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3D Reconstruction of Advent City
(SEPF ID 16/64; RiS ID 6917)

Final Report

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NON-TECHNICAL SUMMARY

Today, the former English mining settlement of Advent City in Adventfjorden, Svalbard, is in ruins. Many of its buildings still exist at nearby Hiorthhamn in their original state.

In summer 2016, a team of archaeologists carried out a high-resolution topographic survey at Advent City as well as detailed photographic recording at Hiorthhamn.

With the funding from the Svalbard Environmental Protection Fund (project ID 16/64), a team of archaeologists, surveyors, and software developers of the eScience-Center at Tübingen Univeristy joined the dots: they made the 3D reconstruction and visualisation of Advent City possible

The tangible outcome of this project is a fly-though video of Advent City. After more than a century, the video shows the former pre-fabricated houses back again in their original locations.

You can view the video and read more about the project online at:

https://escience-center.uni-tuebingen.de/svalbard/dist/

The project was an initial phase. We are planning more fieldwork to improve the visualisation of Advent City. We hope to attract interest to this work in order to develop a network of “digital enthusiast” and drive the digitisation of some of Svalbard’s most valuable heritage sites.

KEYWORDS

3D reconstruction, digital visualisation, knowledge representation in digital spaces, perception of digital spaces

CONTENTS

1. INTRODUCTION

Advent City (1904-1908) in Adventfjorden was the first year-round mining village in Svalbard. Today, it is in ruins; only its building foundations are visible (Fig. 1). Most of the former buildings, however, still exist in their original state at Hiorthhamn (Johannessen, 1997; Kruse, 2015; Fig. 2).

Fig. 1. Fieldwork among the ruins of Advent City. Comparing historical photographs with archaeological reality. Photo: Rosanne van Bodegom, 2016.

Fig. 2. Reconnaissance at Hiorthhamn. These are some of the original buildings from Advent City. Photo: Frigga Kruse, 2014.

In August 2016, archaeologists made a detailed topographic survey at Advent City and carried out photogrammetry at Hiorthhamn. That is to say, we systematically took very detailed photos of the upstanding historical houses (Fig. 3). We then sought funding

from the Svalbard Environmental Protection Fund for employing a specialist in order to reconstruct the Hiorthhamn houses in 3D and place them back in their original positions at Advent City.

Fig. 3. Survey and photogrammetry in progress at a former workers' barrack now located at Hiorthhamn. Photo: Frigga Kruse, 2016.

Having received the funding (ID 16/64), the eScience-Center of Tübingen University joined the project and produced an educational fly-over video through the mining village. The fly-through is currently publically available online.

This final project report has been produced as a requirement by the Svalbard Environmental Protection Fund.

2. BACKGROUND

This project is a "by-product" of an archaeological excavation and a vegetation survey that already took place at Advent City in August 2016 in order to investigate human impact of the former mining settlement on its local environment (RiS ID 10516, RiS ID 10597). The fieldwork was led by Dr Frigga Kruse, who has substantial knowledge of the historical archaeology of Advent City (Kruse, 2013; 2015; 2016 a, b, c). She had previously become aware that the houses of Advent City had been re-built in their very original state, no obvious modifications, at Hiorthhamn. Being the oldest group of upstanding buildings still in use in Svalbard, this warranted the detailed recording of Hiorthhamn (in case anything should ever happen to these buildings like the fire that

destroyed a house of significant heritage value at Brucebyen in 2010!). Such detailed recording additionally entailed the opportunity for digital reconstruction of the houses and their visualisation at their former location in 3D.

Thus, it was a very exciting side-line to the excavation that, if time and weather conditions should permit, we would walk to Hiorthhamn and spend a day carrying out detailed photogrammetry, i.e. using geospatial markers and taking photos in such a way that would allow later computer processing and digital reconstruction. This method has been employed in Svalbard before with fantastic results (see, for example, the recent 3D model of grave 202 at Likneset: https://sketchfab.com/arild.vivaas)

3. AIMS AND OBJECTIVES

Time and weather did permit a fine, calm day for data collection in Hiorthhamn (before two archaeologically-minded polar bears visited our excavation and cut our fieldwork short!) Hence, the data sets for this project had already been gathered. The additional funding allowed this data to be processed and displayed. Kruse and Nobles did not have the expertise to do so. Therefore, the work was sub-contracted to the eScience-Center of Tübingen University.

We communicated the following project objectives to the eScience-Center:

1) *To process the topographic survey data and photos of Advent City to create a 3D terrain model of the former mining settlement*
2) *To process the photos of Hiorthhamn to create 3D reconstructions of the original buildings of Advent City*
3) *To place the original buildings back in the former locations in Advent City and create a 3D model of the whole village*
4) *To create a fly-over video of the village and in tandem with Kruse add historical and archaeological details to the features*
5) *To create an educational package for display first and foremost at the Svalbard Museum (but with potential use as a teaching tool elsewhere)*

Please note: the creation of this package does not automatically include its acceptance and/or the development of a suitable display at the Svalbard Museum or elsewhere. Future discussions will pinpoint possibilities in Longyearbyen.

In short, the data for a 3D reconstruction of Advent City already existed. The funding was meant to make sure that something can be done with it to let a broad public enjoy and appreciate this unique example of Arctic industrial heritage – and learn from it.

4. METHODOLOGY

After a slow start with an unsuitable sub-contractor, Dr. Matthias Lang from the eScience-Center at Tübingen University send us a very encouraging email on July 21, 2018. We include it in full because it essentially constitutes the project methodology. Anything that we did not carry out as described here, we will comment on in the Reflections below.

Dear Frigga, dear Gary, we had a look for the data and we think we can deliver what you want. But before we really start we want to propose you a workflow and we have some questions regarding the organization.

First to our workflow and the expected results.

1) *We will recalculate all the houses in a more recent version of Photoscan to obtain better texture-packs and a cleaner geometry.*
2) *We will remodel all the houses in Blender based on the photogrammetrical models to keep the polycount as low as possible to make the system performant. Furthermore, remodeling is faster than cleaning and fixing the models.*
3) *We will generate textures from the original models with normal-, height- and ambient occlusion maps.*
4) *As soon as we have the images and the GPS-generated DEM from the site, we will develop a procedural landscape model in Unity.*
5) *The models will be integrated in the landscape.*
6) *Historic photos, texts, and all other additional information will be displayed in the interface.*
7) *All textual information should be incorporated in English and Norwegian. We have a team member who is fluent in Norwegian so we wouldn´t need any help with that.*
8) *We will try to offer different ways of exploring the site.*

a. It will be possible to walk from house to house. As it will take long and it gets boring easily, we will offer two other ways.

b. We will incorporate a mini-map in the interface, which can be used to jump from feature to feature.

c. You can fly over the site with a jetpack

9) We will make the project available in different versions.

a. as an exe-file which can be run on every Windows-based machine.

b. as an HTC-Vive-ready VR environment which also can be run on every Windows-machine and a HTC-Vive.

c. as a web-based application – as we don´t have any experience with that, we cannot guarantee it.

