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STEEL SANCTUMS

THE ADAPTIVE REUSE OF A DERELICT CARGO SHIP

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THE ADAPTIVE REUSE OF A DERELICT CARGO SHIP

BY

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A 120-point thesis submitted to the Victoria University of Wellington in partial fulfilment of the requirements for the degree of Master of Interior Architecture.

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School of Architecture, 2017

Fig. 0.01 An example of workers quarters on a shipbreaking yard.

0.02
ABSTRACT

This Master of Interior Architecture design research project proposes that a derelict cargo ship within one of the ship breaking yards of Chittagong, Bangladesh can be reused to accommodate the sites workers and act as a vehicle through which an interior intervention can be used to explore the significance and value of a derelict cargo ship. A design response that acknowledges the context of the site will allow for the exploration of the derelict cargo ship as a viable space for reuse and interior intervention.

As relevant case studies suggest there is a contemporary trend to reuse abandoned and derelict spaces. The implementation of derelict cargo ships as a viable spaces could provide a new perspective on the contemporary tendency to adaptively reuse these types of structures. This speculative research project explores ways in which one such structure could be investigated for interior intervention.

A derelict ship in the shipbreaking yards of Chittagong will become the shell in which a speculative, interior design solution will be explored. This will investigate the viability and significance of the adaptive reuse of cargo ships for the site's context and the wider built environment. It will allow for a deeper understanding of the implications of inhabiting cargo ships.

Fig. 0.02 A partially dismantled ship at Chittagong, Bangladesh

0.03
ACKNOWLEDGEMENTS

Firstly, I would like to thank my parents for all of their support over the last five years. I am incredibly grateful for the opportunities they have given me.

Secondly, thank you to my supervisor, Natasha Perkins, for all of the guidance and time you have given me.

Lastly, thank you Charlotte Whitehead for helping with proofreading and the rest of my friends and classmates for being there along the way.

Fig. 0.03 The beach of a shipbreaking yard in Chittagong.

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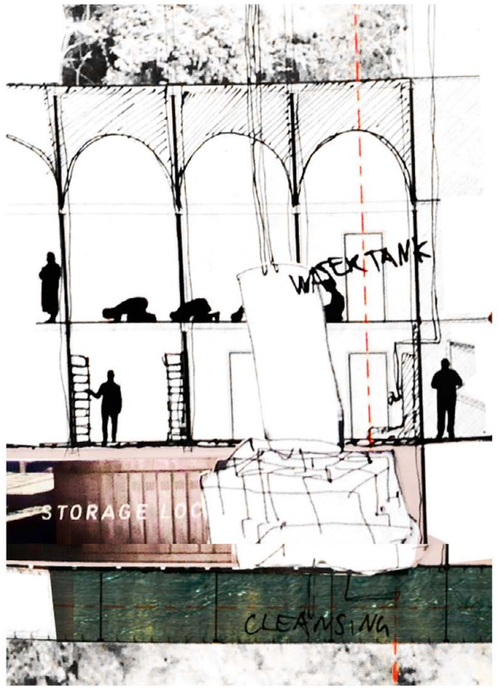


Fig. 0.04 Mixed media section exploring communal space on an adapted ship.

CHAPTER 1.00

INTRODUCTION

1.01
INTRODUCTION

The advancement of technology creates obsolescence and through obsolescence comes abandonment. Abandoned objects and spaces may lose their purpose but do not lose all of their value. Rehabilitation and renovation of these sites restores the value lost in their dereliction and gives them a new purpose. It is a contemporary trend to reuse abandoned and obsolete buildings as it is aligned with current concerns about sustainability and a desire to preserve structures of heritage or significant historical value.

There are many structures that still have potential value that, if not given a new purpose, are left neglected; they fall to ruin or are destroyed completely. Cowan, Hill & Frank state that over the past several years, they have seen a rise in architects engaged in service or community-engaged activities thereby moving their client base beyond the wealthy few in the suburbs to those in dire need of shelter, medicine, and overall care. They go on to say that due to this, 'found objects' begin to play a greater role in architecture and engineering (2013). In this sense adaptive reuse becomes more about repurposing objects and structures that did not originally function as architecture. Architectural intervention acts as a vehicle through which these objects and structures can be rehabilitated and reconsidered for new uses and inhabitation.

> *Transformation is seen not in design quality, but rather in the way planning makes abandoned objects and spaces relevant to everyday life again* (Baum & Christiaanse, 2012).

For this Master of Interior Architecture research project the cargo ship was one such structure that was identified as a space that is both abandoned and neglected with the possibility of transformational reuse and intervention. Although cargo ships like most other ships have existing habitable spaces, their abandonment and subsequent ruination allows them to be looked upon from a new perspective, through the lens of adaptive reuse.

A site where many abandoned cargo ships can be found is a shipbreaking yard in Chittagong, Bangladesh. The accelerated ruination, that exists as a result of the dismantling process that occurs here, relates back to issues of sustainability and questions perceptions held about the historical significance of industrial artefacts. The unique conditions of a shipbreaking yard where cargo ships are sent at the end of their productive/economic life, as well as the requirements of the various theoretical stakeholders, provides a context for which to construct a design solution around.

PROBLEM

Obsolete industrial sites and artefacts are abandoned and fall to ruin when they are not perceived as objects of significance or value.

The workers of the Chittagong site live under very poor conditions, often without access to electricity or sanitation facilities.

To what extent can interior architecture play a role in the adaptive reuse of the cargo ship and can it be used as a driver to improve the lives of the workers of this shipbreaking yard?

RESEARCH QUESTION

How can a cargo ship beached at a Chittagong shipbreaking yard be reused to generate inhabitable interiors and could this investigation inform ways in which other derelict or abandoned ships be reused and inhabited?

AIM

The principle aim of this investigation is to explore how interior architecture can transform and adapt a cargo ship to make it habitable and renew its significance to the community of workers inhabiting the site. Additionally, through this process the investigation will explore the following objectives to:

- Provide the site workers with a space or series of spaces that meet their needs and requirements, especially in relation to their day to day life under the conditions of the shipbreaking yard.

- Explore the concept of adaptive reuse and its implications on the design process.

- Explore the implications of site specific issues and how they will impact the design of the intervention.

- Investigate the implications of retrofitting & inhabiting ships.

- Provide an experience that allows people to engage with the historical and social context of the new structure.

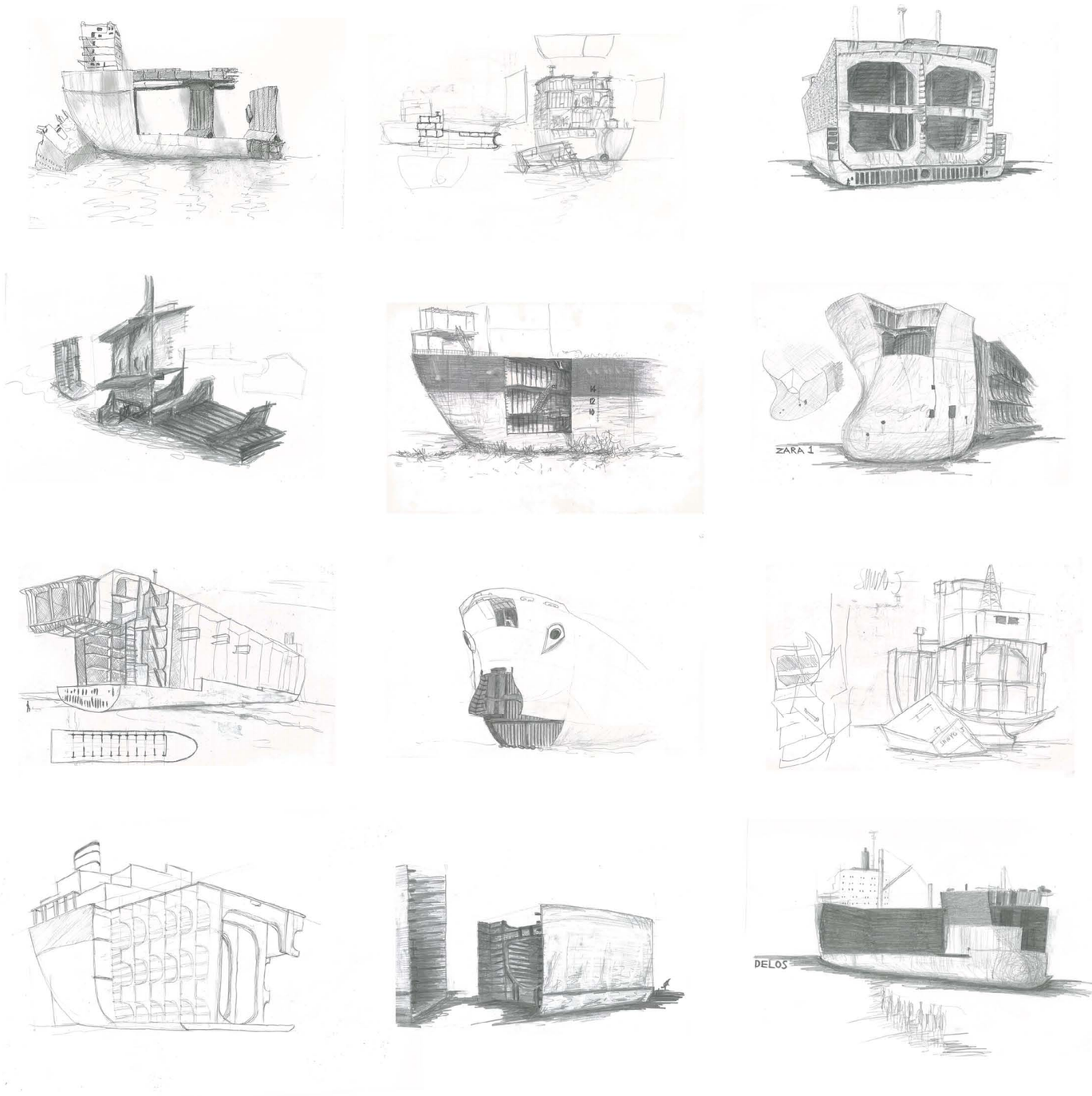


Fig. 1.01 Sketches of shipbreaking yards

1.02
METHODOLOGY

THE HEURISTIC PROCESS

The heuristic design process begins with a problem for which an answer will be sought, followed by a process of discovery and analysis of findings that will lead to further and more discoveries. The process of discovering these findings results in an increasing depth of information for the research and the researcher (Moustakas, 1990). Effectively the sum total of each of the individual discoveries form the final product and the final product is only possible as a result of these discoveries.

