Space Exploration and the Greenland Norse; A Comparative Study on the Application of Technology for Exploration

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Abstract. During the mid to late Middle Ages a group of intrepid explorers from Scandinavia established two colonies in the harsh environment of Greenland. These people were known as the Greenland Norse. While their colonies made a determined effort and survived for about 500 years, they never really flourished and struggled just to survive in their harsh environment. Eventually they disappeared, despite the fact that a neighboring group, the Inuits, was successful in surviving into the modern era. Hence, while survival was very difficult due to a variety of factors, it was possible depending on how the society dealt with the environment. There are a number of interesting parallels between this Greenland Norse experiment and the modern era of space exploration. While comparisons from the past to present day plans must certainly be made with caution, there may be interesting lessons to learn. Specifically, the role of technology and innovation by the Greenland Norse is addressed in this comparative study.

Keywords: Exploration, Space, Greenland Norse, Technology, Survival
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INTRODUCTION

Ever since humans became true humans and explored out of Africa in the original Diaspora of approximately 80,000 years ago, it is apparent that technology may have played a significant role in the eventual success of an exploration enterprise (Brown, 2007). Numerous examples may be cited, such as the exploration and conquest of the Americas and Pacific islands by Europeans beginning in the late 15th century, the exploration and development of the American West, the establishment of permanent scientific research stations in Antarctica, and many more. While analogies to present societies are always precarious (Diamond, 1999), these past ventures may hold some lessons for today's exploration into space and the desire to establish permanent outposts on the Moon, Mars, and elsewhere.

It is the objective of this paper to address the role of technology in the eventual success or failure of an exploration enterprise, specifically those focused on the establishment of a remote human outpost in a hostile, alien environment. Clearly, technology is only one factor which may impact the eventual success or failure of an attempt at settlement. Motivations for the exploration venture, resources the settlers can bring with them, support or lack thereof from the originating institution or mother country for resupply and buildup, local climate and environment, competing groups, indigenous resources, and even cultural attitudes can impact the success of an enterprise (Diamond, 2005). These factors should hold true for past attempts at exploration/colonization as well as the exploration and settlement of space in the future.

BACKGROUND

While making comparisons is clearly difficult and fraught with the potential for misconceptions, by separating the known from what is unclear from what is presumed, and then carefully assessing the facts for relevancy (Neustadt and May, 1986), it may be instructive to compare the current thrust into space to past attempts at exploration of the

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Earth. The specific example selected for this paper is the "Greenland Norse", who attempted to settle Greenland starting in 986 AD, and ending in failure/abandonment around 1480-1500 AD (Diamond, 2005). The Greenland Norse were a group of people originally from Scandinavia or its daughter colonies (e.g., Iceland, Northern England, etc.) who pushed westward into the North Atlantic. With respect to technology, a variety of questions can be focused on this effort which might provide useful observations for the coming age of space exploration. Specifically;

- Was advanced technology, meaning technology advanced for 988 to 1500 AD, used in any significant way by the colonists?
- Was the exploration thrust into Greenland, a particularly harsh environment, enabled by advanced technology? If so, was such technology *specifically* developed to enable long sea voyages into unknown waters or was this an outgrowth of other activities, such as trade?
- How was advanced technology used by the Greenland Norse?
  - Transport ships used to get to Greenland?
  - Tools for agriculture or building?
  - New food production and/or storage?
  - To hunt/grow new food sources?
  - Sources of energy for heat?
  - Weapons for hunting or conflict with competing human groups?
- Were the Greenland Norse innovative and did they change their technology over time? If so, was this from local innovation or from new ideas supplied by their mother country?
- How much use did they make of indigenous resources?
- Did their cultural attitudes encourage, or impede, the development/adoption of new technology?
- The Greenland Norse eventually failed, while another human group, the Inuit, arrived after they did and yet survived to the current day. Can this be attributed, at least partially, to the development and use, or lack of use, of advanced technology suitable to the local environment?

There are a number of similarities between the Greenland Norse and proposed future space colonies which suggest that such a comparison may be interesting. While a number of countries have expressed interest in the exploration and eventual settlement of space, the United State National Aeronautics and Space Administration's (NASA) *Vision for Space Exploration* (NASA, 2004) is the preeminent contemporary example of an organized program of space exploration and colonization. Both of these ventures involve going into a very harsh environment where some level of technology is required both to get there and to survive. Clearly there are differences in the absolute level of technology available to the explorers, but in both cases it was/will be a significant effort. Both ventures were/will be very far from home, making resupply difficult and expensive. Both were/are intended to be permanent settlements, not short term ventures, thus requiring a long-term commitment from the mother country for support. Both were/will be largely self-sufficient and required/require some use of indigenous resources. Both are also ventures into the unknown in terms of the local environment, indigenous resources, and associated danger. And for both, survival is not a given.

