Considerations on the environmental footprint of the Halley VI Research Station project in Antarctica and the PEUGEOT-ONF Forestry Carbon Sink in Brazil

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Abstract

As the effects of the Anthropocene become ever more evident, the duties of architects have begun to vary. The minimisation of environmental impact has become the most crucial of topics in discussion of design, both with regards with construction and in a second instance, functioning of the structure itself. Here, the analysis points at two case studies. First, the project by Hugh Broughton Architects of the Halley VI Research Station in Antarctica and second, the PEUGEOT-ONF Forestry Carbon Sink intervention in the areas at risk along the Juruena River in Brazil. These are used bilaterally. Firstly, as a mean to highlight the fundamental importance of minimising the overall environmental footprint and developing an internal energy strategy. While in a second second instance, to point at the focus that the architectural school must involve when considering the environmental context in which new projects take place. This research is significant to the architectural community because it explores the socio-economic dynamics related to the activity of certain agencies in specific areas of interest.

Introduction

Nowadays, many scientists agree that the state of human actions has become unbearable for the biosphere. It is therefore essential to deal with the crisis humanity is facing. The International Geosphere-Biosphere Programme, through Global Change and the synthesis of the Earth System, has declared that humanity is in the age of the Anthropocene (Steffen, 2004). Concurrently, as Justin McBrien asserted, humans are living in the Capitalocene, highlighting capitalism's drive towards extinction in a world-ecological sense. Since humanity will probably, as time goes by, find itself living in an increasingly apocalyptic scenario, it is important to define why it is crucial to follow specific rules and to respect specific norms when designing in a climate sensitive environment.

The objectives of minimising the overall environmental footprint and developing an internal energy strategy are of critical importance in the architectural field, especially in the current period, when every emission that is produced amplifies the climate change process. Energy strategy is a long-term plan for how a business will address changes in energy use, cost, and regulation (Max Dworkin, 2017). In order to argue the topic in such a way, I determine two types of energy strategies can be distinguished: the planned strategy to limit the overall environmental footprint of the intervention, which includes the administrative, logistic and construction phases, and the internal energy strategy to regulate the building's emissions during its activity. This distinction was chosen solely in relation to the dissertation, as a mean to analyse the general dynamics and the peculiar dynamics of the environmental footprint. The internal energy strategy is intrinsic to the life of the building, and can indeed be defined as particular and individual in a much larger and more complex context of administrative dynamics. On the contrary, the overall energy strategy, which also takes into account the administrative part of the project, is apparently much more difficult to manage, presumably because the majority of agents acting on the intervention require an interest, often outside the environmental requirements.

In this dissertation, I take into consideration two case studies of interventions conducted in climate sensitive areas, both in terms of design complexity and environmental impact. The case study that I analyse in more detail is the project by Hugh Broughton Architects of the Halley VI Research Station in Antarctica, while the second case study is the PEUGEOT-ONF Forestry Carbon Sink intervention in the areas at risk along the Juruena River in Brazil in cooperation with Pro-Natura. Since these are very different risk areas, in order to have a parameter to compare

similarities and discrepancies with the first case study, the second case study will be used.

The focus of this dissertation is on the Halley VI Research Station case study. More specifically, the investigation focuses on the facts related to the predicted atmospheric emissions for the construction of Halley VI and the demolition of Halley V, as well as the amount of CO2 and other pollutants emissions during the 5 summer seasons of research operations. Data from Final Comprehensive Environmental Evaluation. In addition, I will investigate the measures taken by the operating agents to minimise the environmental footprint in the logistics, pre-construction, construction and relocation phases. It is important to ask questions regarding the decommissioning of Halley V, analysing and criticising the solutions used for the decommissioning of waste and its destination. For example, a fundamental question that arises is whether certain materials have been recycled. Is there any building waste still deteriorating? How much of this waste is impossible to dismantle? According to what criteria was the decision to leave building waste on site taken? Is there a document that could have guaranteed that the continent would remain a pristine environment?

In a first instance, this paper will analyse how the HBA study in collaboration with AECOM has achieved the drafting of an efficient internal energy strategy, which allows the building to keep its environmental footprint low during its life. Moreover, since the bodies that financed these two interventions are bodies that are in a critical and decisive position for emissions of pollutants and therefore bodies active in the climate change process, it is interesting to analyse the administrative dynamics that took place against the background of the interventions.

As asserted by Felix Guattari, the growth of technical and scientific resources failed to produce social and cultural progress. Accordingly, as Isabelle Stangers stated, humanity is facing the mobilisation of technology against the Earth (Stengers, 2013), in which innovation is carried on for purely geo-engineering purposes. The sciences are not perceived by investors as fast enough. In fact, according to Moore, the capitalist machine considers Nature “cheap”, both in terms of price and in an ethical-political sense (Moore, 2016).

Society vs Nature

Moore (2016) asserted that the topic of the Anthropocene shows the dualism Nature/Society at its highest stage of development, arguing that no socio-ecological concepts emerged as the Anthropocene attracted so much

popular attention. Society and Nature are concepts immanent to the development of capitalist reality. The intensification of the production of material and immaterial goods is increasingly irreparable and threatens individual and collective existential ecosystems (Moore, 2016), but if attempts to discern this reality remain trapped in the dualism Society/Nature, then a turn will not be possible. (Moore, 2016) It can be said that we are witnessing a presumable irreversible degradation of the traditional meanings of the Society exploiting the Nature.

The Theory of Gaia

The Theory of Gaia is especially relevant to the global significance it implies for the ecosystem. The theory presents the terrestrial organisms and the inorganic environment in a perfect integration that forms a unique system capable of self-regulation, allowing the planet to be inhabitable (Lovelock, Gaia: A new look at life on Earth). The Hypothesis was formulated by the chemist James Lovelock and co-developed by the microbiologist Lynn Margulis in the 1970s. Nvertheless, the theory remains highly topical. The Hypotheses imply that organisms influence each other's evolution and the environment in which they develop according to Darwinian's biological theory of evolution. (Lovelock, 1979) If we want to associate the Gaia hypothesis to a political sense of the biosphere, James Lovelock asserted that "the stable state of our planet includes man as part of a very democratic entity" (Lovelock, 1979).

The absolute power over space

The meanings of sovereignty have fluctuated throughout history, but the absolute meaning involves a supreme authority within a territory (Philpott, 2016). The concept of Sovereignty can be defined as a contemporary notion of political authority. The state is the political institution in which sovereignty is embodied and a set of states forms a system of sovereign states. Sovereignty as absolute power over space. Gaia's intrusion marks the end of any chance to ignore the damage caused to her. The impotent fear of the future sets in, functionally demobilising people. (Stengers, 2015). The fear that has spread all over the planet is the result of a peculiar form of governance. Humanity finds itself in a status quo imposed by the sovereignty. Stengers calls "our Guardians" the authorities who actively work to produce the actual situations in which it is impossible to imagine anything other than the condition suggested by them. What follows is humanity in a global unbundling. The government has lost its social legitimacy by justifying its actions with needs related to security and access to resources. (Stengers, 2015) . How are the political and economic powers determining the

outcome of territorial interventions in the war against Gaia? How do these interventions deal with the constraints linked to the economic power of the great sovereigns? Since the exploitation requires the use of new tools and a reassessment of the relationship between the methods of configuring territories and the institutions that act on them, the main concern is…

In order to argue the issues outlined above, a variety of primary and secondary sources were obtained. As far as the Halley VI case study is concerned, the British Antarctic Survey archive has provided me with the Final Comprehensive Environmental Evaluation of the project, in which relevant dynamics such as the logistic, construction, waste destination and operational phase of the station are examined in detail. In addition, HBA has offered me an overview of the project report in which each design phase is described, from the client's requests, to the concept and the technical details of the structure and its energy strategy. Instead, with regards to the PEUGEOT-ONF Forestry Carbon Sink case study, I conducted an interview with the vice president and chief strategist of Pro-Natura International, Brando Crespi, with some questions covering the new fund management techniques that the organisation is experimenting with and some more general questions about the current policy on which interventions in areas of difficult management depend.

In order to better contextualise the topic, it is important to view the situation in the Polar regions. Polar regions are an extension of human technical infrastructure, the possibilities of creating network, research facilities and archives, but also of exploitation of resources as drilling oil and uncontrolled fishing. Antarctica is the Earth's only continent without a native human population.

In the third millennium there are now various organisations dealing with territorial changes related to government policies, with consideration of environmental impact. One of these is Territorial Agency. TA is an independent organisation that deals with changes in the structure of policies and their operational spaces in changing environments. TA deals with architecture and urban planning to develop sustainable territorial transformations, creating tools and methodologies to ensure greater spatial quality. They focus on changes in the physical structures of inhabited territories and work on global projects to strengthen community resilience (Works - Territorial Agency). North is a TA project in which the organisation deals with the modification in the North Sea. North tackles environmental problems from the oil resources off the Norwegian coast to the disputed continental shelf below the North Pole to access to Russia's Baltic waterways. As John Palmesino asserted, the vision of the North

seems rooted in stereotypical concepts of unspoiled nature, a territory of mineral and biological resources (video 1). On the contrary, unprecedented changes have taken place. Climate change, in fact, is not the only transformation that man is facing in the North, where a “system of displacement” is slowly revealing itself in the physical, institutional, social, spatial, economic and cultural structures (video 1).