It refers to a process of internal searching through which one discovers the nature and meaning of experiences and develops methods and procedures for further investigation and analysis. The self of the researcher is present throughout the process and, while understanding the phenomenon with increasing depth, the researcher also experiences growing self-awareness and self-knowledge. Heuristic processes incorporate creative self-processes and self-discoveries (Moustakas, 1990).

Steps

1. Identify a problem
2. Immersion into the topic and question
3. Incubation
4. Illumination
5. Explication
6. Culmination of the research in a creative synthesis

This process allows for the reflection and analysis of individual discoveries that, regardless of relevance to the final outcome, will have contributed to the researcher's knowledge and self-discovery while simultaneously identifying important aspects of the problem that are significant and worthy of further inquiry. This process is reciprocal as it moves backwards and forwards between immersion and explication, ensuring that the problem is thoroughly addressed. This can be seen in Fig. 1.02.

IDENTIFY A PROBLEM

The problem is the focus of the research, it is constantly evolving as more about its nature is discovered through investigation and design.

IMMERSION

Through investigation into the problem and the site itself, via architectural theory, case studies and analysis of the physical/temporal/social properties of the site a body of information can be accumulated. Sketching and collage as well as composite images for analysis are methods that augment this process positively and are used throughout the project where appropriate.

INCUBATION

Reflection on the information gathered grants insight into how the problem can begin to be addressed. Additionally, this reflection will also begin to reveal aspects of the primary investigation (immersion) that require further attention. This will aid in forming a more comprehensive basis for the design of the project. This process also has the opportunity to reveal findings that influence the direction of project entirely as more is discovered about the true nature of the problem which will itself reveal new directions to explore.

ILLUMINATION

Illumination is where the results of the immersion coalesce to form the design that addresses the problem. This will be explored through experiments in a variety of means and mediums including, drawing, 3D modelling and computer based rendering as a way to explore atmospheric qualities. One of the other techniques that is being explored throughout this project is the use of digital painting to augment or enhance different drawings.

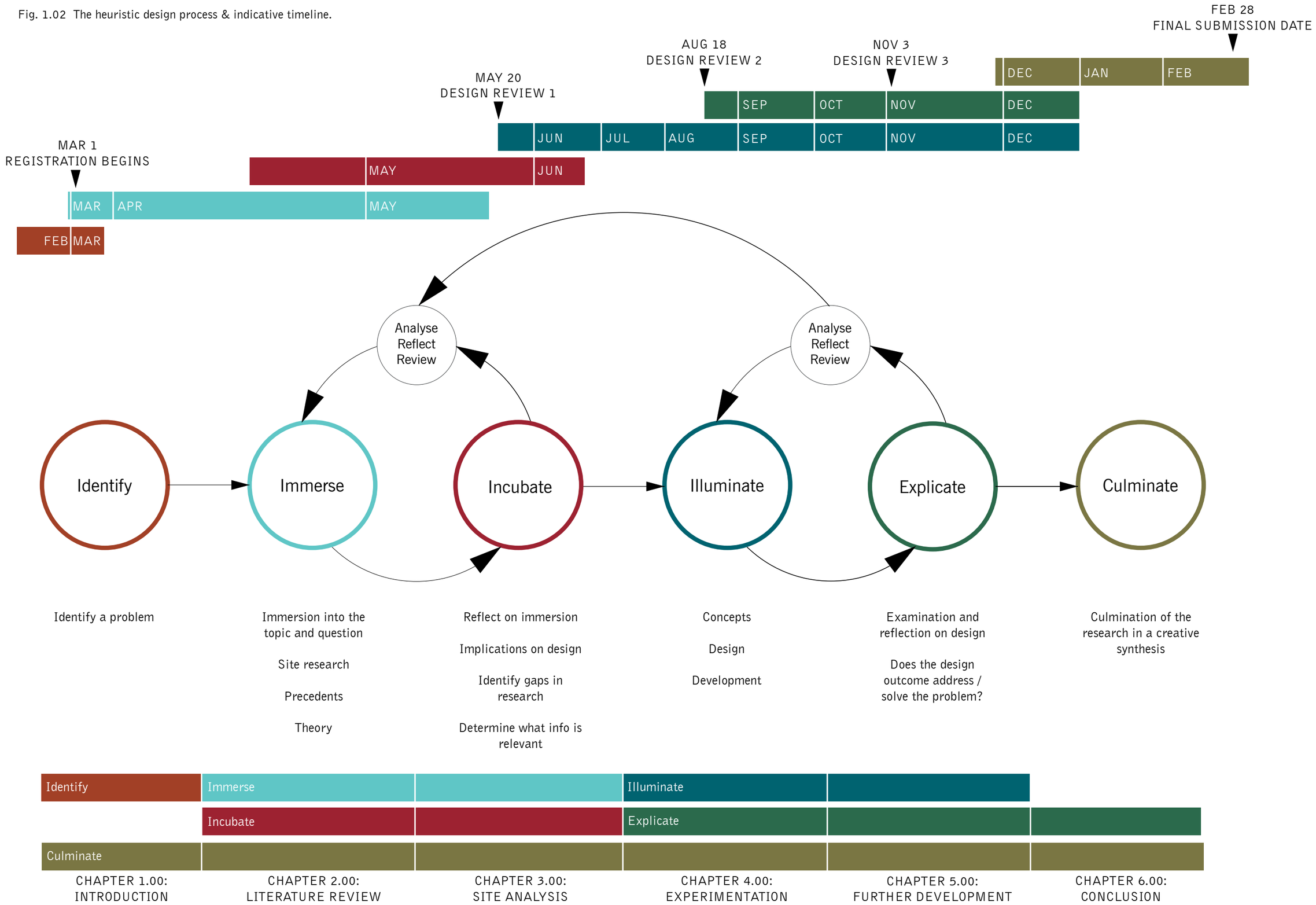
EXPLICATION

The reflection and analysis of the design experiments is to determine how successfully it addresses the problem. At this point it may be revealed that further investigation is required before advancing with the design. One of the important parts of this stage is getting feedback on the design through external critique, this consists of 3 formal design reviews and numerous informal critiques. An ongoing dialogue with others about the ideas and designs that are being explored will be useful in reflecting on and testing design decisions against different opinions. Much like the incubation stage, this is a stage of revelation that will contribute to the discovery of the true nature of the problem as well as its solution.

CULMINATION

The culmination of the body of research that reveals an answer to the problem as well as the processes that formed that solution. This is also the stage where the final reflection and analysis occur to determine the designs success and where the research could be headed.

Fig. 1.02 The heuristic design process & indicative timeline.



1.03
SCOPE

It is important for this project that its scope is clearly defined as a result of the context of the site and its relationship with the subject and intent of the research. As the principle aim of this investigation is to explore how a cargo ship can be reused there are a number of factors that need to be acknowledged as falling outside of significance to the project. These include assumptions made to progress the project and aspects that are worth noting but for various reasons are not explored in depth.

Firstly, it is irrelevant to the research question how the development of a cargo ship at the Chittagong site will be financed. This is because the project looks to investigate how a cargo ship could be inhabited rather than how to house the local population. However due to the context it is appropriate to consider and accept that the intended inhabitants have a very low income and will have implications on a number of the design decisions.

Secondly, the size of a cargo ship is immense. Due to this it has been decided that only the main hull and the storage holds of the ship will be adapted for this project. The existing facilities will remain where they are appropriate for accommodation or fulfil a function that would enhance the experience of the occupants (such as retaining the ships generator to provide a rudimentary lighting system). These facilities are located near the aft of the ship and are separated from the storage holds. The additional excessive components would be stripped out for recycling as is typical of the shipbreaking process.

Thirdly, for aspects of the design such as water storage/ transmission, septic tanks and electrical systems, the technical details of their functionality are acknowledged but they are too time intensive and of little relevance to the project to be explored in depth, as such they fall outside of the scope of the project. Their location and approximate size have been referenced however.

Fig. 1.03 A streetside market near the shipbreaking yard.

