"The ship took us to the deep, outermost Ocean
And the land of the Cimmerians, a people
Shrouded in mist. The sun never shines there,
Never climbs the starry sky to beam down at them,
Nor bathes them in the glow of its last golden rays;
Their wretched sky is always racked with night's gloom."

-Odyssey, Chapter 11, lines 13-18.
(Stanley Lombardo Translation)

CHAPTER 1

Introduction

Introduction

The experiences of Odysseus and his men in Cimmeria invoke a vision of Svalbard that many of those who visit Spitsbergen and its neighboring islands today never witness, the nearly six months of total darkness that result from its location above the polar circle. One can only imagine what it must have felt like, one hundred years ago, to trek upwards for more than a thousand feet to enter the coal mines of Old Longyear City, shrouded in the steady dark of the polar winter. Most have no experience comparable to leaving the freezing, bare night to enter the restricted gloom of a coal mine, to resurface hours later back into that all-encompassing darkness. I think Homer's quote, as it evokes not only the strangeness of a life without sunlight, also captures another quality experienced by the brave souls who first successfully mined a stable supply of coal on these remote islands. The American overseers and Norwegian workers who lived there were far from home, lost to the sun for months at a time. Did they share in Odysseus and his men's homesickness and frustration? Did they regret the decision to move to this remote part of the world?

The eventual success of the Arctic Coal Company's operation at Old Longyear City suggests that those who worked there overcame many of these negative aspects (Dole 1922b:435). I feel very fortunate to play a small role in telling their story. The focus of this thesis is not to create a theoretically-rich tapestry of what went on within the minds of the men (and a few women) who began Svalbard's first successful coal mine. Instead, what I seek to do with the data and experience gained from my time on Svalbard as part of an international team in August 2004 is help other archaeologists (especially students) learn to apply a body of techniques to successfully investigate the surface archaeology of a site. Where John Munro Longyear and his Arctic Coal Company successfully pioneered coal mining in Svalbard, I intend this thesis to pioneer a method of organizing archaeological data for use in a geographic information system (GIS). It is my intention to document the process of data collection and management within a GIS in such a way that it remains a viable research tool for future researchers at Michigan Tech and beyond.

Often, in archaeology, the use of technology is relegated to the periphery. Project leaders have come to increasingly rely on those who have specialized knowledge of certain technologies to conduct portions of archaeological investigations. In some cases, this is understandable, as with geophysical prospection. The host of technologies that now fit under that rubric includes magnetometry, conductivity, resistance surveys, and ground-penetrating radar (GPR). The specialization required to successfully operate these geoprospection machines require significant instruction and experience. This is even more necessary when these technologies are applied to archaeology, never the intention of those who first designed these machines (Conyers & Goodman 1997:18-19). In the past twenty-five years or so, a handful of archaeologists in the U.S., such as Dr. Kenneth L. Kvamme (University of Arkansas) and Dr. Lawrence B. Conyers (University of Denver), have pioneered the use of these machines in archaeology and continually seek to educate the next generation of archaeologists on their operation and use. Their efforts have resulted in practical manuals and methods of instruction to convey knowledge and practical experience to students and fellow archaeologists.

However, GPS and GIS are not as esoteric as the above technologies. In the past, using computers for anything other than the most basic functions was restricted to those who took the time to learn to program and understood a great deal about the structure of data systems. Today's archaeologist makes use of computers daily, from answering emails to writing up reports in a word processing program. Recent GPS and GIS technologies have reached a point that most people with a basic knowledge of computers can begin to make use of these increasingly intuitive technologies without relying on specialists.

The operation of geophysical technologies (such as the aforementioned GPR units) is similar to the use of any sophisticated piece of scientific machinery. Their cost and sensitivity (easily compromised by minor errors in set-up and use) means that their use is necessarily restricted. However, the same does not apply for GPS units any longer. Several manufactures (Trimble, Thales, etc.) now produce affordable units that offer substantial increases in accuracy and usability over previous models, which has led to their wide-spread use in numerous settings, increasingly so in archaeology. The use of GPS for recording measurements at a fine scale (i.e. on the order of centimeters) has only recently become a reality (Branting & Summer 2002; Tennant & Bristow 2004).