10) We will maintain the project for one year.

11) Raw-data will be archived in standard formats in the research-data repository of Tübingen University.

Second to our questions and wishes

1. *Who will be responsible for the setup in the museum and who will be responsible for buying and maintaining the equipment?*

2. *On which platform and under which license the project should be made available?*

3. *We would recommend to publish everything under CC BY NC including all the raw-data for re-use.*

4. *We want the right to use all data for teaching purposes after publication.*

5. *We will investigate how being a sub-contractor to the project verses initiating an official research collaboration with you relates to German tax requirements.*

6. *To get access to the money, our University administration will send an invoice to the funding body.*

In CC you will find the email-addresses of the three developers. Vinzenz [Rosenkranz] is a software-developer, who will be responsible for some of the modelling and the data-management. Philippe [Kluge] is a surveyor, will generate the landscape-model, and will setup the game-engine with all its interfaces and functionalities. Luca [Brunke] is an archaeologist with a Masters in Digital Archaeology from Leiden and is responsible for the modelling and the textures. If it comes to technical questions, they might contact you directly.

We are looking forward to work on your project as it fits so perfect as a case study in our research on using complex 3D-enviroments as a research tool. Beside my own team the Leibniz-Institut für Wissensmedien and the Max-Planck-Institut für biologische Kybernetik will be also incorporated into the project to discuss knowledge representation and the perception of digital spaces.

Thanks for having us in your team! All the best, Matthias

5. RESULTS

The project "3D Reconstruction of Advent City" sought funding from the Svalbard Environmental Protection Fund for employing specialist help in order to visualise the historical buildings of Hiorthhamn in 3D and place them back, so to speak, in their original positions at Advent City.

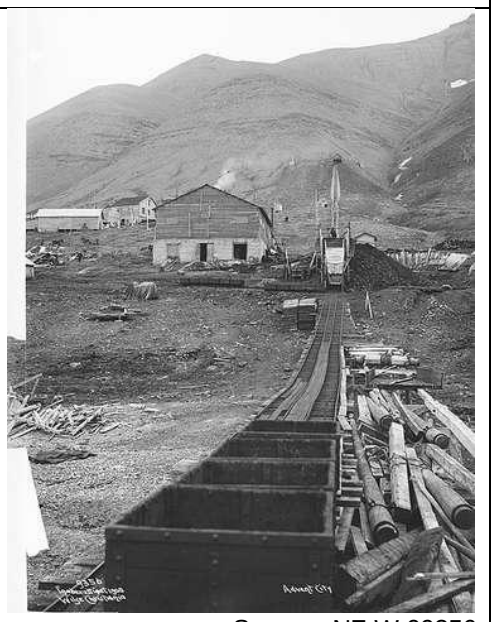
5a. Fly-through video

As promised, the tangible outcome is **a fly-over video** through the former English mining village that once operated across the fjord from Longyearbyen (Fig. 4).

Fig. 4. The fly-through is titled *Advent City. Svalbard's first year-round mining town. A visualisation of the year 1908.*

We include a few screen shots from the fly-through (Table 1). We did not choose the flight path specifically with a direct comparison to historical photographs in mind. Where they come close, we include those scenes here to give an overall impression of the accuracy of the visualisation.

Table 1. A rough comparison between screen shots from the fly-through and historical photographs of Advent City. NF.W stands for the Norsk Folkemuseum – Wilse Collection. Np stands for Norsk Polarinstitutt.

 Overview of Advent City in Adventfjorden, Svalbard	 Source: Facebook
 The engine house and self-acting incline to the mine	 Source: NF.W 09356

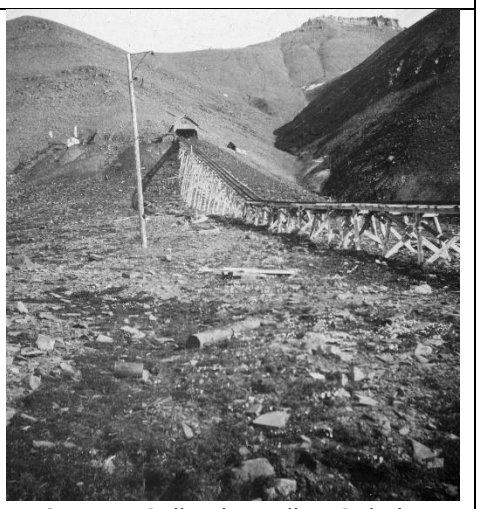
A village “street”

Source: np002339

Huset: the manager’s house

Source: NF.W 05521

The self-acting incline to the mine



Source: Collection Miles Oglethorpe

The smithy at the mine

Source: NF.W 05514

Overview of Advent City as seen from the mine

Source: Collection Miles Oglethorpe

The workers' barracks as seen from the mine

Source: NF.W 05517

The official house

Source: Collection Miles Oglethorpe

5b. Publically accessible website

The fly-through is embedded in the publically accessible website **"Virtual Advent City"**, which is hosted by the eScience-Center of Tübingen University:

https://escience-center.uni-tuebingen.de/svalbard/dist/

This public platform allows us to include some informative and educational details. Figs. 5 – 9 are screenshots of the individual web pages and their content.

