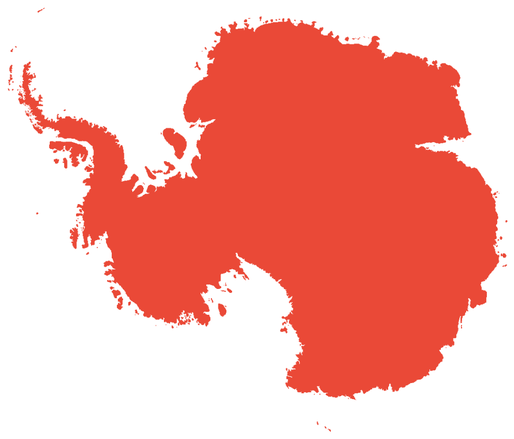
USING GLOBAL DESIGN PRINCIPLES TO IMPROVE THE SUSTAINABILITY OF POLAR RESEARCH STATIONS

JOE SMITH
19167191@BROOKES.AC.UK

1 INTRODUCTION



RESEARCH BACKGROUND

Implementation of place-making in Antarctica is a unique challenge. Not only do planners and designers have to take into account the harsh environmental context, but also the struggles of implementing these designs in the most isolated environment on Earth, with no local resources or existing unifying personal identity in the icy white expanse to aid in achieving their goals.
Therefore my research will aim to explore the impacts of design and place-making on those that live and work in Antarctica, the details that have to be considered and the decisions that have to be made to ensure that the best possible facilities are being provided so that quality research can be conducted, at a cost that can remain sustainable for international Antarctic programs and using construction methods that are environmentally sustainable.

The focus of this research is to determine the factors that go into designing a polar research station which can excel in all its desired operations while remaining sustainable, economically, environmentally, and socially.

RESEARCH OBJECTIVES

1. Formulate an analytical framework based upon the three key aspects of sustainability that can be used to assess the successes and failures of existing research stations.
2. Review existing literature on the relationship between people living in isolated extreme environments and the built environment in which they live.
3. Identify relevant case studies based upon their location and facilities and ensure that case studies are chosen from a range of nations to gain more accurate & representative data.
4. Collect data from primary sources through the conduction of interviews with research staff with experience using polar facilities and designers involved in polar projects.
5. Using the resulting data from case studies, analysis and interviews, develop a set of internationally applicable guiding design principles for polar construction.
6. Illustrate these design principles in the form of example designs and analyse the effectiveness of the resulting design using the previously used analysis methods.

RESEARCH AIM

To explore the ways that life in polar regions can be improved and that research in these extreme regions can become more cost effective and accessible on a global level.

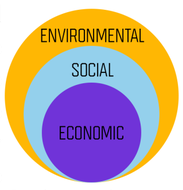
2 CONTEXT

RESEARCH SCOPE

The purpose of this research is to produce design recommendations focused on the environmental, economic and social sustainability of a proposed Antarctic research station by looking at aspects of design which improve the quality of life and efficiency of research while minimising operational costs and negative environmental impacts.

SUSTAINABILITY

Following the Brundtland definition of sustainable development and using the concentric model *(Right)*, the three aspects of sustainability have been nested as the sustainability of each outer ring is dependent on the sustainability of the inner ring. This heirarchy will inform decisions that are made during the creation of the planning and design principles.



ECONOMIC SUSTAINABILITY

1. The advent of containerisation as a method for Antarctic logistics and construction has revolutionised operations and significantly reduced the costs related to polar science.
2. Construction & design considerations such as modularity have allowed Antarctic operations to effectively and efficiently scale based on demands to make sure there are no unnecessary operational costs.

Implementation of advanced insulation and heat recovery systems allow bases to operate more efficiently.

SOCIAL SUSTAINABILITY

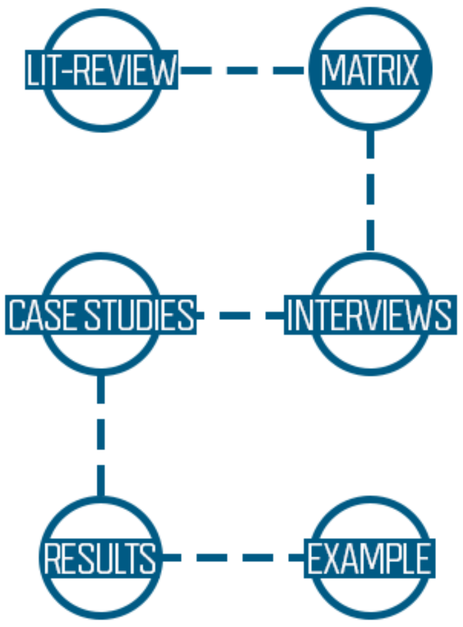
1. The social cohesion of a station is essential to its operational sustainability, and ensuring that the design of public and private living spaces meets the needs of those living and working in the Antarctic is paramount to maintaining good mental health, operational efficiency and quality work.
2. Maintaining the health and safety of residents is even more vital as any failure can quickly become a danger to life. The use of advanced fire suppression & isolation systems aims to combat this. To combat psychological issues, techniques such as smart lighting are used and design features such as the use of native materials and hydroponics facilities provide boosts to psychological well-being.