Therefore, few archaeologists have begun employing it for intra-site recording of features. Scott Branting (2002), among others, has used the extremely accurate (and equally expensive) real-time kinematic (RTK) units at sites such as Kirkenes in Tukey. While the use of RTK units would be preferable for any project, my honors thesis focused on using smaller units that are more often within the price range of individuals, small groups, and newly formed CRM firms. My undergraduate thesis at the University of Arkansas successfully demonstrated that the accuracy of mid-range GPS units (priced from $2,000 - $4,000 US as of May 2005) is now sufficient to use for intra-site feature recording. In other words, mapping objects quickly and inexpensively, with a high level of precision and accuracy, has become a reality. I also mention in this work that GIS has reached a similar level of intuitiveness. The current ease-of-use that exists for GIS software means that it can now begin to enjoy a wider use

Goal of This Thesis

In one sense, this thesis is an exploration of tools that should become basic to archaeological investigation. These tools currently include total stations, GPS units, and their successful combination. Unfortunately, many archaeology students have difficulty distinguishing between basic surveying instruments such as transits, theodolites, electronic-distance measurement (EDM) units, total stations, and so forth. While a complete understanding of surveying instruments is certainly not a pre-requisite for conducting archaeological investigations, dangerous situations may arise when field technicians are required to use equipment that they cannot correctly identify. This danger is not one of personal jeopardy, but rather it creates an atmosphere where gaps in knowledge and skills are permitted. In my opinion, when a thing is permitted, it in effect becomes encouraged (or at the very least legitimized). The danger of gaps in knowledge such as this while working in remote areas (e.g. the Arctic) centers on the fact that returning to correct errors or re-collect necessary data is typically not an option.

I have recently become interested in the methods of archaeological fieldwork and the management of data that results. Specifically, the use of total stations and GPS units to map surface features began with my work in New Zealand and my growing abilities with GIS technologies. I have struggled to find ways in which I could structure GIS data collected during my projects and projects I have been part of, hence this thesis. However, my desire to find a suitable method to structure data has far-reaching consequences, mainly in the realm of archaeological ethics and our obligations to the data we create, manage, and hopefully build upon.

The Society for American Archaeology (SAA) and the Society for Historical Archaeology (SHA) have recently released statements that outline ethical guidelines for archaeological practice. The SAA's *Principles of Archaeological Ethics* (referred to as the *Principles* forthwith) were published in 1996 (Lynott 1997:589-599). These built upon a report by the SAA Committee on Ethics and Standards from 1961 (*American Antiquity*, 27:2:137-138). The updated 1996 *Principles* outlined eight principles that should form the core of archaeological ethical practice. *Principle No. 7 - Records and Preservation* is relevant to the creation and management of GIS data, it states:

> Archaeologists should work actively for the preservation of, and long-term access to, archaeological collections, records, and reports. To this end, they should encourage colleagues, students, and others to make responsible use of collections, records, and reports in their research as one means of preserving the in situ archaeological record, and of increasing the care and attention given to that

> portion of the archaeological record which been removed and incorporated into archaeological collections, records, and reports. (Lynott 1997:593).

However, it is the SHA's *Ethical Statement*, adopted on June 3rd, 2003, that specifically addresses the collection and maintenance of digital data. *Principle 4* of the SHA's *Ethical Statement* reads:

> Members of the Society for Historical Archaeology have a duty to collect data accurately during investigations so that reliable data sets and site documentation are produced, and to see that these materials are appropriately curated for future generations. (*Historical Archaeology* 38:1: 33)

These statements, and the larger ethical codes outlined as part of the SAA and SHA's statements, implies that our obligation to the maintenance of archaeological records is, in theory, as important as archaeologists' obligations to protect sites and include descendant communities in our work. However, while healthy discourse has developed in relation to archaeological obligations to site protection, inclusion of descendant communities and the public, looting, and so forth (Zimmerman et al 2003), there has been little discussion of the obligations outlined in the two principles quoted above. This thesis is designed to stimulate a discussion of the archaeological community's ethical obligation to data sets.

Drawing upon the SAA's *Principles of Ethics* and the SHA's *Ethical Statement,* I will demonstrate a method for using new GIS data structures – specifically the ESRI geodatabase – that satisfies the ethical obligations archaeologists have towards their data sets. In order to do this, this thesis will address three main issues:

- It will discuss archaeological surveying techniques, placing GPS firmly within it, as these methods produce the data used in a GIS context

- It will sound a call to standardize GIS data structures using a geodatabase organization developed within this thesis, which allows for the creation of 'living documents'
- It will place the 2004 Svalbard geodatabase in the larger context of archaeological GIS uses by exploring several possibilities available with data collected in 2004

The final two chapters are expressly designed to show how GPS and GIS can assist in answering recent archaeological concerns (e.g. the interplay of class on the landscape) and point to several potential applications.