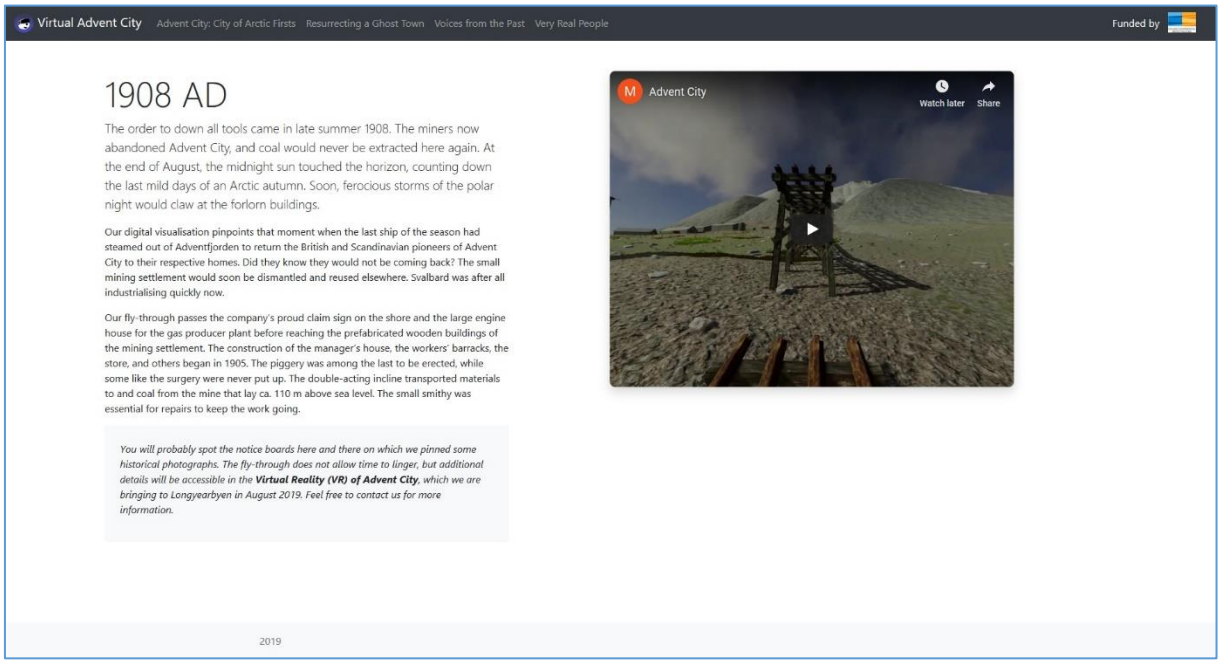


Fig. 5 Our web-based narrative begins at the end of summer **1908 AD** – one day after the last steamer had taken the last people away from the site. After four years in operation, Advent City lay deserted.

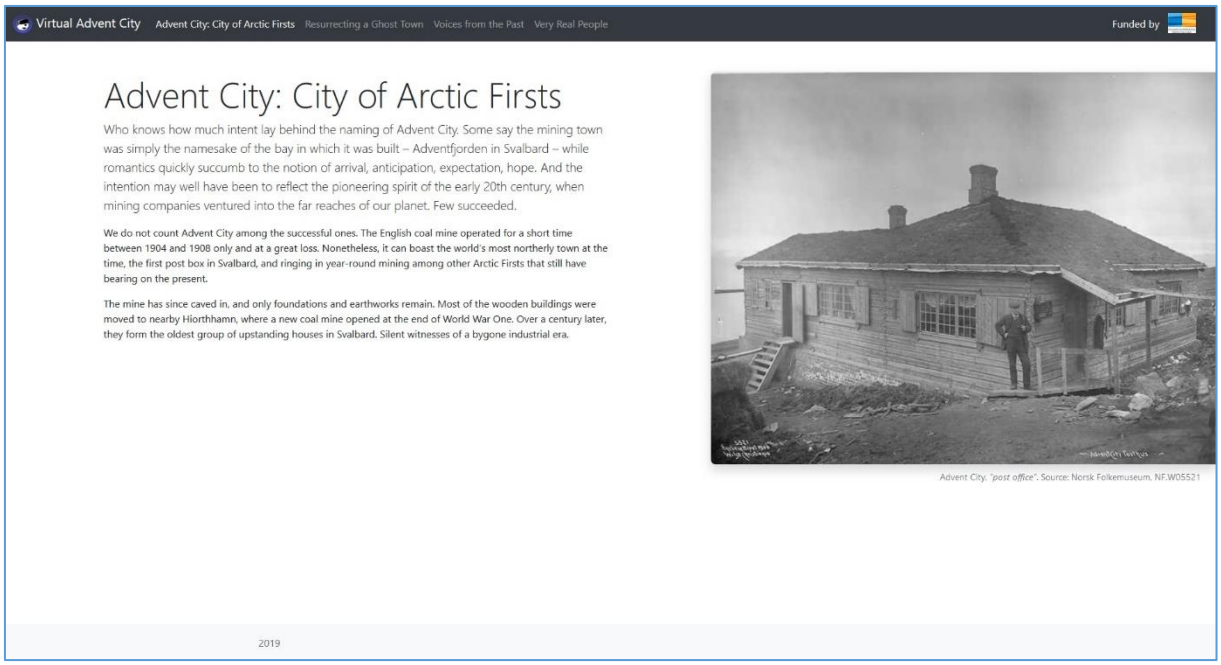


Fig. 6. It is important that our narrative is not just one of mining failure. A key message is that Advent City was a **City of Arctic Firsts**, a pioneering site in industrialising Svalbard.

Fig. 7. Generally, we have kept the educational content of the website brief. This page informs the visitor of the fieldwork in 2016 and the data processing at the eScience-Center that preceded the **Resurrection of a Ghost Town.**