Fig. 1.04 Digital painting of a partially dismantled ship

CHAPTER 2.00

LITERATURE REVIEW

2.01
INTRODUCTION

This chapter presents existing literature and the case studies relevant to the project that have been examined. This explores how similar research and ideas have addressed themes that relate to this project, along with case studies analysed to find out how relevant problems are solved.

This chapter is split into sections that relate to the themes explored and include brief case studies to demonstrate how these ideas have been addressed in reality. This is followed by more in depth case studies that share similarities with this research project.

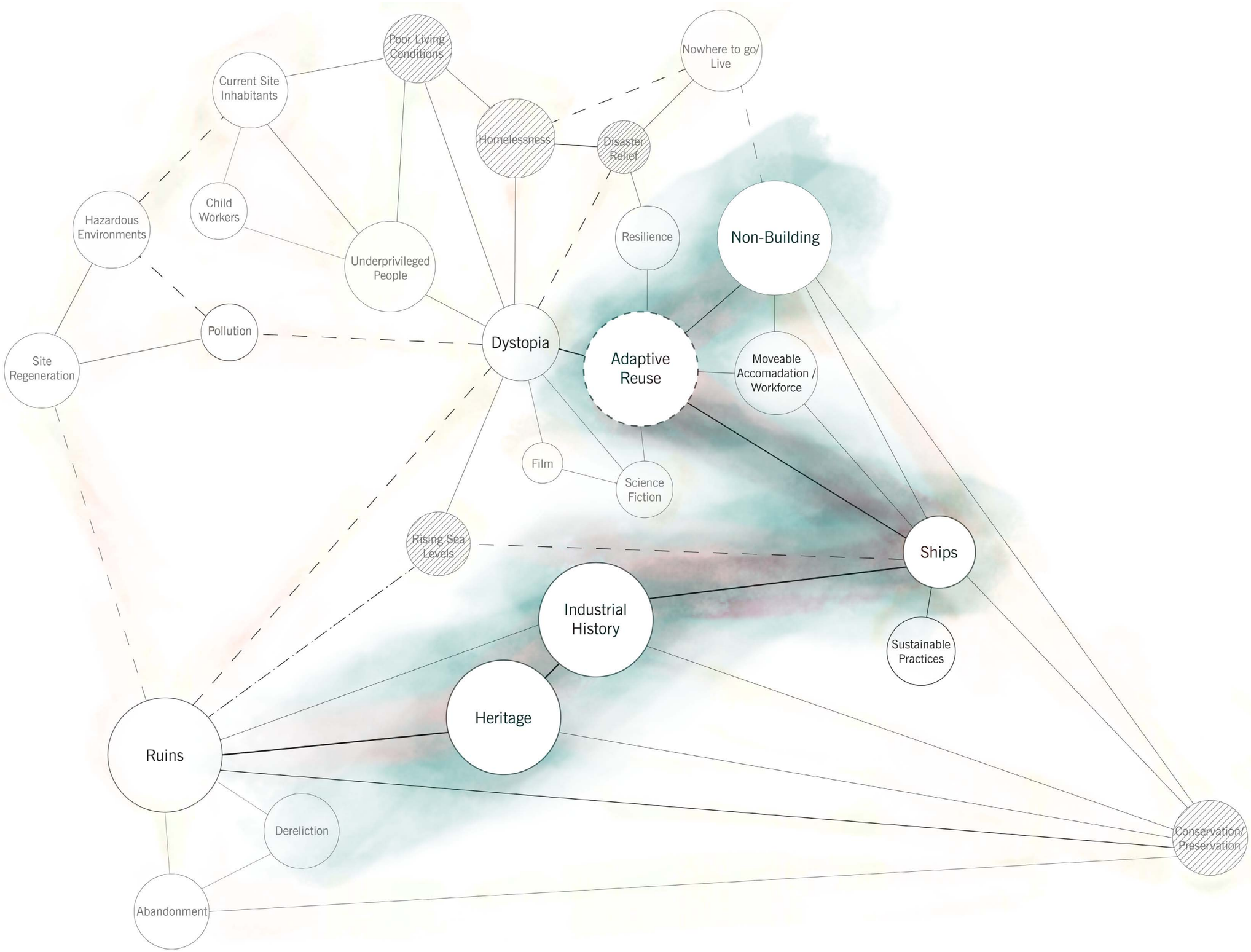


Fig. 2.01 Diagram of themes and ideas showing relationships

2.02
ADAPTIVE REUSE

"Adaptive re-use is beginning to receive widespread attention because of the economic, social and environmental benefits that can be espoused" (Bullen & Love, 2011b). Although adaptive reuse involves converting a building to undertake a change of use (Bullen & Love, 2011a), for the purposes of this research adaptive reuse will be looked at in the context of industrial sites as the object of reuse to maintain relevance to the project as well as draw emphasis to the similarities between cargo ships and industrial sites.

A parallel can be seen between cargo ships and these industrial sites in the fact that the aesthetics and shapes of these abandoned sites were dictated by function, not conventional architectural forms. It was the machines and processes they housed that determined their configurations, moulded to purposes known only to those who used them (Hardy, 2005).

> *"Buildings outlast civilisations, they evolve and they are changed, but their reuse emphasises continuity. A building can retain a remembrance of the former function and value; it has memory of its previous purpose engrained within its very structure"* (Brooker & Stone, 2004).

The appropriation of the container ship as a structure for inhabitation allows for a case of intervention. Through intervention the value of the ship to societies industrial heritage can be preserved due to the idea that its retention allows for engagement with its past and history. Furthermore, Brooker & Stone suggest that the existing context, structure, spaces, function and history can offer many significant opportunities and an appreciation and interpretation of these can provide the inspiration for redesign (2004).

Shen & Langston state that "existing buildings that are obsolete or rapidly approaching disuse and potential demolition are a 'mine' of raw materials for new projects" (2010). They go on to suggest that "an even more effective solution than raw material recovery is to leave the basic structure and fabric of the building intact, and change its use" (2010). The state of partial dismantlement that these ships exist in provides an opportunity where building on these innate characteristics and potential allows for architectural design that does not erase but rather, reveals the beauty of these conditions in unexpected, even radical ways, state Klanten & Feireiss (2009).

Bolles + Wilson is a German architecture firm that converted a derelict WWII U-boat production facility into a furniture retail store, they speak of the enormous potential in the re-scripting of grand industrial spaces (2012). The transformational power of this reuse can be seen in the juxtaposition of the deteriorated existing, industrial structure that resists the intervention of domestic furniture (Fig. 2.02).

The Tate Modern art museum located in London by Herzog & Demeuron Architects converts a power station into a museum. They discuss how reusing existing structures will be an increasingly important issue in European cities. They go on to say that the result of this is more exciting than the pure preservation of a given structure and more complex than a completely new building (Herzog & Demeuron Architects, 2000). In contrast to the previous example the design of this building gives the impression that the exhibitions spaces have always been there say Herzog & Demeuron Architects and that the new and old building components have been interrelated and attuned to each other in such a way that they are indistinguishable (2000) (Fig. 2.03).

The Water tower Sint Jansklooster by the Dutch firm, ZECC Architecten adapts a water tower, transforming it into a watch tower. The original building is a national monument, due to this alterations to the exterior were extremely restrained and the architectural statement was made to the interior of the tower (Fig. 2.04). The existing stair contrast with the new stair which zig zags across the tower to reinforce spatial perceptions. The goal of this is to intensify the experience of the scale of the reservoir and give a better impression of the huge quantities of water that the tower used to hold (ZECC Architecten, 2015). In this example the preservation of the structures heritage was a priority for the design through which visitors can interact with the interior and gain a better understanding of it.