Structure of Thesis

Chapters One & Two - Introduction & History of Svalbard

An introduction and general history of human activity on Svalbard comprise the first two chapters of this thesis. Human history on the islands is restricted to the past five hundred or so years and is episodic. This section draws on a number of academic disciplines. The major resources include Sir Martin Conway's 1906 *No Man's Land*, Nathan Haskell Dole's 1922 two-volume *American in Spitsbergen: The Romance of an Arctic Coal Mine*, Thor B. Arlov's 1989 *A Short History of Svlabard*, and Richard Vaughn's 1997 *The Arctic: A History*. Each of these resources includes excellent information and bibliographies and forms the basis for historical research into Svalbard. Human activity on Svalbard has moved through several phases, and chapter two represents this by the division of Svalbard's history into three phases, centered on the dominant activity of each time period: the eras of discovery and biological extraction (whaling and sealing in the 17th and eighteenth centuries), knowledge extraction (organized scientific expeditions and tourism in the eighteenth and nineteenth centuries), and mineral resource extraction (late nineteenth and twentieth centuries). The 2004 Svalbard Project focused on sites dating to the late-nineteenth and early-twentieth centuries, but the history is reviewed until the present in order to frame the project itself.

Chapter Three - Field Methods

This chapter focuses on the field methods used during our two weeks in Svalbard. One of the main goals of this thesis is to re-open a competent discussion on the use of surveying technologies in archaeological data, including GPS. The chapter begins with a brief history of the development of surveying technology and some basic methods, and a discussion of the development of GPS systems. A brief discussion on archaeological manuals that deal with field methods presents an alarming trend. Specifically, since the 1970s fewer and fewer guides have presented accurate and detailed instructions on the basics of surveying and its associated instruments. Recent texts on archaeological field methods such as Hester *et al.'s* 1997 *Field Methods in Archaeology: Seventh Edition,* Neumann & Sanford's 2001 *Practicing Archaeology: A Training Manual for Cultural Resources Archaeology*, E.B. Banning's 2002 *Archaeological Survey*, Grant *et al.'s* 2002 *The Archaeological Coursebook: An Introduction to Study Skills, Topics, and* Methods, and Collins & Molyneaux's 2003 *Archaeological Survey* (part of the AltiMira's Archaeologist's Toolkit series) hardly mention surveying instruments at all, typically doing so on only a few pages. A brief historical discussion of surveying instruments and their uses is included in order to frame the use of specific surveying instruments during the fieldwork on Spitsbergen.

Instead of imposing a false coordinate system on the site with a total station, the Svalbard team used portable GPS units to input Universal Transverse Mercator (UTM) coordinates straight into the total station. This allowed the machine to record feature points from the site, automatically logged into a real-world coordinate system. The combination of using a fixed total station and a portable GPS unit allowed the field crew to operate both machines simultaneously and resulted in a large amount of data (approximately 70 sturctures/features mapped and preliminarily documented). This case study demonstrates the effectiveness of combining GPS and total station and the importance of using traditional techniques, such as feature sketches, to add detailed information collected by the electronic instruments is explored.

Chapter Four - Manipulation and Management of Data

This chapter fully develops the second goal outlined above through developing an organizational scheme for GIS data that deals specifically with archaeological data. The first step is to present a few thoughts on the current state of technological education aimed at archaeology students. Next, Antenucci *et al.'s* 1991 *Geographic Information Systems: A Guide to the Technology,* Julie Dalaney's 1999 *Geographical Information Systems: An Introduction,* and Nadine Schuurman's 2004 *GIS: A Short Introduction* in are used to present a cogent discussion of the main components and abilities of GIS. This is followed by a discussion of how other archaeological groups or agencies approach structuring their data. These groups' approaches provided a general guide to follow when constructing GIS files, an important consideration when deciding what types of information to collect during fieldwork.

Next, this chapter explores he construction of a geodatabase (instead of simple shapefiles) and its advantages. These advantages are wrapped up in the structure of GIS data, which relies on a thematic classification system (i.e. all points in a map are saved in a point file, all lines in a line file, and all polygon or area shapes in a polygon file). A geodatabase allows for the combination of different types of data (point, line, and polygon) into a ‘single’ file called a feature dataset. Geodatabases also provide the ability to set domains that ensure attribute tables attached to specific files within the GIS are restrained and input errors decreased. A final advantage is the creation of annotation files, which create labels for use in a map that can exist independent of other features. The fundamental goal for exploring these issues is to make sure the data created is formatted to facilitate the incorporation of future data and/or use with other datasets.

Chapter Five - Archaeological Uses of GIS

This chapter addresses the third goal of my thesis; it reviews archaeological uses of GIS during the past 15 years including a number of case studies, drawing heavily on the work of Dr. Kenneth L. Kvamme (University of Arkansas), Dr David Wheatley (University of Southampton, UK), and Dr. Mark Gillings (University of Leicester, UK). Specifically, two classification schemes are often used to organize specific examples archaeological GIS work. Aldenderfer (1992) divides the uses of GIS based on three classes: to do things we have already done (i.e. create static maps), to do things rarely done (i.e. complex spatial analysis), and to do things not done previously (i.e. using tools developed with GIS such as viewshed analysis). Fisher (1999) classifies the uses of GIS based upon the intended goal, defining three types of produced materials: maps, spatial analysis to answer specific questions (corresponding with the second and third classes defined by Aldenderfer), and publication.