ENVIRONMENTAL SUSTAINABILITY

1. As the majority of Antarctic science relates to the study of the environment it is essential that the stations where this research is conducted do not cause any negative environmental impact.
2. A Comprehensive Environmental Assessment system is enforced by the Antarctic Treaty to ensure that operations do not cause harm to the continent.
This is made up of Initial Environmental Evaluations, Environmental Impact Assessments and Comprehensive Environmental Evaluations and enforced by the Committee for Environmental Protection.

The high level of scrutiny and adherence to these reviews has created notable strength in the Antarctic EIA system in achieving its goals and reducing environmental harm.

3 METHODOLOGY

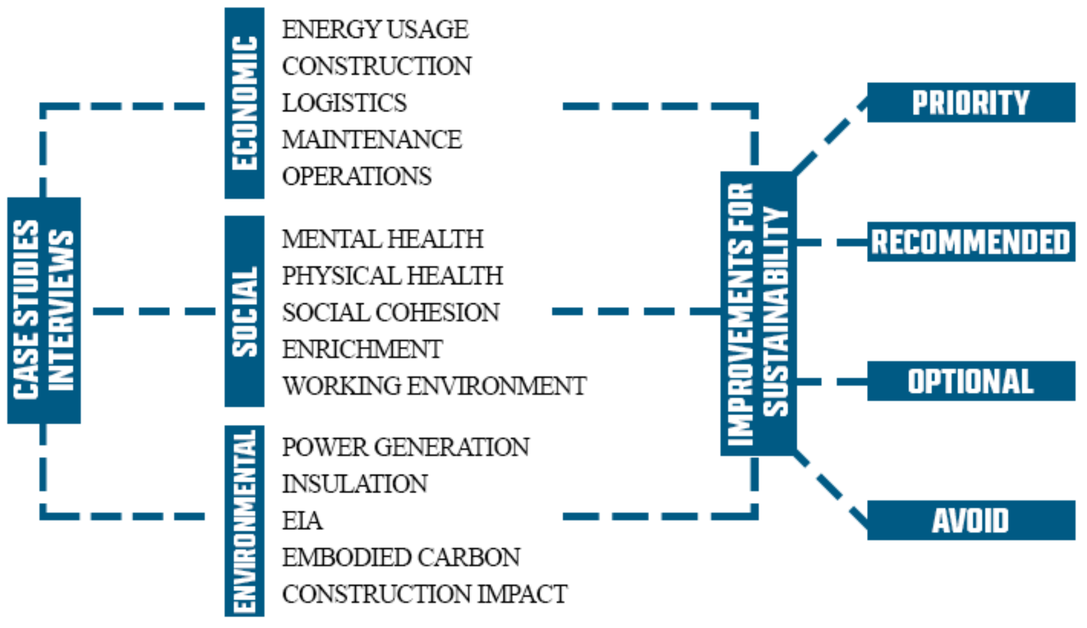


ASSESSMENT CRITERIA

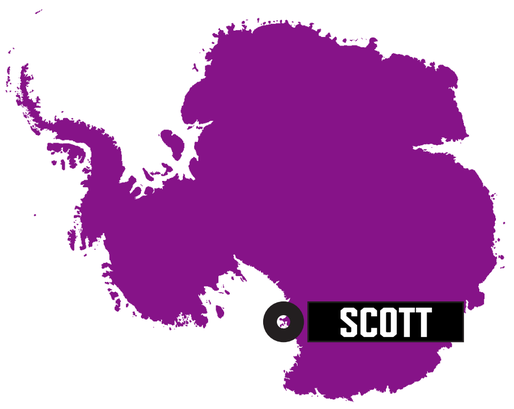
Informed by the literature review the main aspects of social, environmental and economic sustainability have been extracted. These aspects are the ones that are found to be the most important for the sustainability of a research station.