In order to better contextualise the topic, it is important to introduce one of the most significant factors relevant to the war against Gaia. One third of earth’s land mass is covered by about 3 trillion trees. Each year men plant about 5 billion trees and since 1990, losing about 15.3 billion, ending up with a net loss of 10 billion trees. Since 1990, humanity has lost 1.3 million square kilometers of tree cover (the size of South Africa). The global canopy cover may shrink by 223 million hectares by 2050, with the vast majority of losses occurring in the tropics. Avoiding deforestation could cut 4 gigatonnes of CO2 emissions per year - the equivalent of half the world’s cars. Additionally, forests store and recycled our water, clean our air, prevent erosion.

Etiènne Turpin’s reflects on concepts that to the architectural community are of major importance: “Have things always been done, thought of or produced in this way? Have things been done, thought of or produced differently in other places? And, can we imagine other ways in which things could be done, thought of or produced in the future?” (Turpin, 2013).

Has capitalism negatively or positively influenced the architectural design of Halley VI Research Station and the territorial intervention in Juruena by Pro-Natura? Who are the investors and what role did they play in the development of the interventions?

Halley VI Antarctic Research Station

Halley VI is the southernmost scientific research station run by the British Antarctic Survey and is one of the most important research centres. Ozone studies have been of great importance in research at Halley since 1956, even leading to the discovery of the Ozone hole. The space weather data acquired at Halley contribute to the Space Impacts Expert Group which advises the government on the impact of space weather on UK infrastructure and business. Halley VI's project is the culmination of an international design competition that began in 2004. The process has captured the attention of the media. His design is part of a travelling exhibition curated by the British Council entitled "Ice Lab: New Architecture and Science in Antarctica". "Halley is probably the first significant architectural contribution to Antarctica," and enhances the work of the British Antarctic Survey, which investigates the impact of the polar regions on terrestrial systems, forming a deep understanding of man's impact over nature. (BAS website)

BAS decided that the best way to design the station was to launch an international design competition together with the UK Royal Institute of British Architects (RIBA) cee. The competition was won by Hugh Broughton Architects and AECOM. BAS displayed the key objectives which the operation should have respected. Most of these requests were related to the environmental footprint of the intervention and issues about designing in a sensitive climate area. They asked for a relatively easy to deliver to site, build, operate and ultimately decommission structure. This would allow for the replacement of individual facilities without significant interference with the whole station. Additionally, to minimise through-life environmental impact from construction to decommissioning with energy efficiency, reduced water usage and an improved waste management strategy were also introduced. Similarly, to be fully relocatable inland. The project was to provide flexibility to support a 5-yearly science programme in a building with a minimum life of 20 years. (HBA documentation) Halley VI Research Station was named "Best International Education and Research Building of the Year" and "Global Project of the Year" at the Engineering News-Record Global Construction Summit in New York for showcasing the "ultimate achievement in global construction excellence" and standing out across all criteria.

PEUGEOT-ONF Forestry Carbon Sink

In order to argue the GEF-funded Peugeot project to "Promote Conservation and Sustainable use of Biodiversity" implemented by Pro-Natura, it is important to mention the land and environmental reform movements, revitalised by the democratisation of civil society in Brazil in the 1990s. These movements have found their objectives in the conflict over forest areas that settlers want to convert to agriculture, but which are important for the conservation of wildlife. In the Atlantic forest, 95% of the trees have disappeared (Cullen, 2005).The forest remains in the proximity of protected areas which do not have sufficient habitat for the long-term survival of rare endangered species. Environmental NGOs, including Pro-Natura, have encouraged agricultural alternatives that improve living conditions and provide incentives for habitat conservation planning (Cullen, 2005).

Brando Crespi, co-founder of Pro-Natura Paris, vice president and chief strategist of Pro-Natura International, has designed, financed and implemented numerous sustainable development plans in the Americas, Africa and Asia over the past 30 years. Over the past 15 years, he has focused on agro-ecological projects in 15 African countries, mainly using Biochar to combat climate change and strengthen food security. He is an active investor in several "clean and green" technology companies and is a member of several international boards of directors. The Pro Natura model was developed as an institution that combines economic growth with human development and quality of life. In 1985 he founded Pro Natura in Brazil and in 1992 he expanded the institution's activities globally in the United States, Europe, Central and South America, Africa and Asia.

Beginning in 1989 Pro Natura has participated and later organised with the French Museum of Natural History the world's largest expeditions to study global biodiversity. Of the 13 expeditions to the world's biodiversity "hot spots," the largest was in Papua New Guinea where over 180 scientists from 22 countries, collected, over a period of a year and a half, one and a half million samples of life forms. Amongst scientific in partnership with Pro-Natura are the Smithsonian Tropical Research Institute, The University of Tokyo, Russian Academy of Science, ATDN (Amazon Tree Diversity Network). Pro Natura's global developmental work has led, over the last two decades, to dramatically innovate agricultural practices. Pro-Natura's climate smart agro-ecology (CSA), inspired by agro-forestry, permaculture and especially by the use of Biochar, can

be used under the forest canopy to greatly increase the initiatives' effectiveness. Depending on soil conditions, biochar, can increase growth of trees up to 300%, sequester carbon, multiply yields, and vastly improve soil health. Combining biochar with a number of Pro Natura's CSA techniques and smart ag-tech, like drones, will revolutionise reforestation programs around the world.

At a time when actions have such a weight to determine the fate of Gaia, it is crucial to deal with the actual context related to the changing environment, in order to create new sustainable solutions.

Analysis on Halley VI Research Station environmental footprint

The creation of a new research station in Antarctica was a compelling event. In discussions regarding territorial interventions over areas where the climate is hostile to human beings, it is imperative to consider all possible aspects during the design process. HBA is a pioneer architectural firm of this complex design procedure. On the geopolitical spectrum, designing in Antarctica is an incredibly peculiar case. A variety of factors make the region unique. First of all, Antarctica is an uninhabited region rendering it an appealing option for foreign states to exploit. For instance, fifty countries have set research stations in the region, giving rise to a process of environmental contamination. The Environmental Protocol of the Antarctic Treaty signed in Madrid (1991), was indeed an inevitable consequence of the damages brought onto this special territory. The aim of the protocol was to ensure that the continent remained a pristine environment, strictly controlled by the requirements dictated by the fifty nations operating on the territory. I real terms however, to what extent is it possible for fifty nations to operate separately over a certain territory fully preserving its natural status? Has Antarctica truly remained untouched?

In light of the extraordinary demands of the harshest climate on earth, the construction and operation of the Halley VI station had to meet the rigorous criteria of the Environmental Protocols of the Antarctic Treaty (The Madrid Protocol). The Protocol sets aside Antarctica as a scientific reserve, it allows freedom of scientific investigation and bans military activity on the continent. The agreement also states that should a new research station be planned, this must first be presented and discussed at the annual Antarctic Treaty Consultative Meeting (HBA Halley VI Report, 2007). The applicant nation must submit a Comprehensive Environmental Evaluation to assist discussion of the proposal. The need for the station, the environmental footprint, scientific credentials, general design and impact are then debated and finally negotiated in a forum which is to be considered the ultimate form of consultation (HBA Halley VI Report, 2007). The design of Halley VI was approved by the ATCM in 2005 in Stockholm. The idea was then presented to members again at the ATCM in Edinburgh in 2006 just prior to the start of the construction process (HBA Halley VI Report, 2007).

A long tradition of collaboration characterises all nations present in Antarctica. The Halley VI project for instance, was examined by the French, German and US polar programs over a variety of informal meetings aiming to exchange information and conceptual ideas about the design of the structure. These reviews led to significant changes. For example the final decision to use GRP coatings followed a review with the French IPEV program. (HBA Halley VI Report, 2007). The main aspects enshrined in the Protocol in relation to the actual work on Halley VI are therefore crucially examined in this thesis. The Protocol designates Antarctica as a ‘natural reserve, devoted to peace and science’. It establishes environmental principles that must be a fundamental consideration in the planning and conduct of all activities, prohibiting mining indefinitely. The Protocol requires that all proposed activities are subject to a prior assessment of their environmental impacts. The accomplishment of this i clear in an analysis of the Comprehensive Environmental Evaluation requirements and the development of contingency plans to respond to environmental emergencies.

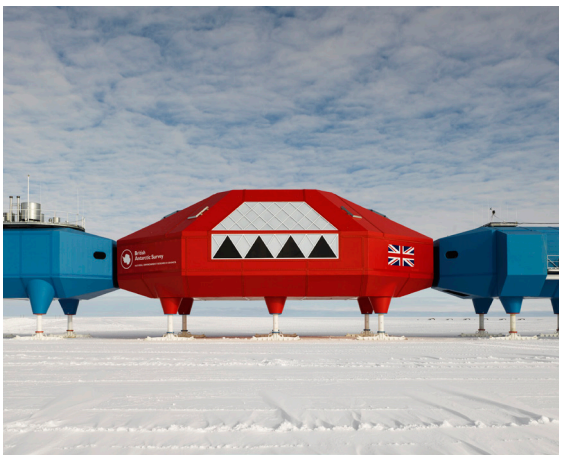
The article 1, comma 2 of EPAT states “If an activity is determined as having less than a minor or transitory impact, the activity may proceed forthwith.” However, by which criteria is a minor transitory impact determined? In article 2 “If an initial Environmental Evaluation indicates that a proposed activity is likely to have no more than a minor or transitory impact, the activity may proceed, provided that appropriate procedures, which may

include monitoring, are put in place to assess and verify the impact of the activity.”