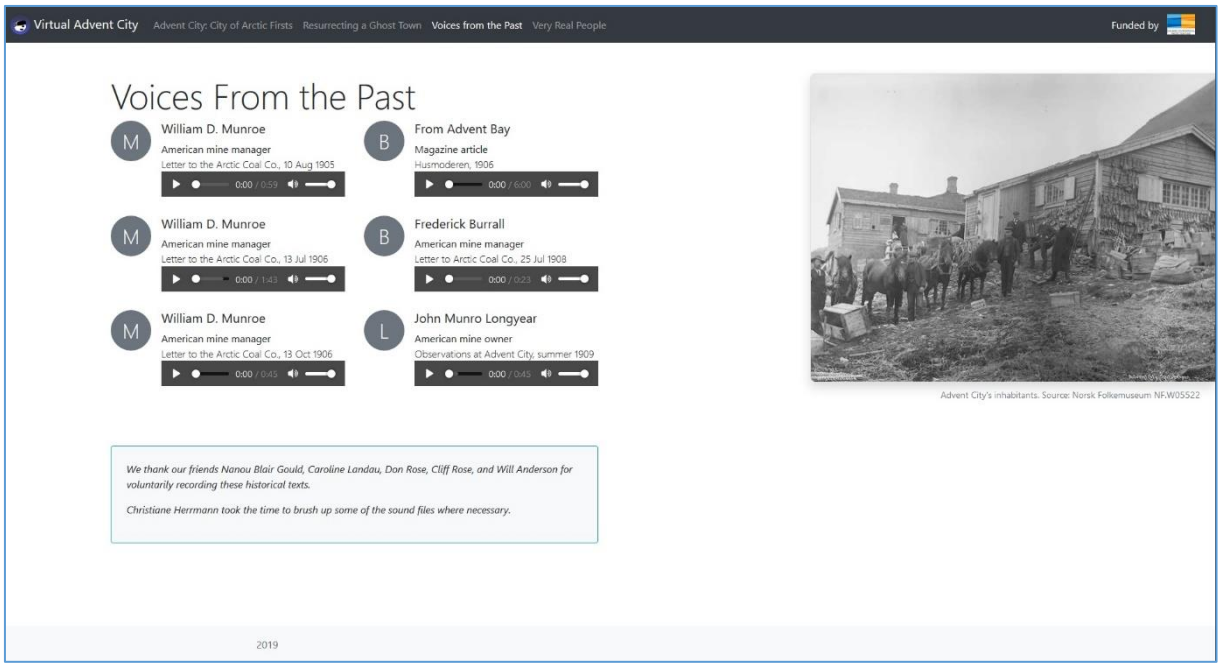


Fig. 8. Sieving through the available historical texts, we pinpointed some poignant passages that paint a contemporary picture of Advent City. Friends helped us to record these **Voices From the Past**.

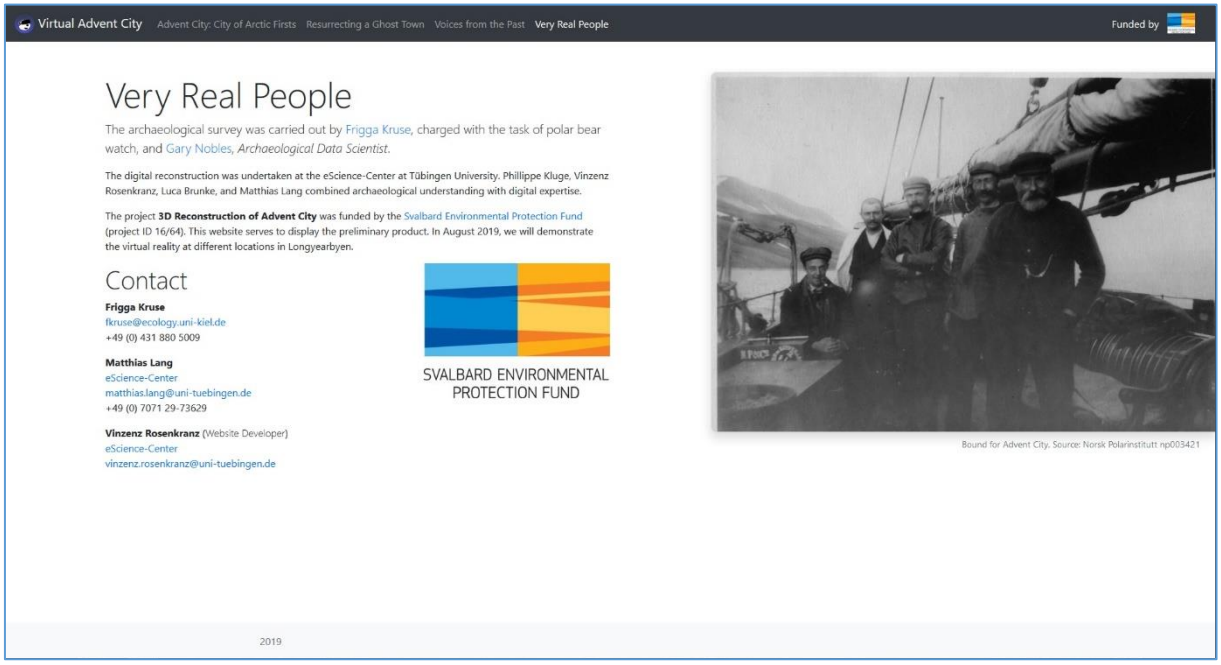


Fig. 9. Behind every historical, digital, and virtual project, there are some **Very Real People**. We have been lucky to generate quite some interest from volunteers, too.

Although we are in the possession of much more textual, photographic, and audible material, we have drawn a line under the website for the time being. Reasons for this are given in the section below.

6. REFLECTIONS

We view our digital reconstruction and visualisation of Advent City as a first important step both for eventually achieving a much higher standard of virtual environment and archaeo-gaming at our mining site and for initiating the systematic digitization of Svalbard's cultural heritage as a whole (or at least a representative whole).

This first step has brought with it much opportunity for reflection. Our reflection is guided by two projects similar to our own, a Canadian Arctic example and another Svalbard example, from which we have drawn much inspiration. We have also recently submitted an abstract for a presentation at the Digital Humanities Conference 2019 in Leiden – the hard but fair rejection of our paper provided further food for thought.

6a. A Canadian Arctic example

With their aptly titled paper "From science to survival: using virtual exhibits to communicate the significance of polar heritage sites in the Canadian Arctic", Dawson and Levy (2016) present a magnificent project funded by and completed for the Virtual Museum of Canada. Without explicitly stating so, they make very clear why a digitisation project in the Polar Regions is very different to one in temperature regions. Their sentences are to the point, and we make no attempt at paraphrasing. Instead, we prefer to quote the most poignant and Svalbard-relevant statements in full:

Climate change and the emerging geopolitical significance of the Arctic have important implications for Canada's polar heritage. P. 209

[The] key messages that define the significance of polar heritage are often challenging to communicate to the public. Heritage agencies such as Parks Canada rely primarily on visitor experience (i.e. going to see a heritage site) to explain the historic events and personalities associated with certain places, and why they have been deemed significant by national and international bodies […] p. 210

Virtual heritage offers a potential solution to this problem [of geographic isolation and complete inaccessibility]. Allowing visitors to virtually experience an online computer reconstruction of a polar heritage site, including historic buildings and other cultural

features, provides unique opportunities to communicate key messages used to define their significance. P. 201

[…] we discuss how reality capture technologies, computer reconstructions, and games are being used to achieve these objectives for Fort Conger […] p. 201

At the same time, we point out that issues relating to authenticity, the limitations of cyber infrastructure in northern communities, and the need to eliminate barriers to web accessibility present challenges that must be addressed for these technologies to be used to full effect. P. 201

Online virtual heritage environments created using 3D media offer a viable alternative when opportunities to physically visit heritage sites are restricted – as is the case at sites like Fort Conger. These types of educational technologies, which also include "serious games", have proven an effective means of communicating history to non-specialists. P. 215

(A serious game or applied game is a game designed for a primary purpose other than pure entertainment. Serious games have been used in industries like defense, scientific research, emergency management, and education. P. 214.)