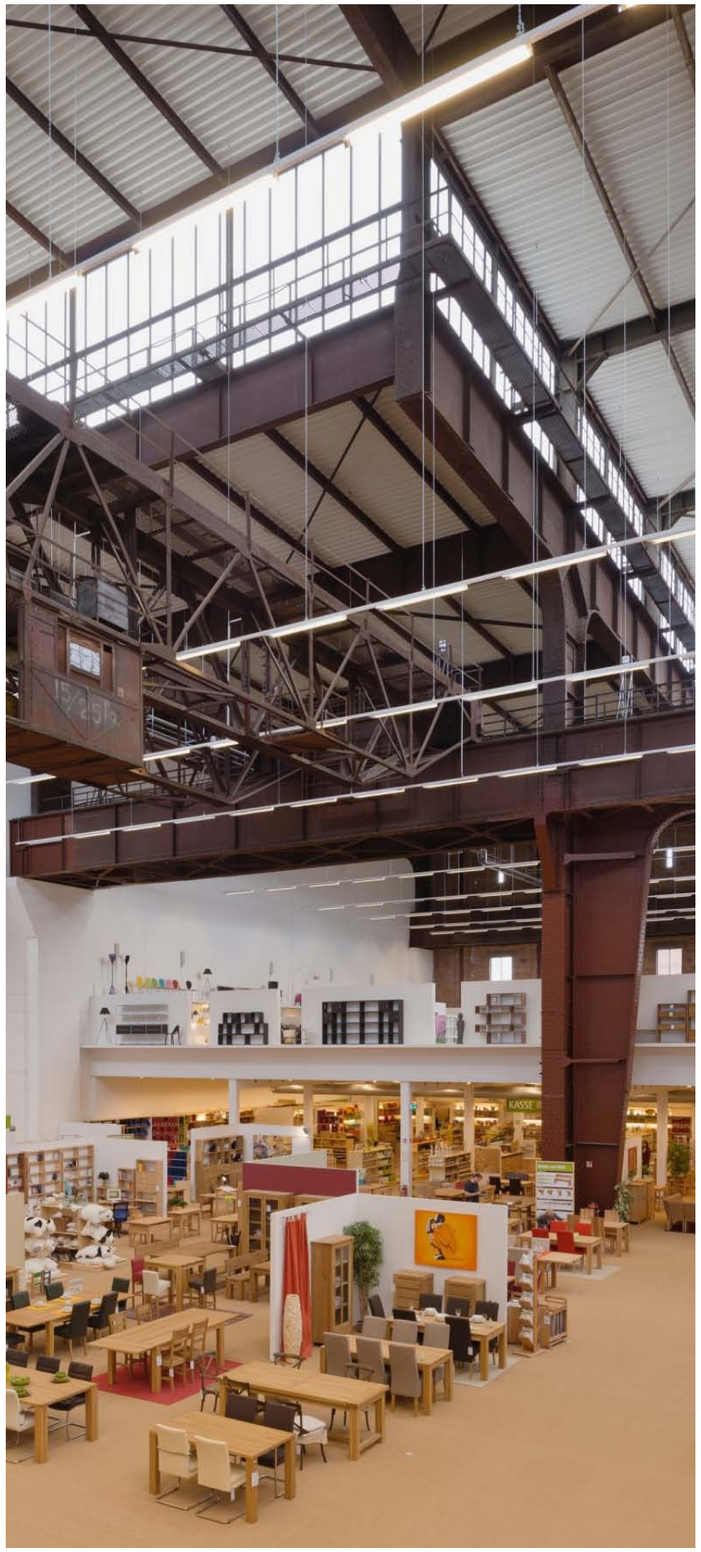


Fig. 2.02 U-Boat Hall by Bolles + Wilson

Fig. 2.03 Tate Modern turbine hall entrance ramp

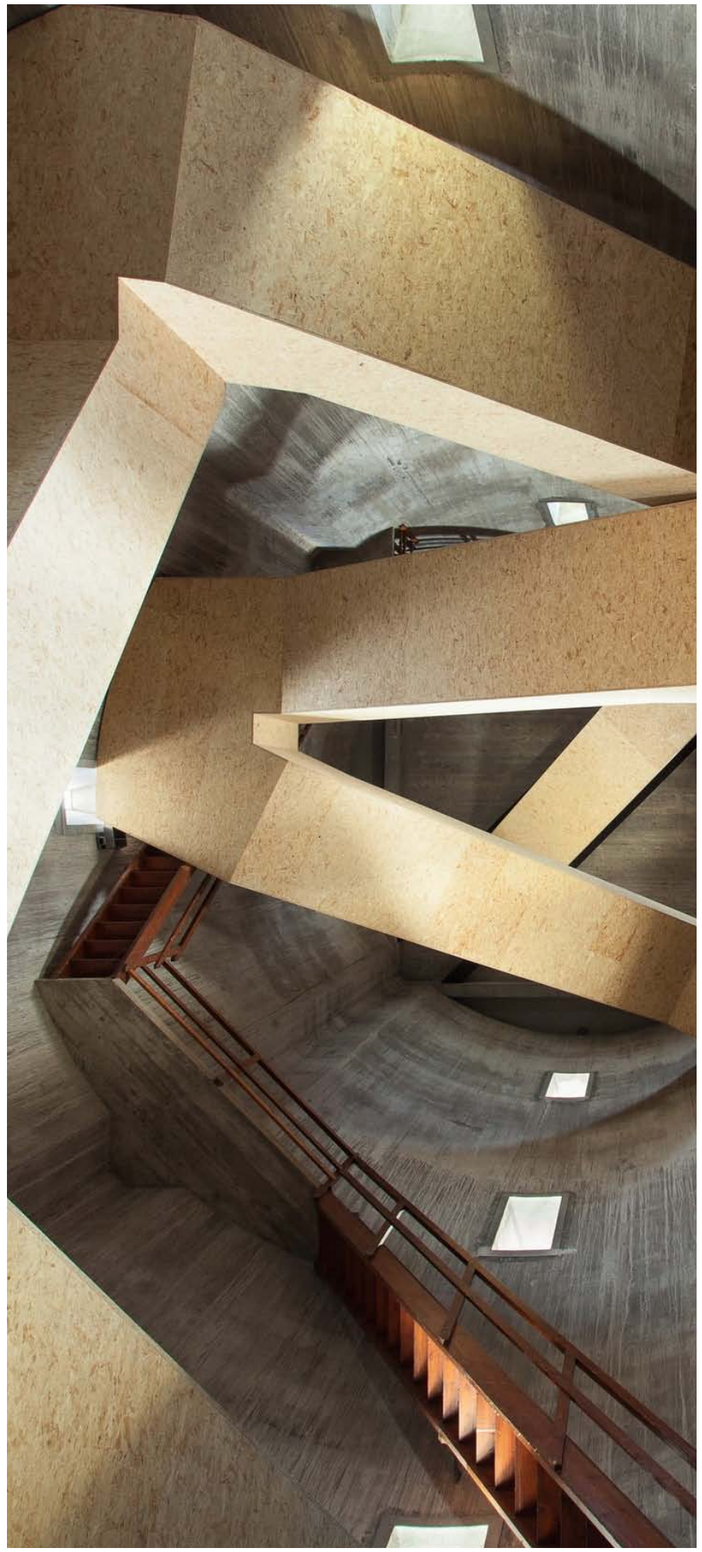


Fig. 2.04 Water tower/ watch tower adaptive reuse

2.03

SHIPBREAKING & SHIPS

The History of Shipbreaking

- The breaking up of old warships is performed in dry docks.
- Hard to craft parts are valuable to salvage
- Shortages of seasoned timber
- Ships are often lost at the end of their useful lives.
- Ships are often burnt as a means of disposal.

1400 1500 1600 1700

- The beginning of shipbreaking as an industry
- The 'Castle' firm is established, specialised in breaking up wooden warships.

1800 1810 1820 1830 1840

- The first completely iron-hulled ship is built

1850

- Iron-hulled ships are common

1860 1870

- Steel replaces iron in vessel construction
-Scrap steel used in new ship construction

1880

- Holland, Germany, Italy and Japan buy obsolete ships as scrap for new manufacture.

1890

- Oxy Acetylene welding and cutting invented, revolutionising shipbuilding/breaking

1900

- Shipbreaking boom following WW1
- Most naval vessels built pre 1910 declared redundant.

1910 1920

-Operation Crossroads
- 95 'target vessels' to be disposed of, including obsolete warships and ships surrendered by Japan/ Germany following WW2 for nuclear testing

1930 1940

- Japan has the largest shipbreaking industry in the world

1950

- M.D. Alpine is stranded on the shores of Sitakunda, Chittagong

1960

- M.D. Alpine is bought by Chittagong Steel House to be scrapped
- Beginning of shipbreaking in Bangladesh

- Taiwan has the largest shipbreaking industry in the world

1970 1980

- The majority of shipbreaking now occurs in South Asia

1990

- USN begins sinking exercises as a means of ship disposal
- Obsolete ships used as target practice and scuttled

2000

- Basel Convention, old ships are classified as toxic waste
- Ships cannot leave a country without permission of the importing state

2010 2020

A majority of the global trade in materials and goods is by sea. 80% of all raw materials and manufactured goods are transported via ships. As such, the shipbreaking industry is subject to boom and bust cycles. It thrives during times of economic contraction and declines during periods of economic growth. (Frey, 2015).

> *The business of shipbreaking is one of the numerous industries which have grown up round shipping and the sea. It was apparently first practised in the dismantling of ships which had been driven ashore in bad weather. Those who had the legal right to a wreck, and often those who had not, used the materials for building their huts ashore or for any other purpose* (Winchester, Hardy, & Bowen, 1936).

Shipbreaking has been around for as long as there have been ships, although it wasn't practiced as an industry until the mid-19th century. Over time "ship breaking moved from the core to peripheral countries in Asia when the cost of breaking ships in the core due to increased regulations as well as increased labour costs estimated to be more than 50 times that of developing countries exceeded the price obtained from the scrapped metal" (Frey, 2015). The countries where the majority of shipbreaking occurs today include Bangladesh, India, Pakistan, the Philippines, Vietnam and Turkey.

Shipbreaking is sustainable in practice, at least to the extent of its near total reuse and recycling of materials. Despite this not all ship are dismantled at the end of their useful lives and in some cases- receive new, sometimes drastically transformational, uses. The following are three different examples of ships that have gained a new uses after they lost their original functionality.

Sometimes when a ship has significant historical significance its function will be adapted to that of a museum where visitors can learn about the ships history and context. They are often restored or preserved in their current state. The USS Missouri, located at Pearl Harbour, Hawaii is a floating museum ship whose "exhibits, with special exceptions, are largely categorized as restored spaces or operational displays. These include many of the operational, engineering, navigational, administrative, food service and living spaces aboard Battleship Missouri that are restored to their "in-operation" appearance" ('Exhibits & Collections - USS Missouri', n.d.) (Fig. 2.05). This form of preservation allows visitors to gain some insight into how people occupied the spaces in the past.