Description

The modules are constructed with a robust steel structure and clad in a highly insulated airtight composite GRP panel system. Bedrooms, laboratories, office areas and energy centres are housed in standardised blue modules. A larger two-storey light-filled red module provides the social heart of the station and is used for living, dining and recreation. Inspiring interior design provides an uplifting environment to sustain the crew through the long dark winters, helping to combat the debilitating influence of Seasonal Affected Disorder. Halley VI incorporates medical operating facilities, air traffic control systems and CHP power plants and is a microscopic self-supporting infrastructure-free community. HBA had designed an ergonomic home to support 16 people over the 9-month austral winter and 52 in the 3-month austral summer within a building which is safe, comfortable and stimulating to live in.

Following the station’s completion, the architect and client have collaborated on the development of a Post Occupancy Evaluation Strategy. A variety of questionnaires were prepared with the assistance of space architects from the University of Vienna, using techniques developed for the European Space Agency for assessing human resilience on future missions to the moon and Mars. Results from the first full winter were extremely positive. whilst also instigating some minor changes to furniture configuration and station management protocols, in order to deliver the best possible living and working conditions at Halley (HBA Halley VI Report, 2007).



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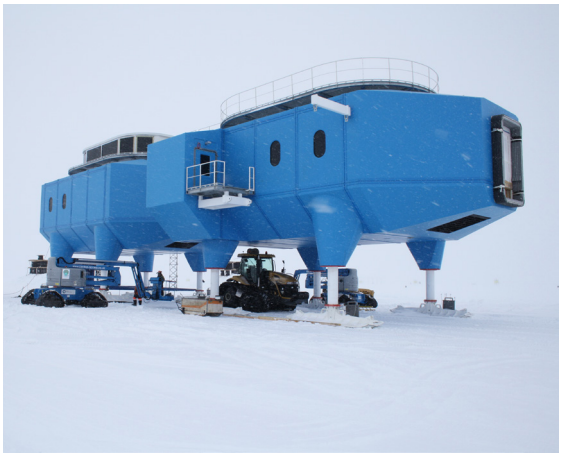

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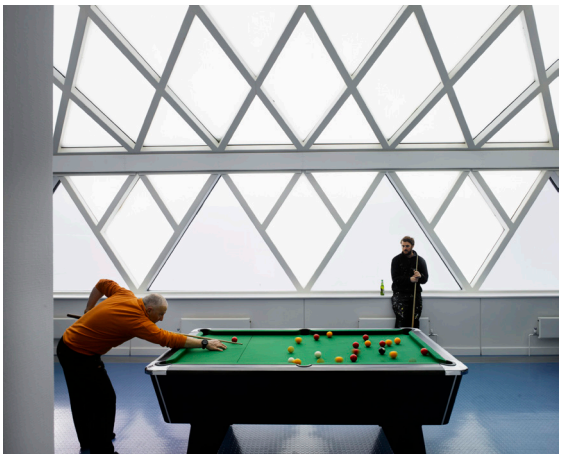

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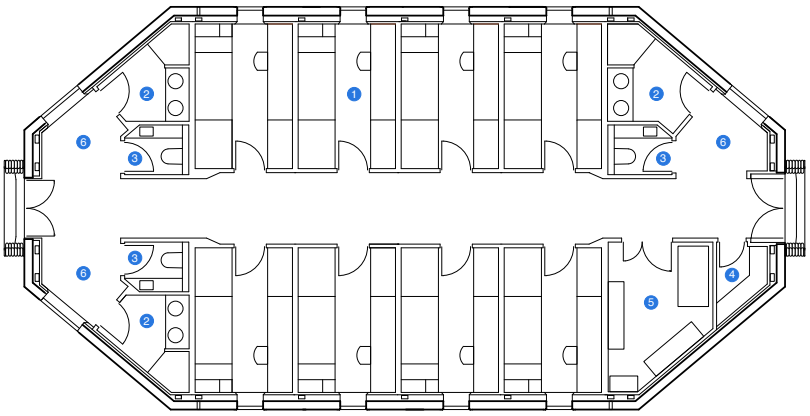
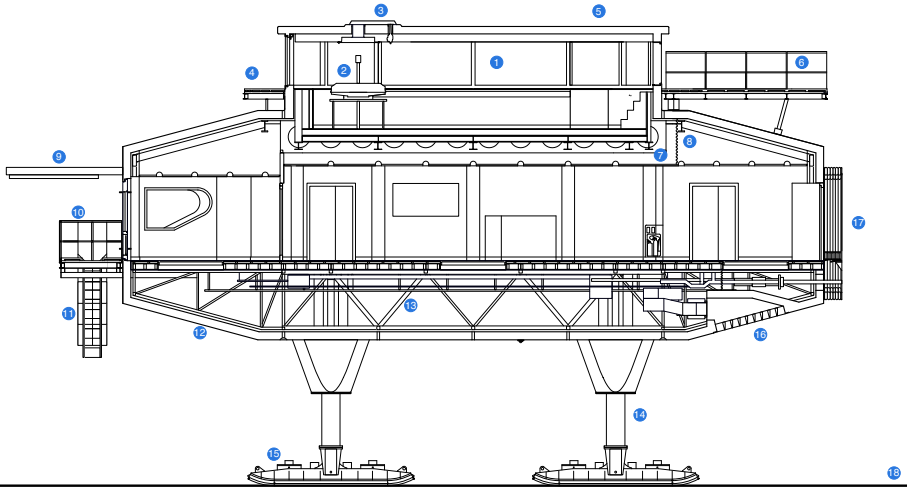