NASA'S VISION FOR SPACE EXPLORATION

On January 14th, 2004 the President of the United States announced a new guiding policy for NASA, the *Vision for Space Exploration (VSE)*. This policy is intended to be a "Renewed Spirit of Discovery" for the United States space program and build upon the Apollo missions to the Moon, past robotic surveys of the planets, and the stunning astronomical observations of the universe. The VSE acknowledges how humanity's past experience in space has "fundamentally altered our perspective of humanity and our place in the universe" and postulates that "a renewed U.S. Space exploration program with a significant human component can inspire us – and our youth – to greater achievements on Earth and in space". The key goals and objectives of this policy (NASA, 2004) are to:

- Implement a sustained and supportable human and robotic space exploration program
- Extend the human presence across the solar system, starting with a Moon Colony and then eventually travel to Mars and other destinations
- Develop the needed innovative technologies, knowledge, and infrastructures to implement the VSE, and
- Promote international and commercial participation in the program.

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In the pursuit of the VSE, NASA has identified a number of guiding principals for exploration. These include pursuit of compelling questions of scientific and societal importance, such as the origin of our solar system, the potential existence of life beyond earth, and how we could live on other worlds. Ultimate possible destinations include Mars, the moons of Jupiter, and even other solar systems. The Moon and near-earth asteroids are postulated as stepping stones to test and demonstrate new exploration technologies.

The VSE is thus intended to be a long term effort, not driven by any immediate political, economic, military, or religious motivation. The basic goals are fundamental exploration of the unknown regions of space and science. Clearly the development of new technologies, both as needed to perform the mission and as a serendipitous result of the VSE, will be involved and are also a key motivator. Likewise, economic expansion and solidifying international relations are anticipated benefits of the program.

The VSE is not a crash development program, such as Apollo, with a politically driven deadline. Rather, it is intended to be a sustained and affordable program involving only nominal increases in NASA's anticipated budget. The return to the Moon is postulated to take from 11 to 16 years (2015 to 2020) with dates for a crewed Mars mission decades further in the future.

THE GREENLAND NORSE

While the Norse exploration into Greenland certainly lacks complete documentation, nevertheless significant information is available from their own records such as the Norse Sagas (Ornolfur, 1997), written accounts from medieval European contemporaries, as well as from modern archaeological investigations (Diamond, 2005). This study will use such available information, and assess this past experiment in exploration for "lessons learned" which might be applicable for the future exploration and settlement of space. The following is a summary of what is most relevant from the Greenland Norse experience that is applicable to this comparative analysis.

From approximately 800 to 1200 AD the Vikings from Scandinavia raided, pillaged , and traded in a broad geographical area from Northern Europe, down into the Mediterranean, east to modern-day Russia, and explored and settled the North Atlantic islands from the Orkneys, to Iceland, and to Greenland. For a brief time they ventured to the Americas as far as Newfoundland. Their ships, especially the knorr longboat, represented the most seaworthy and technologically innovative craft of their day (Hale, 1998). These ships had a narrow draft, were very sturdily build in a klinker style with a high bow and stern, had a square sail on a single mast, and were up to about 70 feet long. While the Vikings did not apparently possess the sextant or compass, they did have an extensive knowledge of seamanship which combined with their excellent boats and adventuresome nature permitted them to survive the long voyages of exploration into the North Atlantic. Hence, some tradition for innovation and technology existed prior to settlement of Greenland. Indeed, it was necessary in order to attempt and survive the voyage.

The climate clearly played a significant role in both allowing the Norse expansion into the North Atlantic and Greenland, and in later bringing about the demise of the Greenland colonies. While Greenland is actually further south than much of Scandinavia, it is colder and windier due to ocean currents from the western arctic region. However, during the "little climatic optimum" from approximately 800 AD to the mid 1100's, the climate in the Northern Hemisphere was notable warmer than it is today (Gribbin, 1990). This encouraged and allowed settlement by the Greenland Norse, who farmed the area for almost 500 years until the climate once again became cooler with the arrival of the "Little Ice Age" in the 14th century (Fagan, 2001). This climatic change clearly made their farming economy increasingly difficult, as well as causing increased ocean ice, storms, and hence increased difficulty in trading with their Norse homeland (Lamb, 1995). Eventually contact was lost. In the face of an increasingly hostile and difficult environment, and unwilling to change their technology and food sources, apparently because of religious and cultural reasons, they became increasingly isolated and either died out or were assimilated into the indigenous Inuit society by the late 15th century.