Another example of a museum ship is the Cutty Sark, located in the Greenwich, London. The entire ship has been raised 3m off the ground in its dry berth and had its hull encapsulated (Fig. 2.06). This forms a new space underneath the ship that provides and fantastic and unique experience for visitors (Reid, 2013). This showcases the craft and skill that went into its construction. Due to this it can no longer be considered a seafaring vessel, its conversion from a ship to a museum is more of a practice in rehabilitation rather than restoration (Powell, 2013).

Artificial reefs are a different use for obsolete ships. The USS Oriskany, a decommissioned aircraft carrier, was donated by the United States Navy (USN) to the state of Florida for this purpose (Fig. 2.07). Despite criticism from environmentalists the USN says that sinking ships for use as artificial reefs is an environmentally safe and economical means of disposing of old vessels (Geiselman, 2006). These types of artificial reefs have been shown to have had positive effects on the biodiversity of fish species and plants, in addition to beneficial economic impacts, at the diving sites (Shani, Polak, & Shashar, 2012). The Oriskany now provides a space for recreational activities as well as a habitat for aquatic life, a drastic change from its previous function as a warship.

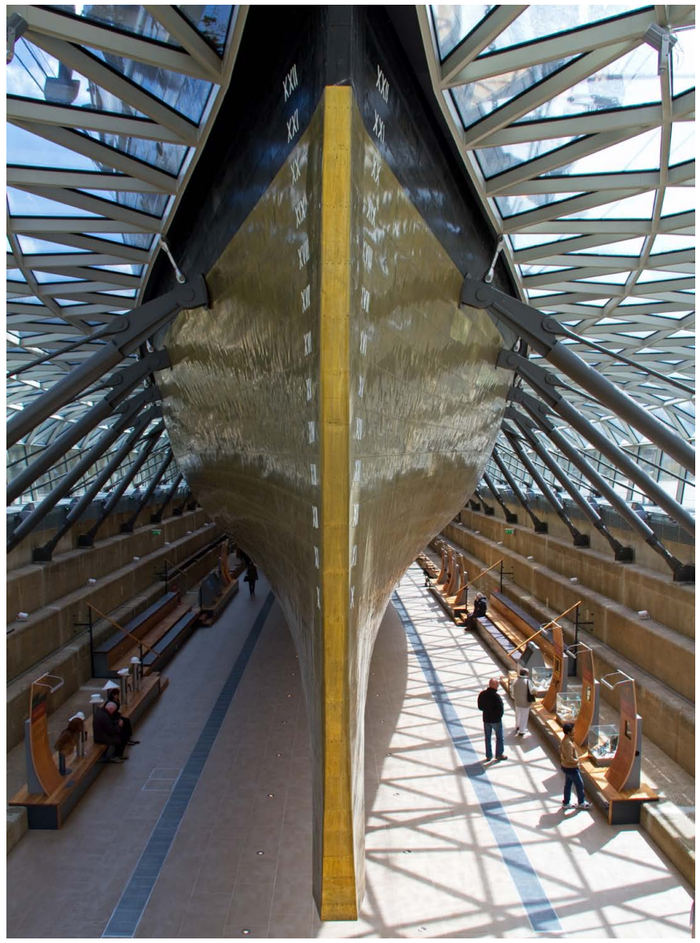


Fig. 2.06 Cutty Sark hull

Fig. 2.05 USS Missouri (BB-63) interior

Fig. 2.07 The decommissioned aircraft carrier Oriskany

2.05
ADDITIONAL CASE STUDIES

NAME: Gargantia, on the Verdurous Planet
DIRECTOR: Kazuya Murata
RELEASE DATE: 6 MAR 2015
MEDIUM: Animation, DVD
RELEVANCE: Adaptive Reuse, Self Sufficiency, Living on ships

Gargantia, on the Verdurous Planet is an animated series set in the distant future where humanity has declined and the planet is covered in water. Groups of people have formed fleets of old ships so that they may coexist and survive.

Gargantia is a large fleet of interlocking ships where the story is set and is presented from the perspective of an outsider who knows nothing of life on earth. Through the protagonist the viewer is shown how the inhabitants of the fleet go about their everyday lives and how they survive.

Over the course of the series the viewer is shown how resources are produced. Entire groups of ships are dedicated to cropping, raising livestock, fishing and it is implied that many fruits and vegetable are grown on rooftop gardens. Fresh water is collected as rain and stored on water barges and presumably pumped around the ship as needed. Electricity is gathered from nano-machines in the water as a sustainable and renewable energy source.

The fleet is separated into districts based on the facilities of individual ships. Entire vessels are dedicated to industrial services, residential space and recreation facilities, others are agricultural, some are for storage and cargo. The interior of only a few key areas is shown. We gain an understanding of how family units live, small apartment style homes are subdivided by curtains to form different flexible spaces and bedrooms with small adjoining kitchens and presumably bathrooms (Fig. 2.08) (Fig. 2.09). Due to the nature of medium the unglamorous parts of everyday life are not shown. These include waste disposal and sanitation, the viewer is given no understanding of how these crucial parts of a functioning society operate. This is an area of the design that this research will take into account as well as building on the detail of the interior for the context of the site

Fig. 2.08 Screen shots of Aimee's house on Gargantia

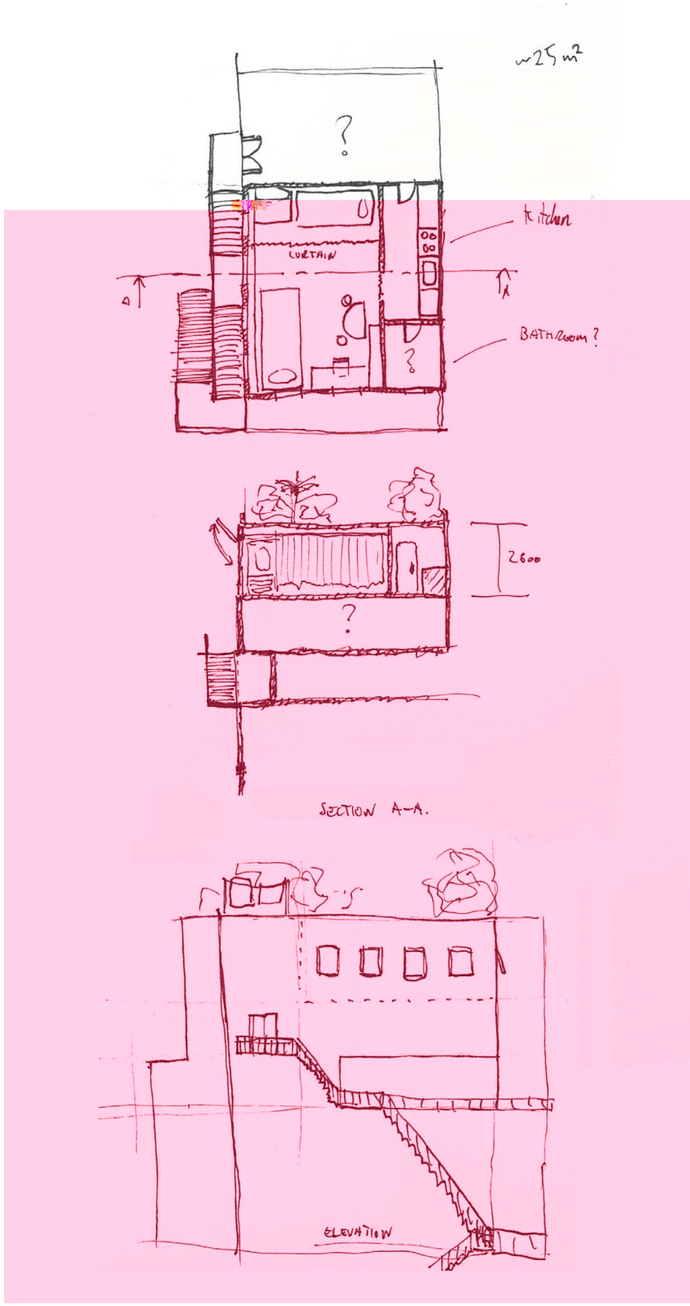


Fig. 2.09 Sketches of the layout of the house

NAME: Quinta Monroy
DESIGNER: Elemental / Alejandro Aravena
DATE: 2004
LOCATION: Iquique, Chile
RELEVANCE: Social housing, Low-budget housing, Self-built/ expansion

The Quinta Monroy housing complex consists of a number of structures intended for families living in poverty, they had to be affordable because of this.

> *We think that social housing should be seen as an investment and not as an expense. So we had to make that the initial subsidy can add value over time* ('Quinta Monroy / ELEMENTAL', 2008).

The solution they came up with involved a typology that, as buildings, could make efficient use of land and allowed for expansion. Each property was built with a subsidy of US$7,500, after a year each property was valued beyond US$20,000, a significant increase (Elemental, n.d.). The main aspect of the design that facilitated this was that only 50% of the building was constructed with the other 50% being self-built by the inhabitants. The building had to be porous enough to allow each unit to expand within its structure. The initial building must therefore provide a supporting (rather than a constraining) framework in order to avoid any negative effects of self-construction on the urban environment over time, and also to facilitate the expansion process ('Quinta Monroy / ELEMENTAL', 2008).

> *That is how we expect to contribute using architectural tools, to non-architectural questions, in this case, how to overcome poverty – Alejandro Aravena.*

The design of the building has allowed a large degree of customisation to the inhabitants. The way they fit out the space will be by their own means, reducing the initial cost of the house. It can be seen in Fig. 2.11 that it is possible to personalise the building significantly.