1. Bedroom
2. Shower room
3. WC
4. Toiletries store
5. Plant room
6. Threshold space

Halley VI Antarctic Research Station
Bedroom Module Plan

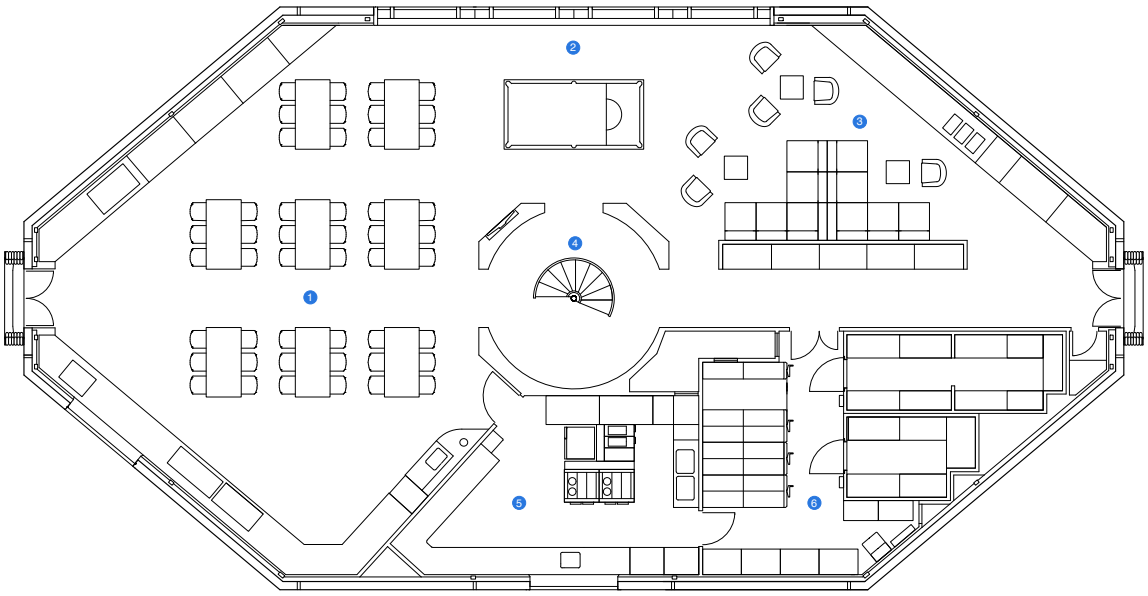
Hugh Broughton Architects
AECOM



Halley VI Antarctic Research Station
Science Module Section

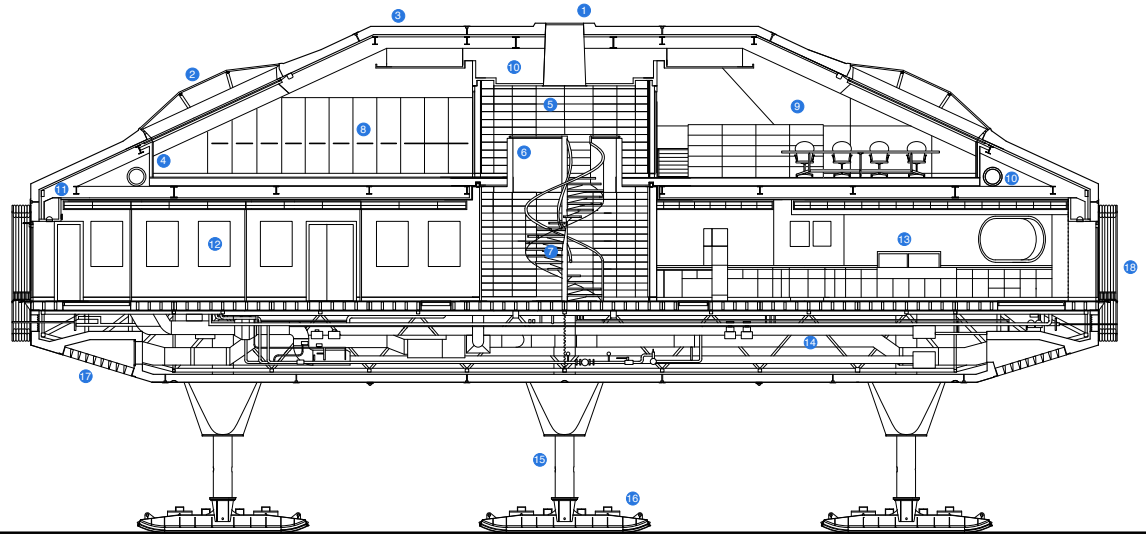
Hugh Broughton Architects
AECOM

1. Triple glazing fixed to GRP mullions incorporating blinds for winter black out
2. Dobson spectro photometer
3. Access hatch with mechanical geared opening allows regular ozone readings
4. Access walkway
5. Insulated GRP structure to meteorological observatory
6. Bridge link to roof deck on neighbouring science module
7. Castellated beam allows service connectivity across module ceiling space
8. Fire barrier
9. GRP encapsulated insulated winch beam for lifting of science equipment to working level
10. Balcony
11. Drop down galvanised ladder for fire escape
12. Painted GRP cladding incorporating PIR closed cell foam insulation
13. Intrumescent coated steel space frame substructure
14. Hydraulic operated GRP encapsulated insulated steel leg
15. Steel skis used as spreader foundation and for relocation
16. Pultruded GRP grille to air intake and extract protects inner aluminium grilles from wind borne ice particles (spindrift)
17. Insulated double skin flexible connectors between modules
18. Ice level



Halley VI Antarctic Research Station
Social Module Main Plan

Hugh Broughton Architects
AECOM



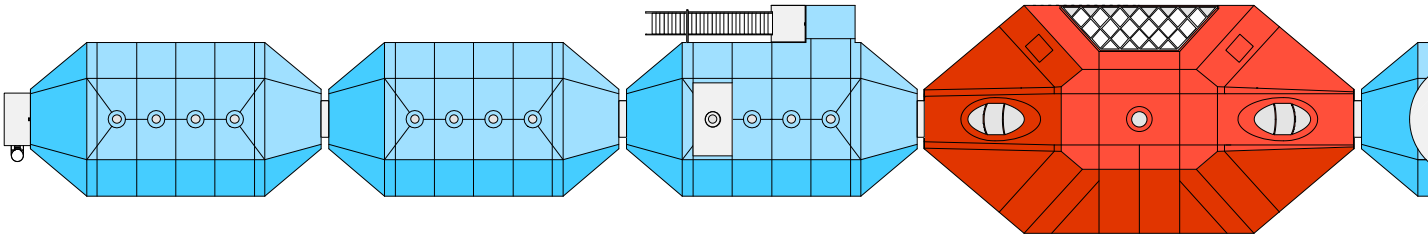
Halley VI Antarctic Research Station
Social Module Section

Hugh Broughton Architects
AECOM

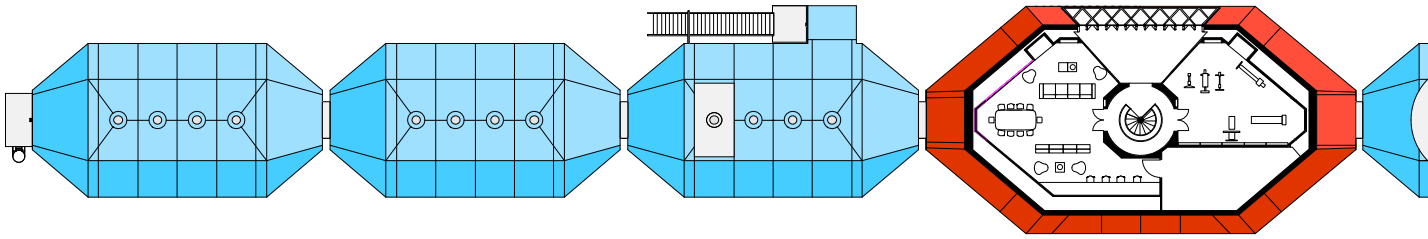
1. Triple glazed rooflight centred over spiral stair
2. Double glazed curved oval cockpit rooflight allows full views of auroral displays in winter
3. Painted GRP cladding incorporating PIR closed cell foam insulation with overall U-value of 0.113W/m2k
4. Painted glass fibre faced Fermacell wall linings with integral movement joints
5. Lebanese cedar veneered curved wall panels to stair hub
6. Solid balustrade to upper landing of spiral stair
7. Satin stainless steel, cherry and glass spiral stair
8. Gym
9. TV lounge and meeting room
10. Service distribution to upper level
11. Intrumescent coated steel superstructure
12. Bar lounge with historical photos mounted on wall
13. Servery
14. Service distribution to lower level within space frame substructure
15. Hydraulic operated CHS leg wrapped in high performance insulation and mandrel wrapped with GRP skin
16. Steel skis
17. Pultruded GRP grille to air intake and extract
18. Insulated double skin flexible silicone rubber connectors between modules