Each case study will be assessed for how its design, implementation and operation responds to or affects each factor and its overall sustainability.

Interviews with the designers of Antarctic buildings and those who have worked in the Antarctic will provide more insight into the considerations in the design phase and their impacts on sustainability when implemented. This will allow greater accuracy in the analysis of case studies and therefore more credible results to the research project.

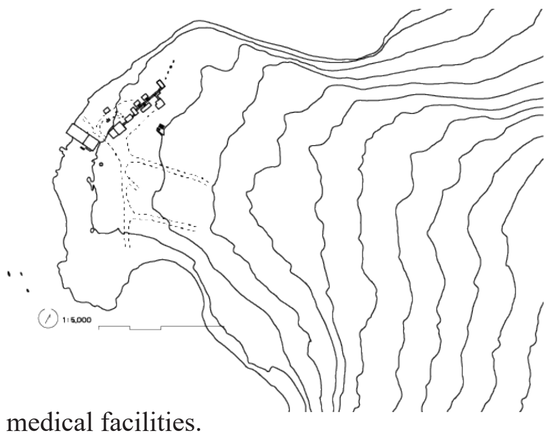


4 INDICATIVE DATA



CASE STUDY 4: SCOTT BASE

Located at Pram Point, Ross Island, the New Zealand operated Scott base consists of 10 individual huts amounting to 4000m² of indoor space, 10% of which is used for laboratories.
The station supports 86 inhabitants in summer and 11 in winter. Its facilities include workshops, interchangeable container laboratories and medical facilities.



Power is supplied by a mixture of fossil fuels and renewables. The current built environment is antiquated with huts constructed in the 60s out of timber and prefab insulation causing failures in sustainability and the spread out figure ground *(Above)* of the station resulting in major inefficiency in movement.

INTERVIEW - DESIGNER 1:

HUGH **BROUGHTON** ARCHITECTS

Hugh Broughton Architects are one of the most experienced firms in the world when it comes to designing polar research stations, working on numerous projects such as Halley VI, Rothera, Summit Station and the Scott Base redevelopment *(Right)*.

I was fortunate to be able to interview a lead designer on the Scott Base redevelopment project to discuss the design choices that were made to improve the sustainability of the station.
The designer talked me through the decision to move all facilities into 3 structures linked with covered walkways to improve movement and energy efficiency, as-well as the visual language used to separate working environments from living spaces.

We also talked about the construction methods for the redevelopment project and the advantages of the design's modular construction and prefabrication as-well as how the innovative methods of insulation used in polar constructions ensure heating efficiency and the complex wind and snow modelling used to ensure the structural resilience of the design.

5 CONCLUSIONS

EVALUATION

While currently still in progress the results of the completed interviews and case studies present compelling examples of the effects of design choices on the sustainability of the built environment in the Antarctic.

Using the data I have processed at this time I have outlined a small sample of expected results in the priority and avoid categories and presented them as illustrated design principles *(Right)*.

CONCLUSION

Much of the existing Antarctic infrastructure is woefully antiquated and many stations are currently undergoing regeneration projects. It is important that the correct design choices be made to ensure the best result for all involved, economically, environmentally and socially.

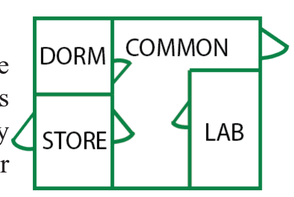
PRIORITY

INSULATION

Inclusion of advanced insulation is essential to polar operations, and neglecting this can have fatal results.

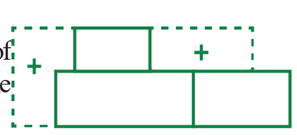
EFFICIENT LAYOUT

Minimising the distance between key locations and ensuring their easy access is a priority for maintaining efficiency.



SCALABLE DESIGN

Ensuring the scalability of designs will allow sustainable growth of operations.



AVOID

DISCONNECTION

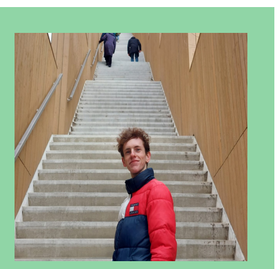
Disconnected facilities can greatly add to operational costs and create dangerous situations.

MONOTONOUS DESIGN

Lack of stimulation can lead to many health complications and negatively impact social cohesion.

COMPLEXITY

Complex designs will add cost to construction and complicate repairs.



OXFORD BROOKES UNIVERSITY