Fig. 2.10 Quinta Monroy unit before expansion

Fig. 2.11 Quinta Monroy unit after expansion

Fig. 2.12 Cargo ship section perspective showing internal bulkheads

CHAPTER 3.00

SITE ANALYSIS

3.01
INTRODUCTION

This chapter looks at important factors relating to the site. These include where it is located, the surrounding local context, as well as the makeup of the shipyards population. In addition to this the ships that can be found at the shipbreaking yard were investigated. These could contribute to the structure and form the interior that this project will explore.

95% of a ships' mass is recoverable steel with the remainder mostly being furnishing and mechanical components which are also recycled or sold on (Hossain & Islam, 2006). In this sense, shipbreaking is an efficient way of reusing the materials, so much so, that the recovered steel from the yards in Bangladesh make up 90% of the country's internal iron and steel supply.

The area surrounding the shipbreaking yard has a build-up of infrastructure as a direct result of the economic value shipbreaking brings to the country. For example, the steel rerolling and recycling facilities are located nearby. There is also a build-up of roadside markets and structures whose purpose is the resale of non-sheet steel recyclables. Hossain & Islam (2006) state that around 25,000 people are employed directly by shipbreaking yards in the country with upwards of 200,000 more employees in businesses related to the shipbreaking industry. Although only a fraction of the workers in the shipbreaking industry work on the yard, a huge amount of energy and resources have been put into the surrounding systems and infrastructure to facilitate the recycling of ships and intensification of the industry.

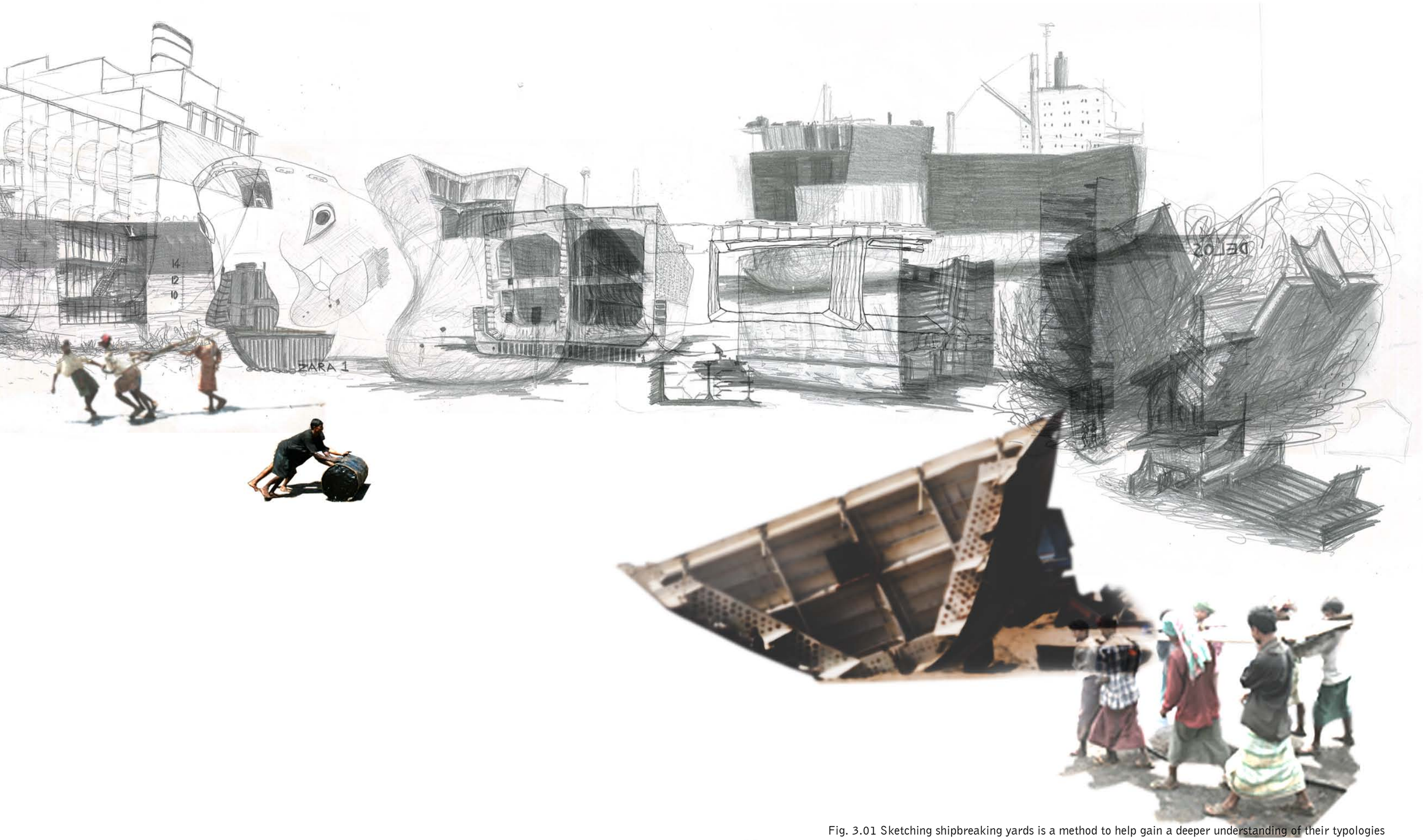


Fig. 3.01 Sketching shipbreaking yards is a method to help gain a deeper understanding of their typologies

3.02
LOCATION

The shipbreaking yards of Bangladesh are located northwest of the city of Chittagong along a stretch of coast of the Bay of Bengal (Fig. 3.03). This stretch of beach where shipbreaking occurs has many advantages making it suitable for the facilitation of the shipbreaking process as stated by Hossain & Islam (2006) including:

- A long, flat, uniform, intertidal beach
- An extended beach with tidal difference of 6m
- Protection by the Bay of Bengal
- Stable weather conditions
- Low labour costs
- Some existing infrastructure (connected to the capital Dhaka by road and railway)
- Moderate enforcement of laws
- Low level of environmental awareness
- Huge demand for iron and steel in the local market
- Nearby location of rolling mills

Over the last 10 years between 100 and 200 ships are dismantled in Bangladesh each year. In 2009 a record high of 2,308,525 light displacement tonnes (LDT) of ships were scrapped (Sujauddin et al., 2015).

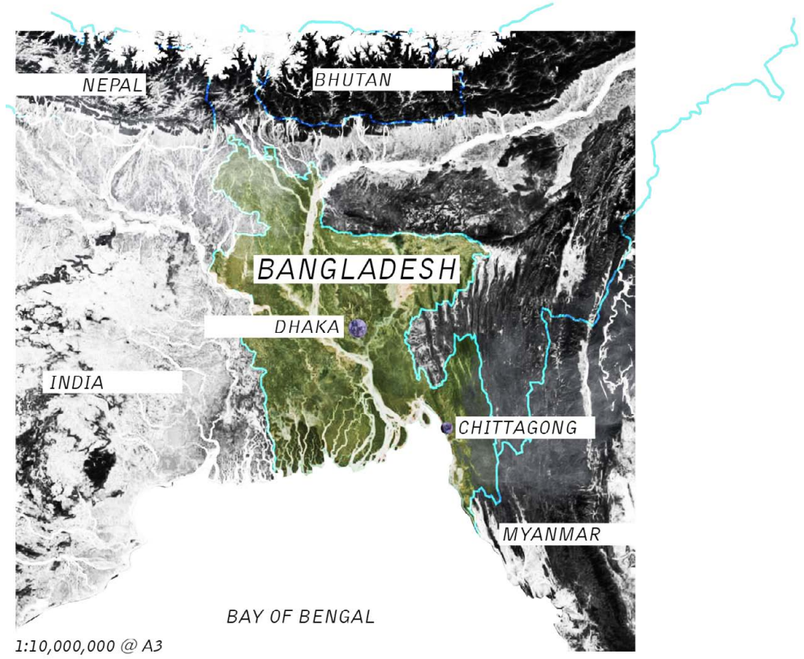
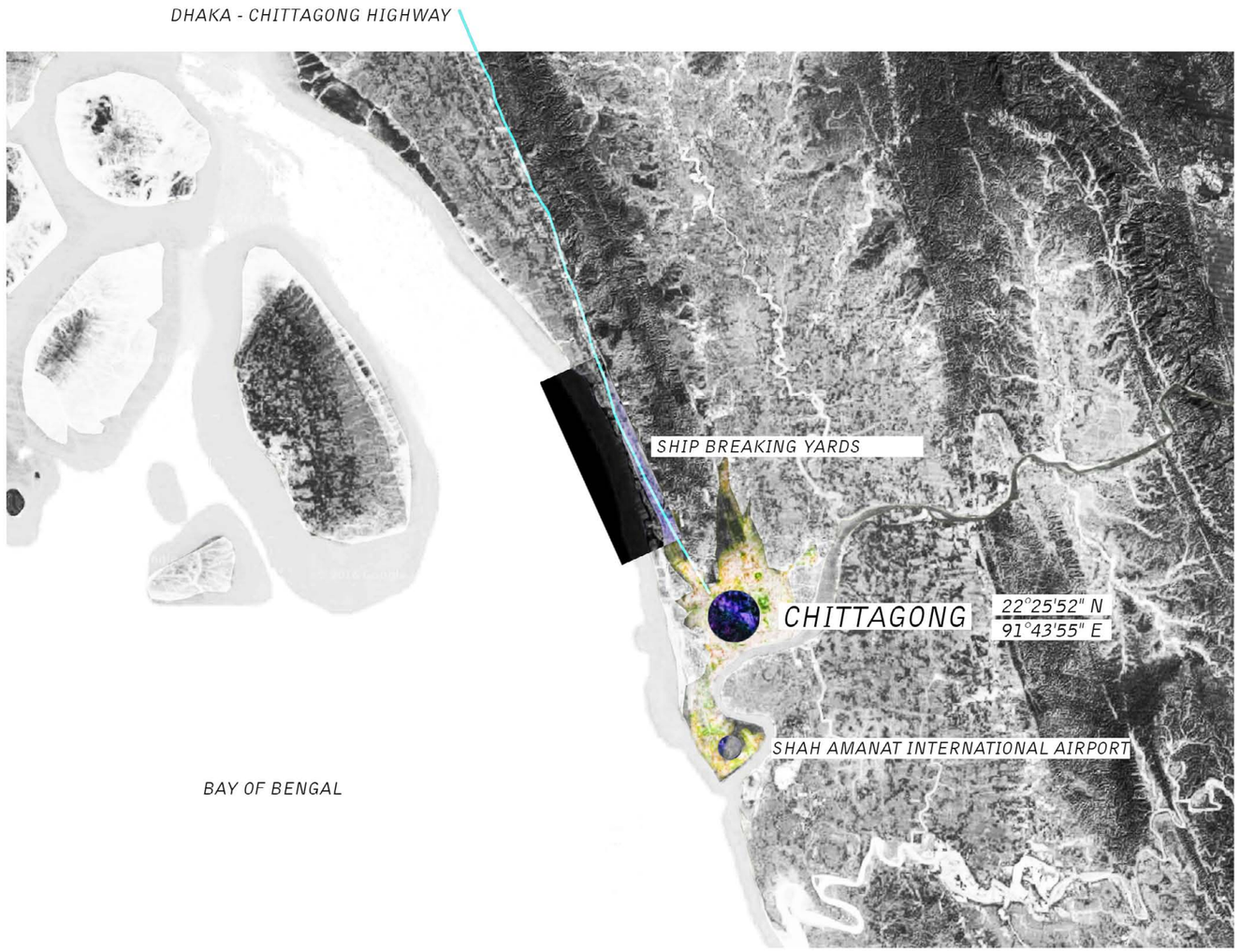