0 5 10m

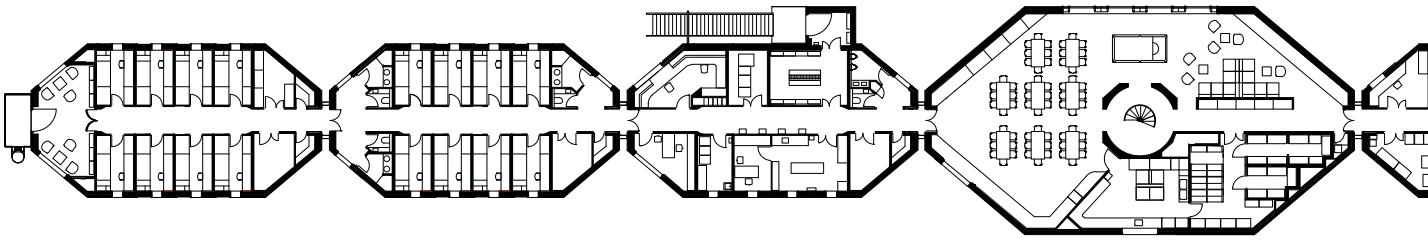
Roof level



Upper level



Operational level

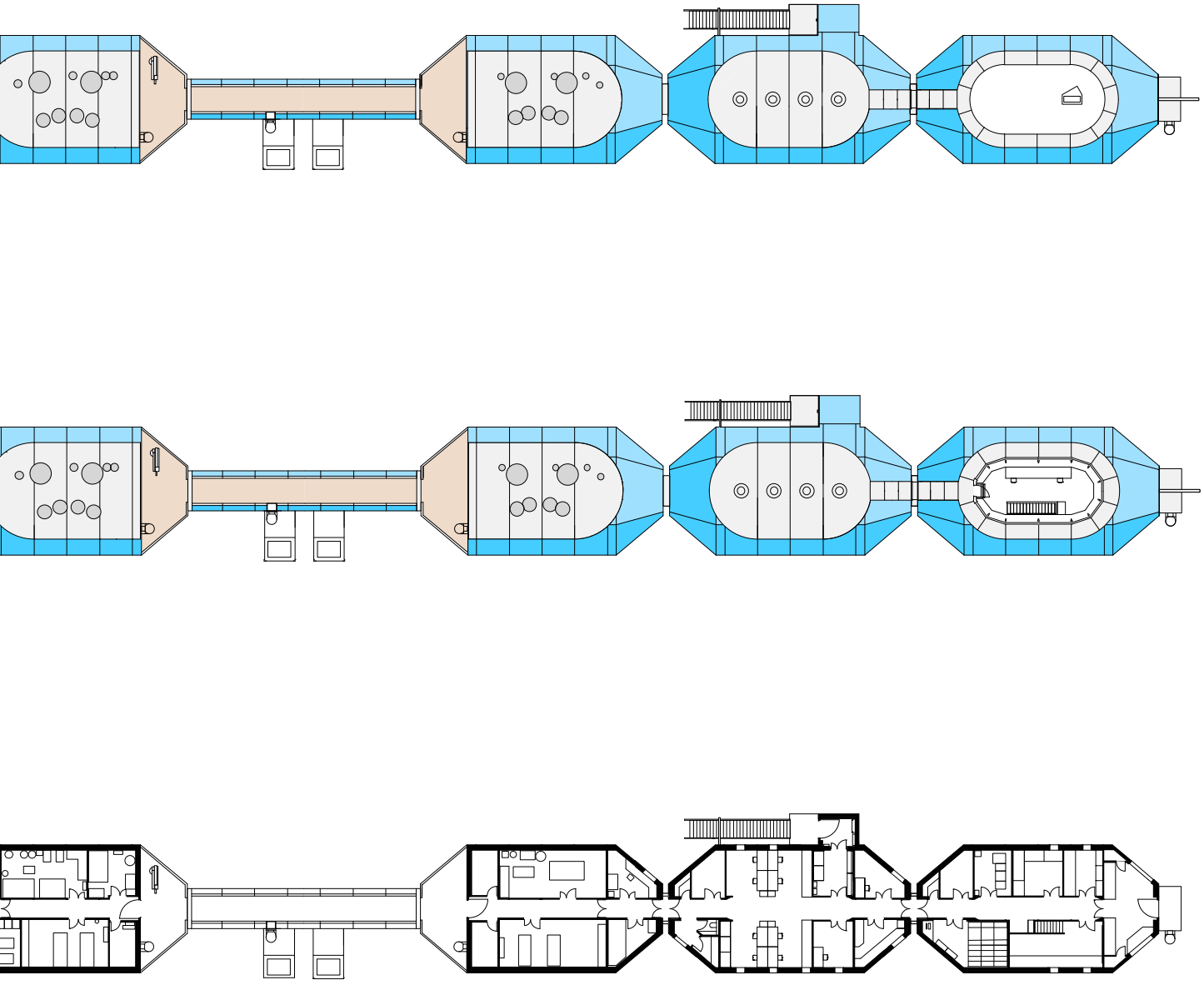


Module B2
Sleeping Module

Module B1
Sleeping Module

Module C
Command Module

Module A
The Robert Falcon Scott Module



Module E1
Generators and Plant

Service Link

Module E2
Generators and Plant

Module H1
Science Module

Module H2
Science Module

0 5 10 20m

N

Halley VI Antarctic Research Station
Platform Plans

Hugh Broughton Architects
AECOM

Logistic and construction site

In Antarctica there is no infrastructure. Everything needed to operate a research station has to be imported by sea or air. Prefabrication of structure, cladding, rooms and services were maximised within the limitations of the sea ice. The station was constructed adjacent to Halley V and then moved 12km to the Halley VI location. The construction of Halley VI was designed to take 10–12 months. BAS planned to reduce construction time significantly from the previous experience of Halley V (CEE, 2007). The latter had required four summer seasons and one winter to be built. The building of Halley VI on the other hand, was estimated to take merely three summers. This is because a major part of the Halley VI design was meant to be pre- fabricated outside of Antarctica and designed for easy assembly on the ice shelf. The construction team required for Halley VI is likely to be similar in size to that used for Halley V. Namely, around 60 MFL construction workers for the first two seasons and 25 for the final season (CEE, 2007).

The centre of pre construction activity was in South Africa. Prior to shipping to Antarctica, a trial erection was carried out in Cape Town of both the blue and the red module. Products were sourced from all over the world with the centre of pre-construction activities, where full-scale trial erection of modules was undertaken before the shipping to Antarctica on ice-strengthened cargo ship. The modules were erected over three 12-week summer seasons using a factory line approach, a production process in which interchangeable parts are added to a product in sequence to create a final product, at Halley V, used to support the construction crew. Once fully clad, the modules were moved 15 kms inland to the Halley VI site, testing the relocation strategy. Fit out was completed in the final season. The areas of disturbance include: the storage and construction areas at Halley V, the routes from the

4.

5.

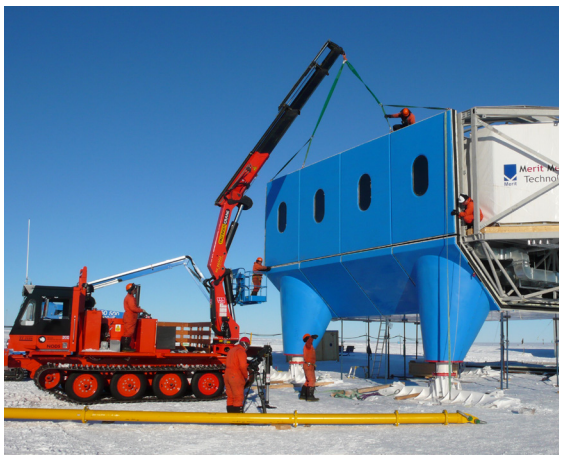
6.

coast to Halley V, the route from Halley V to Halley VI, the area around Halley VI.

Delivery also posed a significant challenge. An unavoidable and cumulative impact of the proposed activity arose from the operation of ice-strengthened vessels to transport cargo, equipment and construction staff to Halley. As the ice shelf protrudes 20 meters above sea level, all materials had to be unloaded onto fragile sea ice with a maximum bearing capacity of only 9.5-metric tonnes. They are then dragged on skis and sledges across the ice, and up man-made snow ramps created in natural creeks at the cliff-like edge of the ice shelf. BAS aimed at using its own logistics vessel RRS Ernest Shackleton to support the construction and demolition work. However, the volume of cargo needed to build the station required an additional ice-strengthened cargo vessel to be chartered and led to Halley. (cee)

Energy Strategy

Among the basic requirements of the project, the Energy Strategy played an important role. The strategy was designed to allow a complex and flexible scientific research programme whilst at the same time, supporting the individuals destined to live there on the long-term in acceptable conditions of comfort minimising environmental impact and thus reducing the time and effort required for snow maintenance and management. Energy-reduction measures were developed on the strength of initially tested technologies, in some cases as a result of innovative application by sectors other than the construction industry. Overall fuel use at Halley VI was reduced by 10% / per square metre in comparison with that used for Halley V, operating significantly more electrical equipment to create an enhanced living and working environment. The key to the energy strategy is reduction in fuel use, achieved with tried and tested technologies, often applied in innovative ways.



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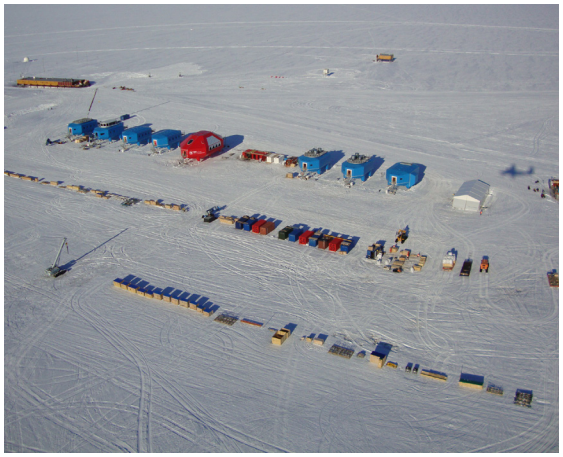

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Minimisation of fuel Usage

One of the key ingredients to achieve an efficient energy strategy is to minimise fuel usage. The station is orientated perpendicular to the prevailing wind (95%). The aerodynamic morphology of the modules ensures that the wind scours snow away from the ski foundations. These measures reduce the amount of snow manipulation required by vehicles, saving fuel usage. Similarly, jacking of the modules utilises a hydraulic system and can be managed by 5 people over a 2-week period compared to a 8-man team working over 10 weeks at Halley V. This also has a significant impact on reduction on fuel use by vehicles. Storage on the elevated platform has been increased for food, materials and fuel reducing the handling required by vehicles and consequently, the use of fuel. Modules are clad in highly insulated pre-glazed painted fibre reinforced plastic (FRP) panels. The thickness of the panels is determined by the low U-value of 0.113 Wm2K required to maximise thermal performance and minimise fuel usage. Using FRP, panels was made as large as possible and weather tightness achieved using a single skin, which reduced erection time on site (HBA Halley VI Report, 2007). The primary source of heat is provided to the structure by the waste heat from the electrical generators as a combined heat and power system. The modules are so well sealed and insulated that the majority of the heat load can be gained using the heat of the generators (HBA Halley VI Report, 2007).

Maintenance and Monitoring

Overall, in comparison with Halley V, the new base requires 10 less people to operate. In turn, less supplies, fuel and embodied energy are expended. Services within the modules run through the warm protected void created by the steel space frame substructure. This makes maintenance relatively easy and prevents risk of damage to systems from freezing. A Building Management System measures temperature, humidity, water consumption and energy use with local control within each module. Humidification and ventilation are restricted when not in use. The system can be monitored from BAS HQ in Cambridge and provides data on use for evaluation and adjustment. This monitoring process allows for energy to be saved. Heating is provided by the CHP plant controlled by BMS. Sludge is incinerated and clean water effluent is returned to the ice. Sewage treatment plant is based on equipment made for ships and uses membrane bioreactor technology. This produces a combination of clean water effluent and centrifugally dried sludge for incineration on site. A bioreactor creates a controllable environment enabling the biological, biochemical and bio-mechanical requirements to manufacture engineered product. These provide the opportunity to monitor and control environmental conditions continuously throughout the culture/reaction period along with the added benefit of maintaining a closed system.

Relocation

Halley VI is the world's first fully relocatable research station. In the case the site was at risk of breaking away as a result of an iceberg collision, the station could be moved to a safer place inland (HBA Halley VI Report, 2007). Within the modules the structure is placed around the perimeter so that the interiors can be reconfigured to suit new directions in scientific research (HBA Halley VI Report, 2007). These two aspects of the design allow this latest station remain serviceable for far longer than any previous base at Halley, minimising environmental impact and, ultimately, fuel usage. Snow levels increase by approximately 1 metre per year and the sun does not rise for 105 days during winter . Temperatures drop to -56˚C and winds blow to over 160 km/h. Access by ship and plane is limited to a 3-month summer window. The base is split in two for life safety; each half has its own energy centre and is self-sustaining

in case of emergency (HBA Halley VI Report, 2007). A bridge link allows the sharing of power, drainage and water. The modules are supported on giant steel skis and hydraulically driven legs that enable the station to mechanically 'climb' up out of the snow every year (HBA Halley VI Report, 2007). And as the ice shelf moves out towards the ocean, the modules can be lowered, towed by bulldozers further inland, and eventually, taken apart when conditions allow (cee).

Water usage

Water usage consumes significant energy in Antarctica as every drop needs to be formed from melted ice, filtered and treated before use. Once used, all wastewater has to be treated, separated and filtered prior to disposal. In the UK the average person uses 150 litres of water per day. In Halley V wasted water amounted to 120 litres per day whilst at Halley VI usage has been cut to 20 litres per day. This was achieved with the combination of a vacuum drainage system, which uses only 1.2 litres per flush as opposed to the 9 litres with a standard WC, the use of flow regulators and timed outlet controls for showers and taps.