Drawing on these citations, we offer some additional reflective comments. Our weather-dependent reality capture technologies were not perfect; in fact, much of the photogrammetrical data (if not all of it) had to be remodelled instead. Computer reconstruction at the eScience-Center, however, appeared to progress swiftly with the current software and procedure standards. We have not yet incorporated any gaming functions, but it is certainly on our minds.

We ran into the issue of Arctic authenticity almost immediately, when we, like the team at Fort Conger, could not easily represent the cold and the darkness in our visualisation and chose to show just one particular day in August 1908 instead. The readily available vegetation packages were for temperate plants only. There were no fences as such at Advent City: we put them and several other secondary features in to reduce the vastness of the site and guide the virtual visitor around the places of interest more effectively. The success of our fly-through and anything we may want to try thereafter now depends on how well we can attract stakeholders in policy-making, society, education, and tourism to our vision: this will also address the question of infrastructure

and hardware that can be made available in Longyearbyen (and elsewhere) to display the product in the best possible way. In terms of web accessibility, we are aware of international differences in web accessibility regulations, but we have not yet immersed ourselves in those (and secretly hope it will not be necessary).

In all, we feel that our technologies at Advent City have by no means already reached their full effect. We have also not yet tapped into the full educational potential of the site, but we intend to do so.

6b. A Svalbard example

Lewinska and Zagorski (2018) provide an example of a digitisation project for Svalbard. In their paper "Creating a 3D database of Svalbard's historical sites: 3D inventory and virtual reconstruction of a mining building at Camp Asbestos, Wedel Jarlsberg Land, Svalbard", they state:

The rapid progress of three-dimensional (3D) modelling software allows for creating or recreating the shape of some of those objects in 3D computer space […] Although this is not the same as proper maintenance of historical objects, it can provide backup information on an object's geometry that could be used for education and reconstruction purposes. P. 1

Also, having a 3D vector shape allows for 3D printing. It would be ideal to create an open-access web server consisting of vector shapes representing various historical sites […] This article proposes how such a database could be started. P. 1

Such objects could be stored in a 3D database and, if needed, destroyed parts could be physically reconstructed using these data. A 3D print would also be available, which would be useful for a physical reconstruction project. Smaller 3D prints can be produced for museums and interactive exhibitions […] p. 8

Based on this paper, we are essentially excited that there are others interested in a joint digitisation project, who recognise the preservation and education potential. The progress in the necessary software is on the whole very fast and good.

However, the paper offers very little in the form of an overarching project design. It does not identify suitable sites, likely stakeholders, crucial funding. An overarching project would probably require the full-time position of a data manager and archivist. What format would we need to store the data in and what would be its longevity? If a network of interested parties were to develop, we would probably first need to discuss and differentiate between current band waggons (like 3D printing) and data and display formats fit and sustainable for the future.

We just opened a large can of worms there… but an exciting one ☺

6c. Our submission to DH2019 in Leiden

Under the title "Virtual Svalbard – new digital approaches to polar archaeology", we submitted an abstract for a presentation to the Digital Humanities Conference 2019 in Leiden – and were rejected. It is instructive to share why.

The most understanding of the reviewers (83 or 100 points) summarised the contribution of our submission to the digital humanities as follows:

The project aims to demonstrate the potential of archaeo-gaming environments for the presentation of archaeological evidence combined with historical sources and media like historic imagery for a wider public.

This reviewer additionally commented that, *the key challenge here was to make accessible an environmentally sensitive and remote landscape to raise the public awareness of Arctic industrial heritage with the past and continuing human impact this landscape is subject to.*

Other reviewers stated:

What is entirely missing […] is a higher level discussion of theoretical and methodological underpinnings. Case studies are interesting but authors should also try to contextualise them in previous work and also discuss the benefits and challenges of their approach. A detailed presentation of a methodology, although useful, does not indicate if the authors have thought about the 'so what' question.

Where the abstract, and the paper itself, require further development is in the analytic. What exactly does the reconstruction offer to the study of this location? How and why were decisions made around specific technologies, and how was that influenced by the needs of the location itself?

[…] the impact is lost by a limited development of the problem and seemingly short discussion of the findings.

We feel that these comments were entirely justified and have taken them to heart. We are now in the process of preparing an interdisciplinary article involving archaeologists, software developers, educators, and others to address the various issues including knowledge representation and the perception of digital spaces in Advent City.

In order to contextualise our project, we have drawn inspiration from the previous work mentioned above and other topical papers. We are keeping a close eye on new developments. We are particularly fond of the serious game "EcoOcean – an Overfishing Simulation" (www.ecoocean.de), which uses interactive posters and a computer game. "Explore the Shore Stations of South Georgia" (www.shadowindustries.co.uk/south-georgia) uses Lidar Interactive Kiosks to relate stories of Antarctic whaling is the wider public.

What it all seems to boil down to, like so often, is money and time to involve the range of specialists needed to develop such intricate educational platforms to a high standard. We have duly noted that the Norwegian Directorate for Cultural Heritage has part-funded the South Georgia project ;)

So what? Archaeo-gaming should not just be a game. It is exciting; it still has a novelty factor in Svalbard, but there is a serious purpose for cultural heritage management. If addressed and promoted systematically, archaeological sites representing one or more Svalbard eras and industries could be captured with the goal of telling the site narratives and, more importantly, share key messages of Arctic and global heritage value. This will be even more significant for sites that have already been closed or are about to be closed to visitors and therefore first-hand visitor experience.

7. RECOMMENDATIONS FOR FUTURE WORK

7a. Upcoming fieldwork in 2019

We have already identified three aims for a trip to Longyearbyen in August 2019. We have asked the Svalbard Environmental Protection Fund for financial help with travel and accommodation, but our envisaged fieldwork does not entirely depend on such a grant.