Fig. 3.02 The location of Bangladesh.



1:500,000 @ A3

Fig. 3.03 The shipbreaking yards in relation to Chittagong.

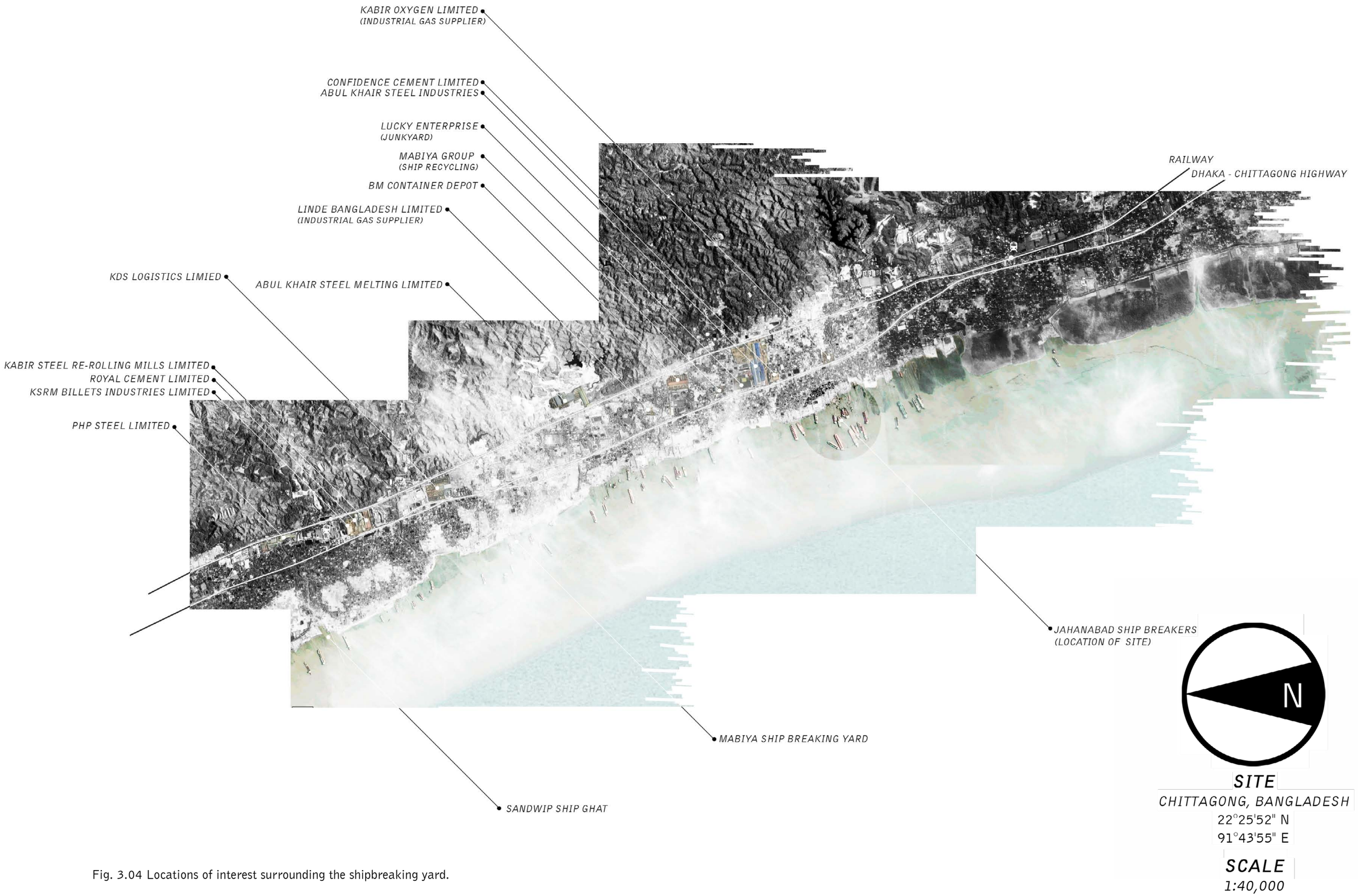


Fig. 3.04 Locations of interest surrounding the shipbreaking yard.

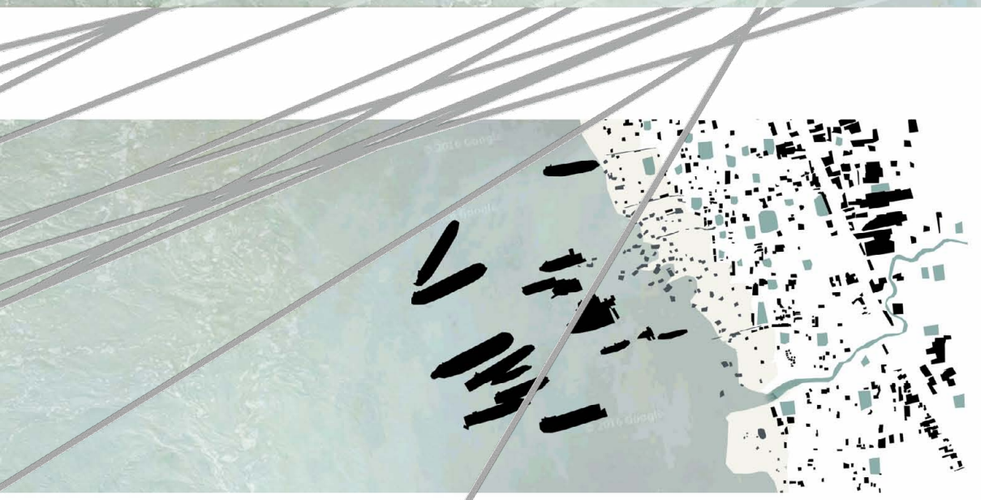
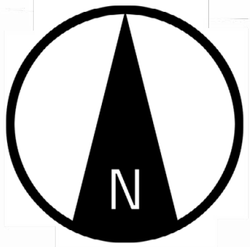


Fig. 3.05 Beached ships and their relationship with the yard.



SITE

CHITTAGONG, BANGLADESH

22°25'52" N

91°43'55" E

SCALE

1:5,000

Fig. 3.06 Changes at the shipbreaking yard between 2008 and 2016.

