L14. Arkeologikonsult
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L15. DAP (Digital Archaeological Process)
L16. Digisam
http://www.digisam.se/
L17. SND. Swedish National Data Service
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L18. Arkeologerna/The Archaeologists
http://riogbg.se/
L20. Bohusläns Museum
http://www.bohuslansmuseum.se/en/
L21. Kulturmiljö Halland
http://www.kulturmiljohalland.se/
L22. Kulturmiljö Halland. 3D models
http://www.kulturmiljohalland.se/3d.html
http://arcg.is/1eb9zD
https://youtu.be/Zhk5ZDziQg
L25. Sandby borg. Information Pavilion
https://www.raa.se/spana/patinerad-paviljong-med-hogteknologiskt-inre/
L26. Sandby borg. House 40 in 3D
https://skfb.ly/LZqQ
L27. Sandby borg. Website
http://www.sandbyborg.se/en/home/
http://arcg.is/1Hbv9S
L29. RISE Interactive C-studio
https://www.tii.se/groups/c-studio

148
L30. EMOTIVE project
https://www.emotiveproject.eu/
L31. Time Berners-Lee 5-star deployment scheme for open data
http://5stardata.info/en/
Appendix 1. Interview material

Original text presented to the participants before the interviews:

Bakgrund
Denna intervju är en del av datainsamling till avhandlingsarbete för Fredrik Gunnarsson (GRASCA, Institutionen för Kulturvetenskaper, Linnéuniversitet). Avhandlingen ämnar studera hur digitalisering påverkar den arkeologiska disciplinen med fokus riktat på uppdragsarkeologin gällande dokumentation och kommunikation. Intervjuerna görs i olika delar av den uppdragsarkeologiska sektorn (på myndighetsnivå, i uppdragsarkeologiska projekt, i uppdragsarkeologiska organisationer och företag) för att belysa läget och digitaliseringens olika delar och dess betydelse för sektorn. Insamlat data baserat på intervjuer är inte en förutsättning för analys utan ett komplement till övriga källor.

Förutsättningar
**English translation:**

**Background**

This interview is part of the data collection for Fredrik Gunnarsson’s work with his thesis (GRASCA, dept. of Cultural Science). The aim of the thesis is to study how digitalisation affects the archaeological discipline. Focus is put upon contract archaeology concerning *documentation* and *communication*. The interviews are conducted within different parts of the sector of contract archaeology (at a government level, in contract archaeology projects, at contract archaeology organisations and businesses) to illustrate the current situation and the different parts of the digitalisation and its impact on the sector. Collected data is not the only base for analysis, but a complement to the other source material.

**Conditions**

This interview is documented with sound recording/video and is then transcribed. Primary data is saved, and the original files will be available for those who wish to study them after publication of the thesis. The interviewed person has the choice of being anonymous in the published text, but that info will be available in the original recording. How this is ultimately done is decided in dialogue with the interviewee. This work aims to be transparent and the concept of open data, including primary data, applies as far as possible (see e.g. Vetenskapsrådet 2016: ’Directions to the future Swedish research system’). In referenced text it will be clear which are the words of the author and which are the words of the interviewees. The author guarantees that the interviewed person will be able to see the text before publication and that nothing is published without *consent*. Participation is *voluntary*, and the interviewee can at any time withdraw (Vetenskapsrådet 2002: ’Forskningsetiska principer’). The interview is based on a qualitative approach and is meant to be performed as a conversation where the questions are seen as a point of departure but not a basis (Olson 2016: ’Essentials of Qualitative Interviewing’). If these terms are accepted on the sound recording, this is regarded as the participant having agreed to the above statement.
## Appendix 2. Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AI</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>ABM</td>
<td>Agent Based Modelling</td>
</tr>
<tr>
<td>ADS</td>
<td>Archaeological Data Service</td>
</tr>
<tr>
<td>AR</td>
<td>Augmented Reality</td>
</tr>
<tr>
<td>ARK</td>
<td>Archaeological Recording Kit</td>
</tr>
<tr>
<td>ASCSA</td>
<td>American School of Classical Studies at Athens</td>
</tr>
<tr>
<td>CAA</td>
<td>Computer Applications and Quantitative Methods in Archaeology</td>
</tr>
<tr>
<td>CAB</td>
<td>County Administration Board</td>
</tr>
<tr>
<td>CADA</td>
<td>Centre d’Analyse Documentaire en Archéologie</td>
</tr>
<tr>
<td>DAP</td>
<td>Digital Archaeological Process</td>
</tr>
<tr>
<td>Digisam</td>
<td>Secretariat for National Coordination of Digitisation, Digital Preservation and Digital Access to Cultural Heritage</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographical Information System</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>GUI</td>
<td>Graphical User Interface</td>
</tr>
<tr>
<td>IBM</td>
<td>Image Base Modelling</td>
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<tr>
<td>IDA</td>
<td>Instant field Documentation system and Availability</td>
</tr>
<tr>
<td>ICT</td>
<td>Information and Communication Technology</td>
</tr>
<tr>
<td>KAP</td>
<td>Kaymakci Archaeological Project</td>
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<tr>
<td>KCM</td>
<td>Kalmar County Museum</td>
</tr>
<tr>
<td>KMH</td>
<td>Kulturmiljö Halland (Heritage Halland)</td>
</tr>
<tr>
<td>KMR</td>
<td>Kulturmiljöregistret (Cultural Environment Register)</td>
</tr>
<tr>
<td>LEAP</td>
<td>Learning of Archaeology through Presence</td>
</tr>
<tr>
<td>LNU</td>
<td>Linnaeus University</td>
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<tr>
<td>LU</td>
<td>Lund University</td>
</tr>
<tr>
<td>MA</td>
<td>Department of Museum Archaeology</td>
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<tr>
<td>MR</td>
<td>Mixed Reality</td>
</tr>
<tr>
<td>NHB</td>
<td>National Heritage Board</td>
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<tr>
<td>PARPS:PS</td>
<td>Pompeii Archaeological Research Project: Porta Stabia</td>
</tr>
<tr>
<td>PBMB</td>
<td>The Pompeii Bibliography and Mapping Project</td>
</tr>
<tr>
<td>RISE</td>
<td>Research Institutes of Sweden</td>
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<tr>
<td>SFM</td>
<td>Structure from Motion</td>
</tr>
<tr>
<td>SNA</td>
<td>Swedish National Archives</td>
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<tr>
<td>SND</td>
<td>Swedish National Data Service</td>
</tr>
<tr>
<td>SKAP</td>
<td>Say Kah Archaeological Project</td>
</tr>
<tr>
<td>tDAR</td>
<td>The Digital Archaeological Record</td>
</tr>
<tr>
<td>UID</td>
<td>Unique Identifiers</td>
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<tr>
<td>VR</td>
<td>Virtual Reality</td>
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GRASCA – The Graduate School in Contract Archaeology – is a research school for Swedish contract archaeology at Linnaeus University. The doctoral students in GRASCA develop new competencies for contemporary archaeology enhancing its capability for meaningful social engagement and competitiveness. This publication is a licentiate thesis (Sw. licentiatuppsats) from the research school. The research school is a unique venture financed by Bohusläns Museum, Jamtli in Östersund, Kalmar County Museum Department of Museum Archaeology and the Conservation Service, Västarvet Studio Västsvensk Konservering in partnership with The Knowledge Foundation and Linnaeus University.

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