1) We would like to present our reconstruction project to the public at selected locations around Longyearbyen
    a. As a talk and PowerPoint presentation
    b. As a Virtual Reality for which we will provide the necessary hardware

2) We would like to improve our visualisation of Advent City by
    a. Returning to Advent City in order to
        i. Test other reality capture technologies
        ii. Gather high-resolution data on ground conditions and vegetation types and patterns
    b. Returning to Hiorthhamn in order to
        i. Test other reality capture technologies
        ii. Record the interiors of the relevant buildings (owner-permission dependent

3) We would like to expand on our digitisation project with a test run at Old Longyear City, recording the foundations of the former buildings and details of the surrounding landscape.

7b. Digitisation of Svalbard's cultural heritage

We are quite convinced that Svalbard's cultural heritage holds narratives and messages of unique significance and regional and global value.

For that reason and due to the fact that Arctic heritage sites are suffering from a number of destructive stressors, we believe that a systematic digitisation programme will be of universal importance to Svalbard and far beyond.

We therefore propose an international workshop for policy-makers, societal players, educators, tour operators, and anyone else who thinks themselves a stakeholder to address matters identified in the reflection above:

- Identification of representative heritage sites for digitisation
- Reality capture technologies
- Computer reconstruction
- Serious games and educational and managerial tools
- Authenticity
- Limitations of cyber infrastructure
- Barriers to web accessibility
- Project design and funding!

Professional recording, display, and archiving is naturally important, but at the project's focus must be Svalbard's historical narratives and key messages.

8. ARCHIVE LOCATION

The topographic and photogrammetical data is currently kept in the personal data archives of Dr Gary Nobles. Copies of these data sets have been shared with Dr Matthias Lang and the eScience-Center at Tübingen University.

The eScience-Center will maintain the project for one year, although this time frame is highly flexible. All raw-data will be archived in standard formats in the research-data repository of Tübingen University.

The eScience-Center recommends publishing everything under CC BY NC including all the raw-data for re-use. So we will test if the RiS database is a suitable location for publication. We will in any case complete our project entry in the database, including a reference to the final archive location.

9. REFERENCES

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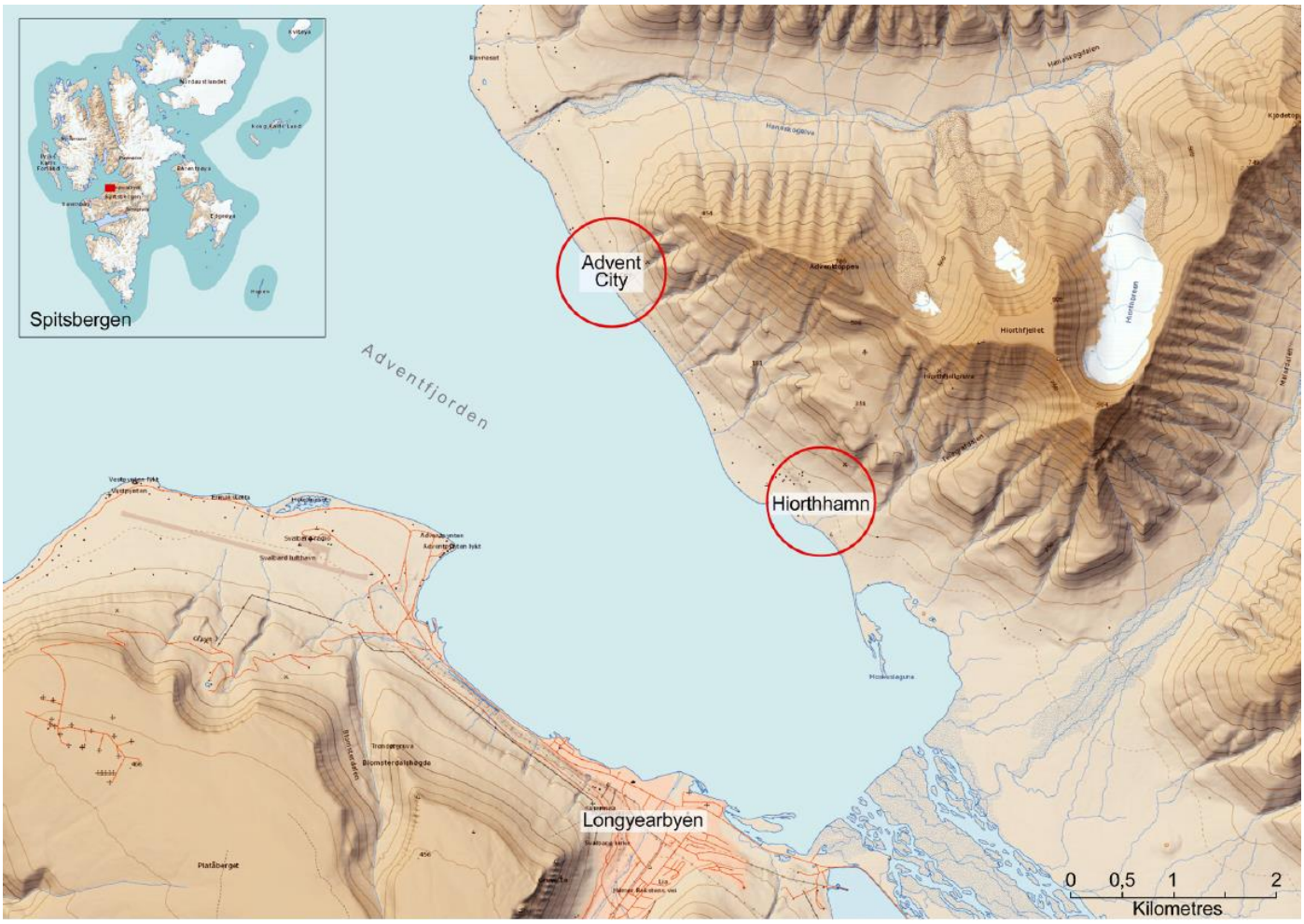
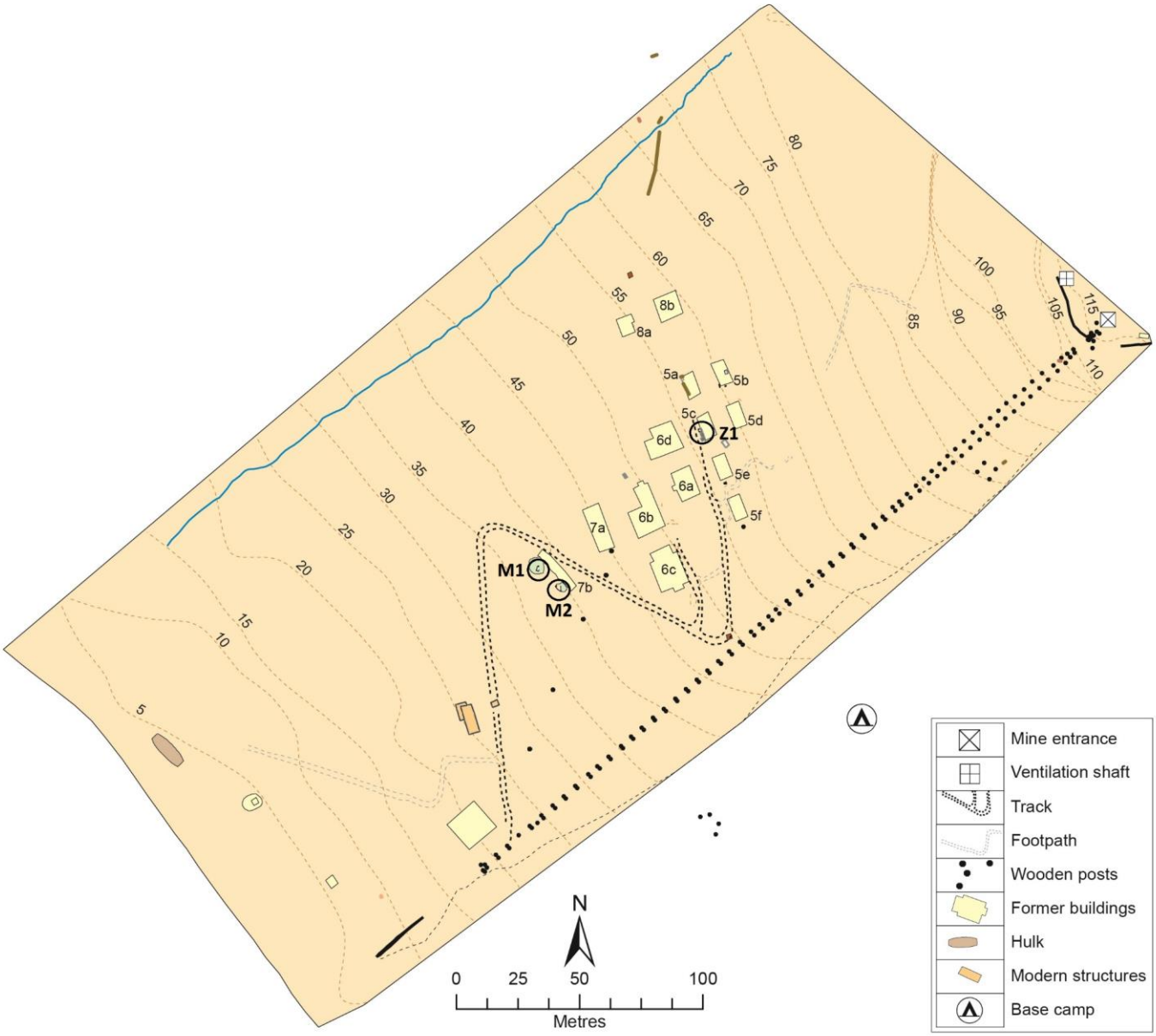
APPENDIX 1