The bulk of this chapter is spent exploring these two classifications schemes by answering specific questions with the 2004 Svalbard GIS, or suggesting how this dataset might be used to do so. These examples include the use of the GIS to demonstrate the impact of the modern world on the site of Old Longyear City, possibly creating a model to monitor the poorly-understood affects of arctic conditions on historical remains, using the ability of the GIS to compute viewsheds that talk about physical expressions (or lack thereof) of class differences at Old Longyear City, and a discussion of how virtual reconstructions of the site can be used to educate other researchers and the general public.

Chapter Six - Conclusions and Further Thoughts

This chapter demonstrates how the data organization scheme developed during this project serves the larger archaeological community. It reiterates the importance of developing an organized data structure and data collection strategy prior to field work as a reminder that archaeologists' ethical obligations extend to the data sets created as part of their work. It also explores how this dataset might serve as an example to other researchers who wish to develop methods to ensure the survivability of their data sets is presented. The fact that the 2004 Svalbard GIS was specifically designed with the intention of being added to –a 'living document' – means that little effort is required to make continued use of this resource. The small amount of effort required to make use of the 2004 Svalbard GIS, however, requires some basic GIS instruction. The chapter concludes with specific suggestions on obtaining the necessary instruction.

Background of Svalbard Project

The 2004 Svalbard Project was possible due to previous experiences by MTU personnel and students. Before proceeding to a general history of the Svalbard region in the following chapter the background experiences which led to the 2004 field seminar is presented below. This section is based largely on conversations between me and Dr. Pat Martin and Dr. Marie Nisser.

The history of MTU's role in industrial heritage work on Svalbard began in the late 1990s when Dr. Patrick Martin (MTU) met Dr. Marie Nisser (Royal Institute of Technology) and discussed Dr. Nisser's ongoing work on the island of Spitsbergen, Svalbard Archipelago, Norway. At one point, Dag Avango (one of Dr. Nisser's PhD students) mentioned that principal players in the development of coal mining on Spitsbergen were American. Eventually, these players were traced to the Upper Peninsula of Michigan. The industrialist John Munro Longyear, a resident of Marquette, Michigan, and graduate of the Michigan School of Mines (now Michigan Technological University) was one of these principal actors behind Svalbard's first successful coal mining operation on the island of Spitsbergen early in the twentieth century. In 2000, Dr. Marie Nisser and Dag Avango contacted Martin to inquire about the possible existence of archival materials concerning Longyear's time in Svalbard. Upon looking, Martin discovered that not only did MTU's archives contain personal correspondence from Longyear concerning the coal mine at Longyear City, but also numerous reports and letters from the overseers who had been Longyear's acting managers during the fourteen years that coal was mined by Americans on Spitsbergen. Nisser and Avango made a trip to Houghton, Michigan, to investigate the materials themselves. A thorough review of the materials with MTU archivist Erik Nordberg resulted in a formal agreement to bring Martin and students from MTU to help investigate the material remains of coal mining on Spitsbergen.

The first exploratory trip from MTU took place in August 2003. Patrick Martin was accompanied by MTU masters student and professional photographer Larry Mishkar. Their trip was largely a fact gathering exercise. Mishkar took numerous pictures, and Martin made plans to join a group of international researchers meeting the next year.

I first became aware of the Svalbard Project at the 2004 Society for Historical Archaeology annual meeting in St. Louis. Drs. Patrick and Susan Martin approached me during a poster session where I was presenting the results of my work in the Otago Region of New Zealand, which focused on using GPS to map entire gold-mining era sites. At the time, I had decided to return to the University of Otago for a Master's Degree. However, after a lengthy discussion with the Martins, my plans changed. One month later I was accepted into the Master's in Industrial Archaeology program at Michigan Technological University (MTU).

I was part of the second MTU trip to Svalbard. In August 2004 six researchers from Michigan Tech arrived on Spitsbergen. This group included two professors (Patrick and Susan Martin); one past graduate from the Industrial Archaeology program at MTU (Larry Mishkar); and three new MTU students (Mike Deegan, Aaron Kotlensky, and myself). We were part of an eleven-day seminar consisting of twenty-two researchers from seven countries. The two-fold goal of this seminar was to create a network of researchers and document the industrial remains of Svalbard's history (especially the period of coal-mining that begin in the late 1890s).