Thermal Performance and Ventilation

FRP has a very low coefficient of thermal conduction. Accordingly, consistency of thermal performance across the whole panel is ensured with minimum heat loss compared to metal or timber SIP panels previously used. The cladding system forms an air tight, monocoque enclosure to each module. Air infiltration was measured to achieve a rate of 0.1 metres3 per metre2 per hour at 50pa of pressure (100 times better than current UK Building regulation limits). Within the parameters of the energy balance, glazing is maximised throughout the station for the well being of the crew and to reduce lighting demand during the 24-hour day lit summer. Windows are triple glazed using high performance glass. In the central module's atrium the glazing incorporates translucent nano-gel insulated panels with a U value of 0.6 Wm2K and 38% light transmittance, filling the volume with a gentle diffuse light whilst minimising heat loss (HBA Halley VI Report, 2007). Ventilation systems incorporate plate heat exchangers to utilise the inherent warmth in extract air to heat the freezing fresh air intake. Where cooling is required, the air is heated less. Ventilation plant is incorporated within local plant rooms within each module. The former avoids that ductwork must pass through the insulated silicone flexible connections between modules, where it might lose energy.

The Environmental Protocol states that 'abandoned work sites of Antarctic activities shall be cleaned up by the generator of such wastes and the user of such sites' (Annex III, Article 1 (5)). The demolition and removal of Halley V will be undertaken simultaneously with the construction of Halley VI.

Approximately 3,145m3 of waste will arise from the demolition and removal of the station. Accordingly to the CEE a part of the existing buildings and structures from Halley V station have been reused. This reduced the need to ship materials to Antartica and accordingly lowers the total waste generated by the demolition of Halley V. Drewry building – technical facilities and summer accommodation, garage building, Clean Air Sector Laboratory (CASLab) used for atmospheric science, waste platform, science cabooses, Skids and Sledges , The BAS fleet of vehicles. These are the buildings and structures which will be refurbished as necessary (CEE, 2007).

The removal of Halley V's remains, including abandoned buildings, waste, will not be possible as sewage and grey water have been buried by the snow on the Brunt Ice Shelf. These materials will remain locked in the ice until they

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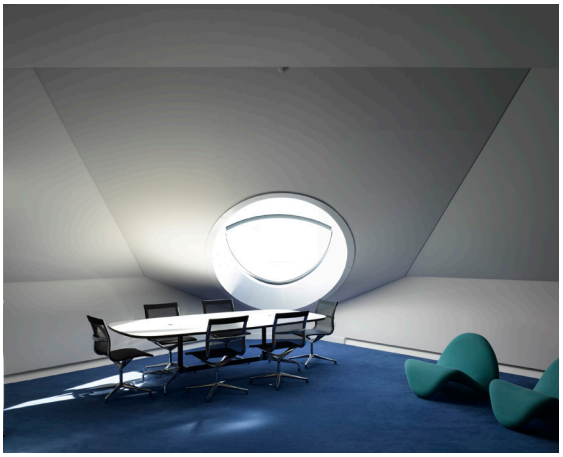

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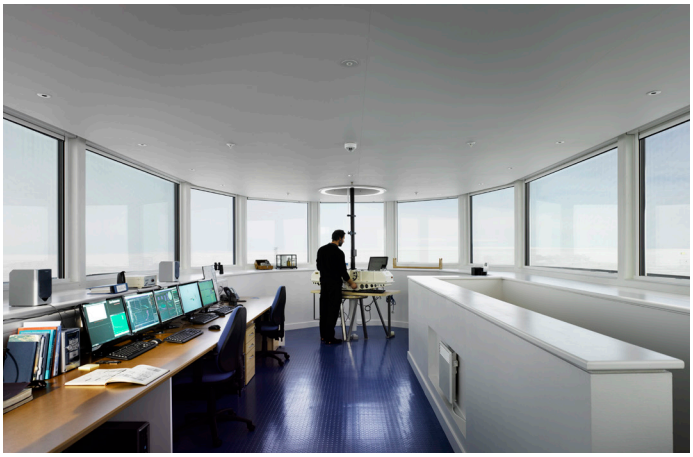

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are ultimately released into the marine environment when the ice breaks off into the sea and melts. This includes the steel ARMCO tubes and steel shafts from the Laws, Piggott and Helium Storage tunnels, and the steel legs of the platforms below surface level. The buried aerials, antennae and the sewage bulb are also going to be released out in the sea. A feasibility study undertaken in 2003, which was updated in 2006, concluded that to remove such items buried 30–40m below the surface is not practicable from a safety, technical or environmental perspective. It would pose significant safety concerns, be highly energy intensive and removal would result in greater adverse environmental impact than leaving it in situ." (CEE, 2007).

Halley VI was expected to remain operational until at least 2029. On 16 January 2017, the Press Office of the British Antarctic Survey issued an article explaining why the Research Station should have been closed. BAS decided to close its Halley VI during the Antarctic winter 2018 for safety reasons. For the second time, the research station, which is located on a platform of 150 meters of floating ice, is closed down because of an unpredictable natural situation.

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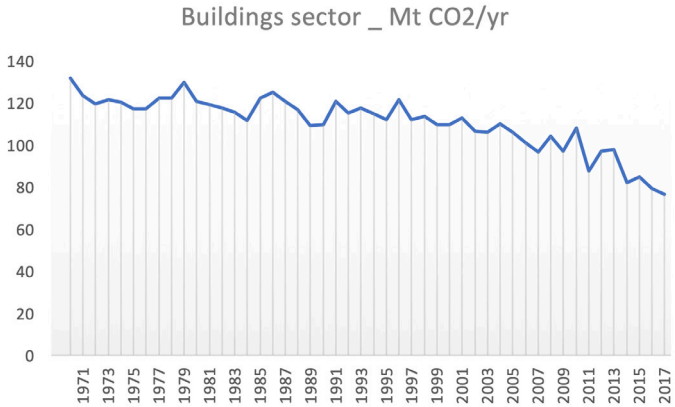

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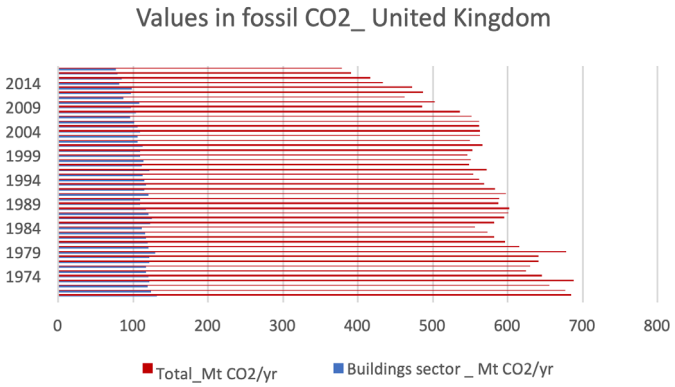

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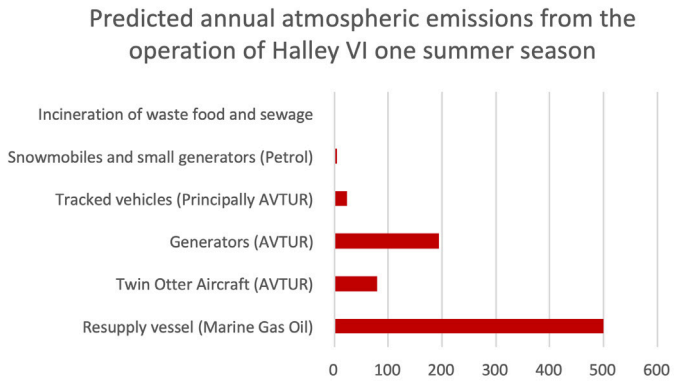

According to statistics from the EU's Emission Database for Global Atmospheric Research, it can be seen that not only has the UK reduced its CO2 emissions in general (2.), but also in the construction sector, in the period 1970-2017, emissions were reduced by 38% (1.). From the graph showing the estimated CO2 emissions in a summer season operating at Halley VI, it can be seen that the resupply vessel is the most damaging element for a total of 500 tons of CO2 per year (3.).

Analysis on PEUGEOT-ONF Forestry Carbon Sink environmental footprint

Pro-Natura has brought to the region of Juruena Peugeot and the Office National des Forêts (ONF) (Reinaud G., 2013). These have given birth to a collaboration in 1999 which allowed the creation of the first carbon sink in the world. The operation involved plantation of more than 2 million trees in the Juruena region of the Brazilian Amazon as a mean to offset the emissions of the car manufacturer Peugeot (Reinaud G., 2013). The project has already sequestered more than a million tons of carbon and more than 100 species new to science have been discovered in the area. The aim was to study the relationship between reforestation, atmospheric carbon sequestration and climate regulation (Reinaud G., 2013). The project, now in its 14th edition, has seized a total of about 240,000 tons of CO2, mainly using sixty native species of the Amazon (Reinaud G., 2013). Such a natural laboratory has a database of scientific research, analysis and systems. In addition, it coordinates about 40 research projects and has over 100 students conducting field studies that can be applied to other tropical regions (Reinaud G., 2013).