Maps of Advent City



A1.1. Location map of Advent City and Hiorthhamn in Adventfjorden, Svalbard



A1.2. Site map of Advent City. The numbering is the same as those in the following lists and texts.

APPENDIX 2

List of archaeological structures (and functions) at Advent City

1a – Mine (1901)	Extracting the coal
1b – Air hole (1903)	Ventilating the tunnels
1c – Smithy (1903)	Repairing equipment and tools
3a & 3b – Gravity tram (1906)	Moving the coal to the shore
5a – 5f – Barrack (1905)	Housing the workforce, 16 per hut
6a – Store and shop (1905)	Provisioning the settlement
6b – Office (1906)	The mine administration
6c – Official house (1906)	Receiving company officials and visitors
6d – Manager's house (1905)	Housing the manager, officers, and doctor
7a – Barrack (1907)	Housing married people
7b – Stables (1907)	Shelter for horses and pigs
8a – Surgery and sickward	Providing health care
8b – Club house (1906)	Recreation for the workers
9 – Engine house (1906)	Power for the settlement and mine
10 – Lighter (1906)	Moving coal from the shore to seagoing vessels
Workers' privy	Outhouse with slop pails

APPENDIX 3

Draft texts per archaeological structure at Advent City.

Based on Kruse (2013). To be included as educational detail.

1A – The coal mine. How would you discover coal in the Arctic? Early prospectors probably targeted the stream beds, and where they found coal or other valuable minerals among the river gravel, they followed the stream upwards to the rock layer of origin. You can try this out yourself! In 1901, Norwegian prospectors claimed coal at this location over 100 m above sea level. The initial operations were so simple that they shot seals and used the seal blubber for lighting underground. When the British owners took over in 1904, they wanted to use longwall mining. The miners prepared a long coal face of over 500 m along which an electric disc coal cutter could run. Since mechanisation and electrification were adopted fairly late in Britain, the world's leading coal industry, we witness an extremely progressive design in the early Arctic mine and catch a glimpse of the ideology of the company. But was it an appropriate design? The electrification of the mine was never achieved and the coal cutter remains at Advent City: apparently no other local mines had any use for it. At a total output of 7,251 tons over four years and an income of only £6,000, the Advent City coal mine had not been a success before it was abandoned in 1908.

1B – The vent. A coal mine high above sea level had some advantages. There would have been very few problems with groundwater, especially when this was all locked up as permafrost. But the miners would still have been at risk from explosive substances and noxious gases. A mine needed at least two openings to assure the ventilation of fresh air inside the mountain. As the tunnels grew, more openings and pumping would have been necessary. Memories of fatal accident haunt every mining community.

1D – The blacksmith shop. The blacksmith was a very important figure at the mine. Who else would have maintained the equipment and repaired any broken tools? Did he also make horse shoes? Probably, as there were horses in Advent City, but there is no indication that the animals were used as pit ponies inside the mine.