Another factor which clearly contributed to the eventual failure of the Greenland Norse was their abuse of the local resources (Diamond, 2005). They initially followed the same farming practices as in their Scandinavian homeland, which focused on sheep, cows and agriculture. They even cleared out what few forests there were in order to secure more pastureland. However, the windy and wet climate of Greenland, the thin soil, and the depletion of trees and groundcover from grazing all quickly lead to significant erosion. This forced some change in farming practices.

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But the growth rate for trees was so slow that they soon had little wood for fuel and shipbuilding. Food crops became increasingly marginal and unreliable. This all led to increased dependence on the mother country, Norway, for trade in critical supplies such as iron and wood. They then experienced a slowly declining population as they had less to trade and their environment degraded. From two separate colonies with a maximum total population of perhaps 5000 people in the 11th century, they had disappeared by the beginning of the 16th century.

While the Greenland Norse clearly faced increasingly significant challenges to survival, nevertheless survival in this environment was possible. This is demonstrated by the Inuit peoples, who actually arrived in the Greenland area after the Norse and have survived to the present day. The Inuit were much better able to adapt to the changing environment and learn to use local resources, such as marine mammals, for food. The Inuit developed a range of hunting and other survival technologies which the Greenland Norse did not. Interestingly, the Norse apparently actively resisted such innovation even though adoption of such technologies might have allowed their survival. Based on their own records, the reason for this antagonism towards the Intuits was cultural. Despite the difficulty in maintaining trade and contact with the mother country, the Greenland Norse fiercely maintained their religion and culture, even when it was counter productive to their survival. This stands in contrast to their previous cultural heritage of innovation.

COMPARATIVE ANALYSIS

It is widely recognized that societies may rise and fall over time. Diamond (2005), in his study entitled *Collapse: How Societies Choose to Fail or Succeed*, presents five factors which influence the success or failure of a society. These factors are:

- Environmental damage caused by the settlers
- Climatic change
- Effect of neighbors; hostile or cooperative
- Access to trade partners (including mother country)
- Settlers response to the local environment

These factors provide a useful starting point for a comparative study on the experiences of the Greenland Norse as a possible analogue for future space colonists. Addressing these factors broadly is well beyond the scope of this paper, which is limited to the possible role of technology in the success of an exploration venture. By focusing in on technology, the following questions are relevant;

- How did/will the settlers obtain shelter, food and water, and other consumables? For space exploitation this would include oxygen and shelter from hazardous radiation. Did they degrade to environment to the point where it threatened their survival?
- How were/will the indigenous resources used and managed? Were/will materials that were/are limited and not renewable be recognized as such and managed accordingly? Was/will new technology developed or adopted to make use of the in-situ resources? Did/will they live off the land without critical resupply from the mother country or trade?
- How were/will waste products handled?
- How stable was/is the climate over time, and what are the impacts of climatic variability on the ability of the colony to survive? This would include impacts on providing necessary food and shelter.
- Climatic change may be more broadly interpreted to include political and economic change in the mother country. This perspective brings into question additional factors related to technology.
- If neighbors are present, do they have technology that can be useful to the settlers for food, shelter, and other elements of survival? If so, do the settlers make use of such technology? For space exploration, this could include technical exchanges with earth-based countries other than the mother country.
- Exchanges of goods and materials between the settlers and trading partners will be necessary to some degree until the colony is self-sufficient. Long transport distances and /or changes in the physical or economic environment may impede such exchanges or resupply. How did this impact the Greenland Norse and how might it affect future space colonists?
- Adaptation to the local environment has been demonstrated to be critical to a society's survival. This would include cultural, political, and economic issues. How did the Greenland Norse respond, and what are the plans for future space colonists?
- Did/will the colonists have a cultural heritage of technological innovation?

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- Did/will the colonists have a cultural heritage of exploration?