The reforestation was expected to be thoroughly accomplished in three years, accompanying the installation of an industrial facility in Rio de Janeiro, in the south-east of the country, the inauguration of which had been scheduled for the year 2000. Hence, reforestation in the Amazon region was planned to begin sooner, to promote the industry's green image in a country where automotive production capacity and market was expanding (May, 2004).
According to May, Peugeot's investment in reforestation could be compared to an investment in advertisement made by a publicity agency (May, 2004). It is a self-fulfilling investment that allows great margin of freedom to the developer. Since it does not depend on external donors and suffers no restriction from the carbon market, the investor is free to make crucial decisions regarding project activities (May, 2004). The concept and


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functioning of the project depends on the company's perception of what will achieve the maximum impact in terms of increased public awareness and enhancement to its environmental profile, specifically towards shareholders and consumers (May, 2004).
The Peugeot project is characterised by the huge amount of images used for promotion as a mean to combine the brand 's image with the enhancement of the environment (May, 2004). At the same time, however, the data report that Peugeot has made public on its website states that there has been a real absorption of emissions. The initial investment was of $12 million which covered for the plantation of 10 million native trees in an area of 5,000 hectares of degraded pastures. The initial objective was to sequester 50,000 tons of carbon (tC) per year from 2003 to 2043, for a total of 2 million tC (Reinaud G., 2013).

Understanding Problems - Discovery Expeditions
Based on technical exploration, Pro-Natura's expeditions have strongly contributed to understanding the problems of local communities and the depletion of natural resources. Such expeditions have been an important step in the launch of exploratory surveys and the mapping of regions. The data collected served as a concrete and conceptual framework for the development of the Pro-Natura business model.

Seeking Solutions – Scientific Expeditions
Pro-Natura operates the phase of Expeditions Program in partnership with the best, most specialised scientific and research institutions, NGOs, private corporation and government agencies. These elements allow for the development of solutions for sustainable economic growth in regions at risk of current or major deterioration, or in regions of high biodiversity or high natural capital value.
"We started exploring ways to explore the canopy of rainforest, that was because we knew that the canopy is one of the most interesting part of the rain forest. Partly it is because of bombardments of UV rays which brought genetic modifications."
Halley VI's success can be attributed to an intimate collaborative process among AECOM, BAS, Hugh Broughton Architects and contractor Galliford Try. AECOM responded to BAS's design brief by producing a compelling concept for sustainable delivery, construction, operation and decommissioning. British Antarctic Survey (BAS), an institute of the Natural Environment Research Council (NERC), based in Cambridge, delivers and enables world-leading interdisciplinary research in the Polar Regions. NERC is the UK's main agency for funding and managing research, training and knowledge exchange in atmospheric, Earth, biological, terrestrial and aquatic sciences.

The policy debate concerning NGOs exemplifies the conflict between liberalism and socialism and private interest/public good. The contemporary context of neoliberal economic policies and structural adjustment represents a vindication of liberal norms (Sangeeta, 2004).

Where land reform groups have been better organised, technical cooperation on settlement agriculture has enabled mutual interests to be explored in combining the productive landscape with conservation objectives. Regular consultations between NGOs, environmental bodies and the private sector revealed that there have been fewer zero-sum conflicts on the same lands than is commonly perceived (Cullen, 2005)

Question of Sovereignties

On 7 February 2014, Alice Bell on the Guardian was writing about the NERC signing a "Memorandum of Understanding" with Shell. "The memorandum does not contain specific details of joint activities [...] is a formal expression of shared interests" (Bell, 2014). Alice Bell is an academic and writer interested in issues of science in public policy and popular culture. The partnership allows Shell access to the knowledge and expertise drawn from NERC's £330m portfolio of research activities. What right does Shell have to such a access, specifically? Are such resources not a public good? It also declares an interest in working together "to understand the challenges each faces and identify where research may be able to contribute" (Bell, 2014). "Why does Shell gain such a role in helping set NERC research agendas? What about scientists, and other industries, and civil society at large? Surely they, of any possible industrial partner, have a massive conflict of interest?" (Bell, 2014). "The deal, however it works out, offers Shell a lot of greenwash. This is business as usual for modern science. If NERC wants to sign memos of understanding with anyone, it should try looking to its own workers and the British public at large." (Bell, 2014).

Is the fact that Shell is on the board of the board that funded a project to meet a common need relevant in the context of the oil tonnage scandal in the North Sea?

British Antarctic Survey: "Antarctica and the Arctic, work together to deliver research that uses the Polar Regions to advance our understanding of Earth and our impact on it." But all the amount of money that NERC, through the Business of the Environment gave to BAS, are for which aim?

"Thousands of tonnes of hazardous waste including crude oil could be abandoned in decaying North Sea rigs by Shell with the permission of the UK government, prompting growing concerns among other European countries. Due to the cost and difficulty of dismantling the structures, the oil giant has proposed leaving the vast concrete legs from three oil rigs standing in the waters. These could remain for up to 500 years after the platforms have been decommissioned. There is an estimated 11,000 tonnes of oil and toxins mixed with sediment held […], structures […] which were built in the 1970s. Hundreds of other enormous rigs, which can be as tall as the Eiffel Tower and weigh as much as the Empire State Building, are due to be decommissioned over the next three decades. In June this year, Shell removed the 25,000 tonne platforms from the three oil rigs, leaving the enormous leg, 20m wide, structures. […] However, returning to remove the legs and the hazardous substances held within would be too expensive and too risky, they have argued." (Cockburn, (2019).

Is it the form that guarantees the protection of certain resources or is it the composition of the body that manages them?

New ways of thinking actions can be thought of and produced

The Shared Value Platform (SVP) is a new operational and financing platform to create sustainable systemic change through socially innovative, as well as environmentally responsible investments. The international NGO, Pro Natura, has been operating in 63 countries for over three decades. The SVP is the result of over 30 years of Pro Natura and IFC history, in collaboration with the 2030 World Resources Group of Harvard/ World Bank and Madeira Global. The aim is to catalyse resources in territories that will soon be or are already undergoing large-scale projects, leveraging the "financial strength" brought to the region to build sustainable, climate-friendly and inclusive projects that aim to alleviate poverty, reduce social inequalities and improve quality of life. The bottom-up participatory element is at the heart of all actions taken and decisions taken under this new methodology. While some institutions transform economies by building businesses, the SVP aims to transform the world by building new sustainable models for entire fully sustainable local and regional economies, focused on the "bottom of the pyramid". Nowadays, development paths dictated by the economic dominance of capital (sovereignty) over nature can have significant implications. Talking about the World Bank's IFC, all reforestation projects have to be owned by local communities and based on principles of long-term economic sustainability. What does the Shared Value Platform consist of? Can we say that this is another way in which Actions could be thought of and produced?

"The SVP was born from the realisation of large-scale infrastructure investments brought by great expectations that lead people living in the countryside to move to the city to work on the infrastructure project of the moment. Unfortunately however, once the project is over, poverty remains a reality for these individuals.
The World Bank and the IFC have been criticised for a number of the ways in which the plans have been implemented and for their generally negative environmental impact. In this case, together with IFC, the investor, we have identified and applied a methodology that is essentially characterised by strategies to help communities define their own long-term goals for 50 years of development. What we do is to help them think strategically and tactically. The next step is to identify a methodology for agriculture and subsequent appropriation creation. We are making an impact from the point of view of this strategy is the risk of investment so it is health, education. Our role within SVP is to identify problems, solutions, give them priority and bring what is technically called capacity." (Crespi, 2019).

The United Nations Office for Disaster Risk Reduction (UNDRR), defines capacity development as "the process by which people, organisations and society systematically stimulate and develop their capability over time to achieve social and economic goals, including through improvement of knowledge, skills, systems, and institutions – within a wider social and cultural enabling environment." ("Terminology". United Nations Office for Disaster Risk Reduction. Retrieved 31 March 2016.) It is not intended to take possession of the territories of the local communities, nor to control them in order to make a financial gain. The SVP initiative does not involve any kind of exploitation.

Conclusion

Environmental issues are undoubtedly to be characterised scientific. Stengers argues that much of the scientific world is an accomplice of the Guardians. It does not matter if we structure the projects in such a way as to minimise the environmental footprint if the same body that financed the project is complicit in an unprecedented North Sea poisoning. Stengers calls for a recovery of science in opposition to the creation of the State and the assumption of profit. The power and scope of capitalism are so broad and intense that they have infiltrated Man extending into all aspects of social, economic and cultural life, sometimes in unconscious subjective layers.

“Indeed, technology allows transparency and fluent mediation. This is revolutionising many sectors. I think Capitalism is charging the world with kind of vague contours. Probably because of different kinds of Capitalism. I will call Extractive Capitalism which is maximising return of investment by extracting the most value even from nature or from human beings and it is to me the source of most of the problems that we have today, specially in environmental issued and developmental areas. There is such a thing as the curse of capturing oil and gas, generally in the most troubled countries because of corruption and because of a number of other social-economical and political problems. I think that there is a new form of economics in which Capitalism could play a role: Regenerative Capitalism. From my point of view it has much more holistic form of economic engagement in which the human being is the centre of the economic discourse and not just one of the elements that can be modified or being taken advantage of.” (Crespi, 2019)

As many authors, Latour provides a strong point of reference for continued efforts against climate change. Bruno Latour calls “terrestrial” the present time in which every human action has consequences in the natural order. This conception of the Anthropocene gives nature a social name: human events and natural manifestations shape each other. (Latour, Down to Earth) According to Guattari, what threatens the continuation of life is an ecological disequilibrium that damages the individual and collective conditions of human life. Guattari proposes a new way of understanding the world ecologically sustainable and socially equal. Guattari suggests a model in which the objectives and techniques of production of material and immaterial goods are reconsidered. It proposes strategies , which fail to appear pragmatic to me, towards a reconstruction of social and individual practices that includes an ethical structure in the political and aesthetic fields, namely, in the three environmental, social and mental ecologies. The remedy to the ecological crisis is a drastic

revolution on a global scale in the political, social and cultural spheres and thus, a resistance to the 'Integrated World Capitalism'. Guattari called for dissent against the "normal" order of things. For Guattari dissent and singularisation must be cultivated. Entities as individuals, organisations and professions need to become more diverse and consequently more united and autonomous. Environmental ecology: national balances will depend more and more on human intervention, for example carbon regulation, the ecology of machines, much more than the simple defence of nature. Guattari states that the answer to 'capitalist' formations is to bet on a return to the past, and that architecture and urbanism are therefore some of the mechanisms on which integrated world capitalism is based.