2A – The ropeway. Here and there, we stumble across small groups of sawn-off posts sticking out of the ground: these were once the wooden towers for the aerial ropeway that transported the coal downhill. This transport system had an advantage over the later self-acting incline in that it required minimal capital outlay and was economical in operation; in short: it was cheap. In the hilly country around Adventfjord, ropeways bypassed the need for tunnels, cuttings, and embankments. They could cross rivers and ravines without the use of bridges. The initial simple ropeway at Advent City was replaced by a double-acting one, shifting loads down as well as up at the same time, already in 1904. The system covered a very short distance compared to the long

stretches around Longyearbyen. You can admire historical ropeway towers on a walk around today's capital!

3A – The self-acting incline. No one really knows why the Spitzbergen Coal & Trading Co. chose to replace the ropeway of 1904 with this self-acting incline so quickly. These transport systems are sometimes called gravity trams, since they operate tubs under gravity. One possible reason was that the incline could have handled greater loads. Mind, the loads never became great at Advent City! The construction work was done in winter 1905/6 by the light of paraffin lamps. It must have been freezing! And it can't have been easy: over 100 wooden posts needing to be sunk into the permafrost! The first 300-m long stretch led from the pit to a tip, where a screen was used to clean the coal. This meant removing the unwanted stone. The next stretch went from the tip to the pier, where the coal was loaded onto boats.

5A-F – The workers' barracks. Early accommodation had been on board or in tents, but proper housing was an important prerequisite to make the mine work. The building of the workers' barracks began in summer 1905. These were pre-fabricated buildings, like an early version of IKEA flat packs, ordered from Digre in Trondheim. A carpenter was sent to Spitsbergen to construct six of them; two more were never put up. At 16 men per barrack, they could house a workforce approaching 100. The wooden beams and boards had distinguishing marks for easy assembly, but despite the simple technique, the single-story houses were not simply made. To protect the inhabitants especially from the deadly winter, the walls had more than one facing. There were usually two double casings of boards with an airspace of several inches between. How do we know the pre-fabs were good? – They've all been relocated to other mining settlements.

6A – The store and shop. This pre-fabricated building was among the first group of houses to be completed in summer 1905. It had substantial concrete foundations. Concrete always gives the impression that something has been built to last, especially in the Arctic. But the particular form and function of the store escapes us. Did the shop actually sell something? No idea. The house seems to have been the last to be removed from Advent City. After the mine closed, Norwegian winter watchmen guarded the site for a while. They lived in this house and manufactured the fox traps they needed for their winter trapping.

6B – The manager's house. Work on 'Huset', the house, started before all others and was completed in summer 1905. This pre-fabricated building was the only one with a brick strip foundation, and we may wonder if this was somehow a show of prestige or rank. The manager was certainly the one to fly the Union Flag of Great Britain over the settlement. The houses of the officers comprised three wall layers with not only an airspace but also a layer made of insulating materials such as felt, cork, or linoleum to conserve yet more warmth. In 'Huset', there was a single row of rooms which accommodated successive managers, doctors, and likely visitors.

6C – The officers' house. We know precious little about this pre-fabricated building. It was put up on a substantial concrete strip foundation in summer 1906. Did the English foreman live here? And the Norwegian engineers? Your suggestions are welcome.

6D – The office. As with the officers' house, we know little more about this pre-fabricated building than that it was put up on yet another substantial concrete strip foundation in summer 1906. Presumably, the kind of office work typical for a small British coal mine of this day and age took place here.

7A – The family barrack. This most mysterious of the pre-fabricated buildings at Advent City first appears in a photograph from summer 1907. No doubt the company hoped to attract families to the Arctic, as they were thought to make more a more stable workforce, but did they succeed? Of the three women in the settlement that we have evidence for, one was the Norwegian doctor – yes, female! – and the other two may have been married to officers residing in the officers' house. No sign of children. This barrack was the first building to be taken down again, by the Arctic Coal Company, to be re-erected in Old Longyear City across Adventfjord. Only a foundation of wooden posts remains.

7B – The stables and pig house. No big deal was ever made out of such functional buildings, so the stables and pig house, which were in fact two buildings or at least erected in two phases, is the second largest mystery in Advent City after the family barrack. The stable to house the horses was built during winter 1906/7. It had a surprisingly thick concrete floor, maybe to keep the horses warm in the absence of bedding like straw. The pig house was probably put up by summer 1908, close to the settlement's abandonment.

8A – The sickward. A concrete strip foundation hints at the intention to construct another building, probably the sickward, directly below the clubhouse. If Advent City had survived beyond 1908, this may yet have happened.

8B – The clubhouse. It was almost certainly a good idea to erect the clubhouse in winter 1906/7 in order to give the men the opportunity for recreational activities when they were not working. However, the idea to also sell ample beer and spirits to them more than backfired. The resultant "unruliness" has often been cited as an underlying cause of the strikes at Advent City.

9 – The engine house. Essentially the power station of Advent City, the engine house of 1906 underlines the company's wish to mechanise and electrify the settlement and mine. Something independent, self-sufficient, and inexpensive was needed, so the directors opted for a suction gas producer. This is where it gets technical, but bear with me: air and water at atmospheric pressure were drawn through the white-hot fuel by the inhaling or suction action of the gas engine; although some water was necessary (no small task when everything was frozen!), the system did not require the raising of steam nor the use of large gas holders, relying on small metal tanks instead. It ran on

a mix of fuels including coal, coke, and charcoal. The crux of the matter at the time: the British Government regarded suction gas producers as unproven technology and refused to support their purchase for municipal usage. Were they an appropriate choice for an Arctic mining town? Fact is that three large and expensive gas engines remain at Advent City till this day; no one thought of re-using them elsewhere.

The privies. One particular question about remote places holds a never-ending fascination: where did they go to the toilet? Early photographs of Advent City reveal three freestanding outhouses, each with two cubicles, probably making use of buckets, so-called slop pails. These outhouses were probably allocated to the workforce while the officers enjoyed more private arrangements, possibly indoors. We may wonder what the alternatives were in a snow storm. Or when the slop pails froze. No less than eleven slop pails can still be found a Advent City today. They are riddled with bullet holes from the impromptu shooting practice of passers-by. We can easily understand why slop pails were not recycled elsewhere.

The pier. Advent City only had a poor natural harbour: the water was very shallow and the coast was exposed to storms and swell. Building any kind of pier was a challenge because each winter, sea ice damaged or destroyed any attempt. The pier was a small affair. Initially, rowing boats were used to transfer the coal from here to sea-going vessels in deeper water. Soon, lighters were bought to make this transfer more efficient. Nothing remains of the pier today. Maybe it was salvaged. It is just as likely that it was crushed.