In their book, *Thinking in Time*, Neustadt and May present a structure to help determine the applicability and limitations of analogies (Neustadt, 1986). This analytical technique is intended to help decision-makers better understand an immediate (or planned future) situation from the context of relevant past situations. The technique is relatively simple and involves separating observations of all situations under consideration into three groups; what is *known*, what is *unclear*, and what is *presumed*. The analogous situations can then be more directly and objectively compared, with specific similarities and differences noted. Assumptions and presumptions may be more critically assessed and tested, and an immediate or planned initiative, such as space colonization, may be addressed from an historical perspective. The focus of the questions are more "what is the story" and less on "what is the problem". In this study this technique has been applied to a comparison of the Greenland Norse experience and future space colonies, with a focus on the technology related questions identified above. The results are as follows;

Technology Factor	Society*	Known	Unclear	Presumed
Ability to live-off-the-land without destroying local environment	SE		Plan to use in-situ resources for energy, building, and possibly fuel and water. Practicality unclear due to unknowns of the environment.	
	GN	Tried, but severely degraded environment		
Severe environment	SE	Yes, advanced technology necessary for survival		
	GN	Yes, but not radically different from home country		
Presence of changing environment	SE		"Seasonally" variable; long term (>100 yrs.) variability unknown	
	GN	Significant variations over the 500 year history		
Transport to/from mother country	SE	Very difficult – significant planning and costs involved		
	GN	Difficult – significant distances and risks		
Long-term trade and contact with mother country	SE			Planned, and presumably critical to long-term survival
	GN		Apparently somewhat regular initially, but increasingly sporadic over time	
Technology exchange with neighbors or others	SE		The 50 years of the Space Age have had a mixed history for international cooperation. Often intended, but not a given.	
	GN	Adamant refusal to cooperate with neighbors – reliance on self and mother country		

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Technology Factor	Society*	Known	Unclear	Presumed
Adaptation to local environment; changing practices for efficiency or survival	SE			Plans are to evaluate local environment and exploit to maximum practical extent; depends on relative cost of resupply from mother country.
	GN		Appear to have initially attempted to maintain traditional lifestyle and then became leaner. Minimal use of some local resources.	
Heritage of technological innovation	SE	Very strong for many types of endeavors		
	GN		Historical record somewhat unclear	
Technological innovation developed specifically to enable exploration	SE	Yes – exploration into space impossible without focused new technology		
	GN	Yes – knorr longboat and open sea navigation		
Development of new technology by colonists for their own use	SE			Presumed, but depends on resources available to explorers. Ideas may be implemented by mother country
	GN		Apparently not – no record of new technology, even when needed for survival	
Sustained cultural heritage of exploration	SE	Yes		
	GN	Yes, for the preceding couple of centuries		

* SE = space exploration society, GN = Greenland Norse

CONCLUSION

There are clearly interesting parallels between the situations faced by future space colonists and the Greenland Norse. While the societies that sponsored/are sponsoring the exploration ventures are different, some of the motivations, resources, and constraints are similar. For example, both were/are an exploration into the unknown, sponsored by a mother country in some manner, with the hope of undefined rewards. Both were/are intended to be permanent, and not merely scouting expeditions, and thus requiring continued contact with the mother country. Both involve the need for comparatively high technology to get to a far off land, which in both cases is a very challenging environment in which survival is not at all certain. This implies that contact with the mother country for resupply is difficult, costly, and takes planning and time to implement. Hence, self-reliance and the ability to live-off-the-land to the maximum extent practical is an appropriate survival strategy.

Development of new technology for maximum use of indigenous resources is clearly beneficial to the survival of a colony, but this may or may not be possible. Cultural attitudes (as in the case of the Greenland Norse) or the cost difficulty in developing such new technology may impede its development and/or implementation. A changing environment, such as experienced by the Greenland Norse and possibly by future space colonists, could cause significant stress on an already strained situation. As it did for the Greenland Norse, this could potentially play a role in the eventual failure of the exploration venture. Based on our current knowledge the lunar and extraterrestrial planetary environments appear to be stable, at least over the past few decades. However, we do know that the sun

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varies its output over century long timeframes, and any future changes in solar output would presumably change the lunar and extraterrestrial planetary environments.

Given these challenges and variables, and the example presented by the Greenland Norse, it would appear that future space colonists should expect the unexpected in terms of environment, be cautious about the prospect of timely resupply, plan to make maximum use of in-situ resources, and be prepared to technologically innovate for efficiency and survival.

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