According to Latour, the New Climate Regime requires a new set of values and meanings on which to build the societies of the future. What Latour proposes is a change that replaces a system of production with a system of generation, in which human actors and the dynamics of overlap between different natural beings have the same importance. His observations bring together the main conditions and requirements needed to achieve an "earthly", human way of doing politics. However, the challenge is how to transfer this repertoire of meanings to a concrete political system. It is difficult to imagine an earthly involvement of a political ecology given the current ideological spectrum. This difficulty is the key to reflecting on the possibilities of changing a global order based on an unequal distribution of power and natural resources. (Latour, Down to Earth)

There is not a clear vision from the contemporary architect of the factor that most affects the environmental footprint. We are used to thinking about an energy strategy to produce a building that can have a low environmental cost throughout its life. When we consider the whole mechanism of a project - from the territorial intervention to the interior architecture - we can see that the factors that determine the greatest environmental footprint are those prior to the project. In Halley's case study, the air pollution produced by the bodies that financed the project is far greater than that saved in the logistics, construction and maintenance of the intervention. Therefore, the result is the total cancellation of the efforts by the technicians for energy and emission reduction strategies. It is a matter of collaboration between several parties of different competence.

HBA and AECOM have tried to minimise the environmental footprint: construction, logistics, energy strategy for the efficiency of the building. This is not enough. The issue is not in the

single territorial intervention, instead an issue of the dynamics between sovereignties. The role of the architect is to take into consideration the general context and pay attention to the dynamics between powers that allow specific territorial interventions because they fund them: a concrete example of dominance of capital over nature. NERC is the board that financed the Halley VI Research Station operation for the British Antarctic Survey. But as with the Shell case, these reductions in emissions and environmental footprints in general seem to be only speculation. We are talking about specific environmental and architectural projects, which are right to have a low environmental footprint. The problem is that this is cancelled out by far greater interventions, often funded by the same entities.

For Stanger progress has broken down. She suggests “the State must not be trusted” and accurately describes the systems that preserve the impasse as a form of non-legitimate governance. For Stengers the main priority is “paying attention”, therefore observe how governance works and the problems it produces. At the same time, it is important to ask questions and intervene on what the Guardians prohibit non-Guardians from interfering. “Paying attention is a political act, an act of knowledge, sharing and resistance.”

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Appendix

Pro-Natura ANTICORRUPTION POLICY

"Since 1985, Pro Natura International (PNI) has been tackling the social, economic and environmental challenges that face rural communities in the developing world. Our mission is to apply integrative, scalable market solutions that offer long-term sustainability and financial independence to the communities we serve." One of the greatest obstacles of Brazil and other several countries to achieve social and economic growth is corruption. Corruption also represents a significant additional cost of doing business in many developing countries. Corruption damages policies and programs that aim to promote sustainable development, to help reduce poverty and improve people's lives. Therefore, fighting corruption is aligned with Pro Natura International's ("PNI) mission and values: we do not allow or any unethical practice or any form of bribery or corruption, whether in the public or private sector. PNI has always cherished the integrity and honesty of its employees and business ethics and is deeply committed to preventing and combating corruption. PNI prohibits any contribution or donation from being made in exchange for undue advantage, or to influence the decision of a Public Agent, directly or indirectly. Contributions and donations to entities or institutions are prohibited at the request of a Public Agent, or in which the Public Agent or a Close Person performs any function."

Nowadays, development paths dictated by the economic dominance of capital (sovereignty) over nature can have significant implications. Talking about the World Bank's IFC, all reforestation projects have to be owned by local communities and based on principles of long-term economic sustainability. What does the Shared Value Platform consist of? Can we say that this is another way in which Actions could be thought of and produced?
“The SVP was born from the realisation of large-scale infrastructure investments brought by great expectations that lead people living in the countryside to move to the city to work on the infrastructure project of the moment. But unfortunately, once the project is over, the poverty of these individuals remains.
The World Bank and the IFC have been criticised for some of the ways in which the plans have been implemented for their generally negative environmental impact. In this case, together with IFC who is the investor, we have identified and applied a methodology that is essentially characterised by strategies to help communities define their own long-term goals for 50 years of development. What we do is to help them think strategically and tactically. The next step is to identify a methodology for agriculture and subsequent appropriation creation. We are making an impact from the point of view of this strategy is the risk of investment so it is health, education. Our role within SVP is to identify problems, solutions, give them priority and bring what is technically called capacity.”

Second, it is really interesting the way you organise and live expeditions, the flying devices. How do you choose them? Why there are so many? Why their functions are so important?
“We started exploring ways to explore the canopy of rainforest, that was because we knew that the canopy is one of the most interesting part of the rain forest. Partly it is because of bombardments of UV rays which brought genetic modifications.
I remember in Brazil while I was doing anthropological work many years ago, after one of the windstorms the look for three that had fallen because of the wind, one of most dangerous things in rain forest. The point is that the channel we collected tips of plants from the top of the trees from the canopy part of the trees, that was essentially much more powerful. Many years ago we studied presence of metabo-

lise active molecules have particulate important sherbet the concentration was much higher in the higher part of the trees than at the base. We decide to find ways to study the canopy. “

In conclusion, talking about innovation, Biochar with a number of Pro Natura's CSA techniques and smart ag-tech, like drones, will revolutionize reforestation programs around the world. Do you think this kind of materials could have been used for architectural interventions? Crypto, tokens crowdfunding and gamification are generating large scale engagement, funding and corporate support. Blockchain, ground sensors, satellite imaging, and AI ensure transparency and allow for donors to measure and engage in the progress. On this framework, to what extent does capitalism negatively or positively influence interventions in the Anthropocene era?

“Indeed, technology allows transparency and fluent mediation. This is revolutionising many sectors. I think Capitalism is charging the world with kind of vague contours. Probably because of different kinds of Capitalism. I will call Extractive Capitalism which is maximising return of investment by extracting the most value even from nature or from human beings and it is to me the source of most of the problems that we have today, specially in environmental issued and developmental areas. There is such a thing as the curse of capturing oil and gas, generally in the most troubled countries because of corruption and because of a number of other social-economical and political problems. I think that there is a new form of economics in which Capitalism could play a role: Regenerative Capitalism. From my point of view it has much more holistic form of economic engagement in which the human being is the centre of the economic discourse and not just one of the elements that can be modified or being taken advantage of.”

Brando Crespi, co-founder of Pro-Natura Paris, vice president and chief strategist of Pro-Natura International, has designed, financed and implemented numerous sustainable development plans in the Americas, Africa and Asia over the past 30 years. Over the past 15 years, he has focused on agro-ecological projects in 15 African countries, mainly using biochar to combat climate change and strengthen food security. He is an active investor in several "clean and green" technology companies and is a member of several international boards of directors.

MEMORANDUM OF UNDERSTANDING

This Memorandum of Understanding (MoU) dated 7th February 2014, is made between:

SHELL GLOBAL SOLUTIONS INTERNATIONAL B.V, (hereafter "Shell") a Netherland Company having an office at Carel van Bylandtlaan 23, 2596 HP, The Hague, the Netherlands

and

The Natural Environment Research Council
Of Polaris House, North Star Avenue, Swindon SN2 1EU, (hereafter "NERC").

1. Purpose

The purpose of this MoU is to outline how Shell and NERC will work together to maximise the benefits from our mutual interests in areas of long-term research, postgraduate training and knowledge exchange.

- This MoU is not legally binding.
- This MoU can be amended only in writing and subject to agreement by both Shell and NERC.

2. Scope

The scope of this MoU covers the science and innovation of mutual interest to NERC and Shell, and the associated strategies and business needs.

3. Expectations and Benefits

Under the terms of this memorandum of understanding NERC and Shell seek, within the scope of this agreement, to:

- Create mutual understanding of the strategy and business needs of both organisations to enable broader Shell understanding of the benefits and opportunities of working with NERC and assist NERC's understanding of the benefits and opportunities of working with Shell;
- Identify synergies between Shell and NERC funded research and training activities where they relate to Shell innovation strategies;
- Create opportunities for future joint or allied funding of research and postgraduate training where there is an alignment of Shell and NERC's requirements and investments;
- Identify and measure the impact arising from Shell collaboration with UK universities and Research Centres enabled through partnership with NERC;
- Influence academic behaviour by articulating Shell long-term research, translation and training needs with NERC;
- Support long-term pre-competitive underpinning research, translation and postgraduate training activities in priority areas that align with NERC and Shell strategies, working with other organisations where appropriate; and