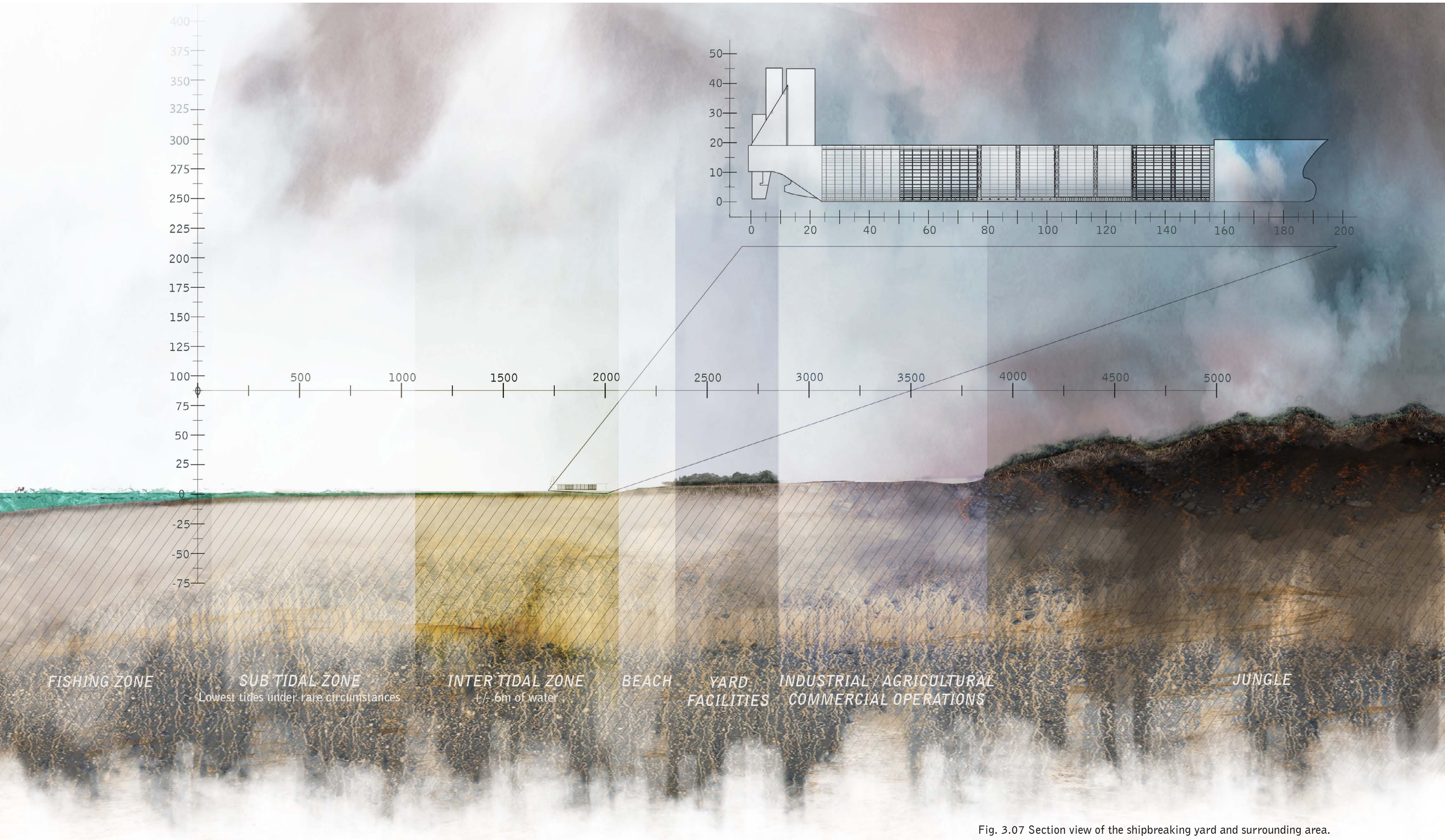


Fig. 3.07 Section view of the shipbreaking yard and surrounding area.

3.03
CLIMATE

Bangladesh has a sub-tropical monsoon climate characterized by rain-bearing winds, moderately warm temperatures, and high humidity. The annual temperature averages between 7°C to 36°C with April being the warmest month and January being the coolest. Storms of very high intensity often occur in the early summer and late in the monsoon season (Hossain, 2014).

Dry / cool season: November – March

Pre-monsoon season: April – May (very hot)

Monsoon season: June – October (warm, cloudy, wet)

Average days of precipitation per year: 104

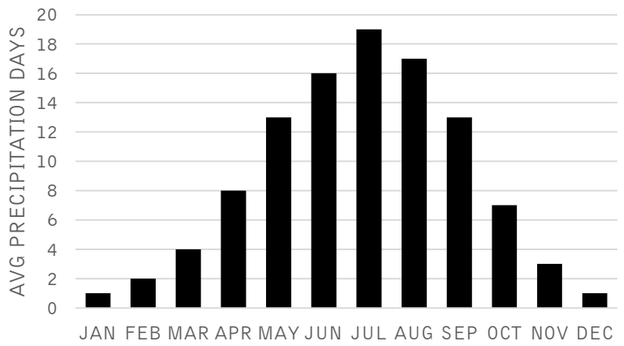


Fig. 3.09 Average precipitation days in Chittagong each month

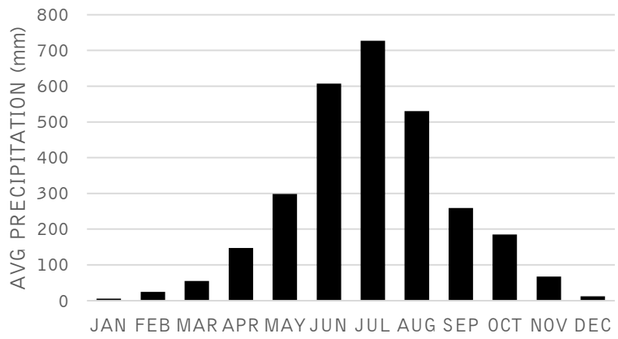


Fig. 3.08 Average precipitation (mm) in Chittagong each month

SUN PATHS
(for Dhaka, Bangladesh)

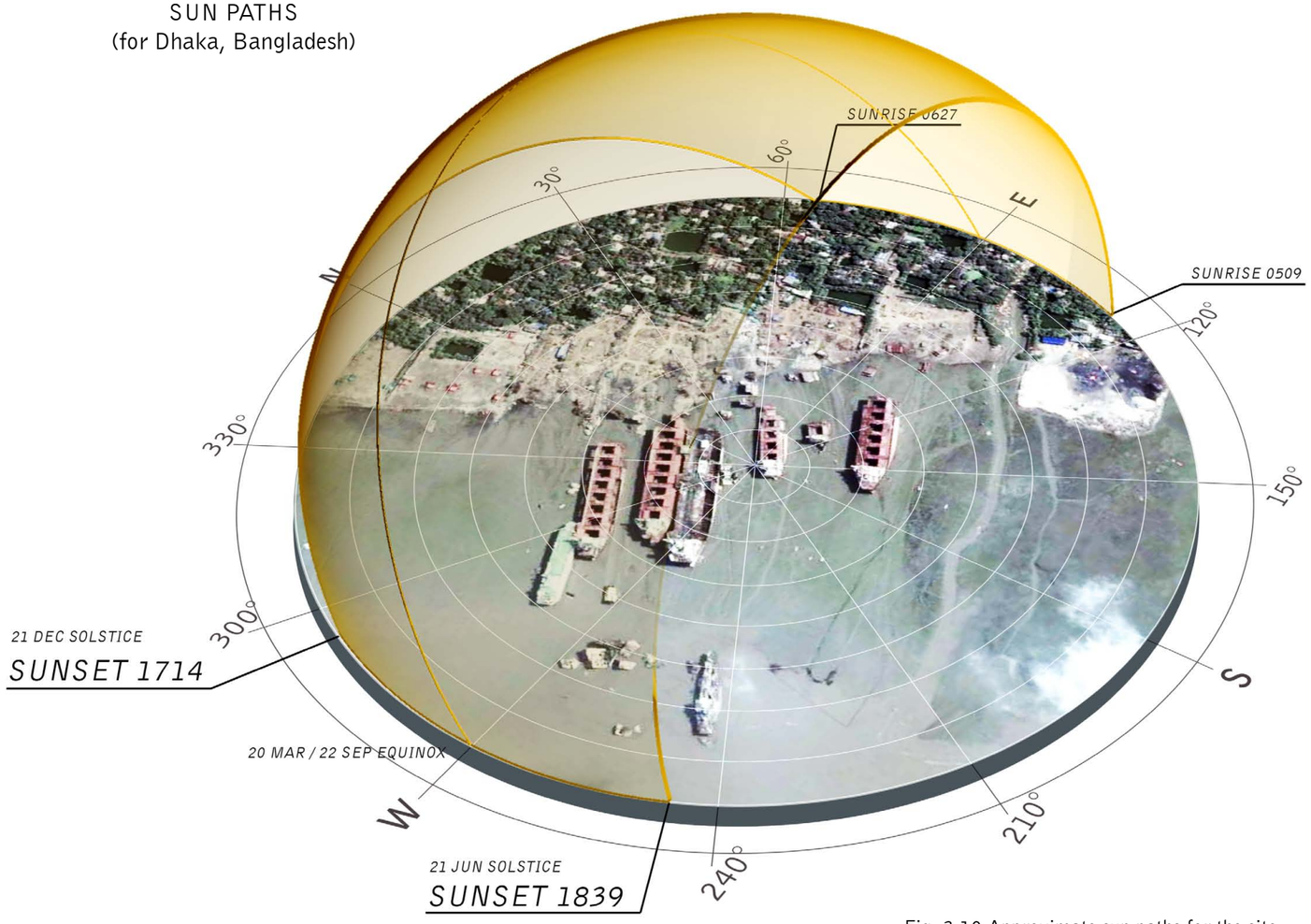


Fig. 3.10 Approximate sun paths for the site.

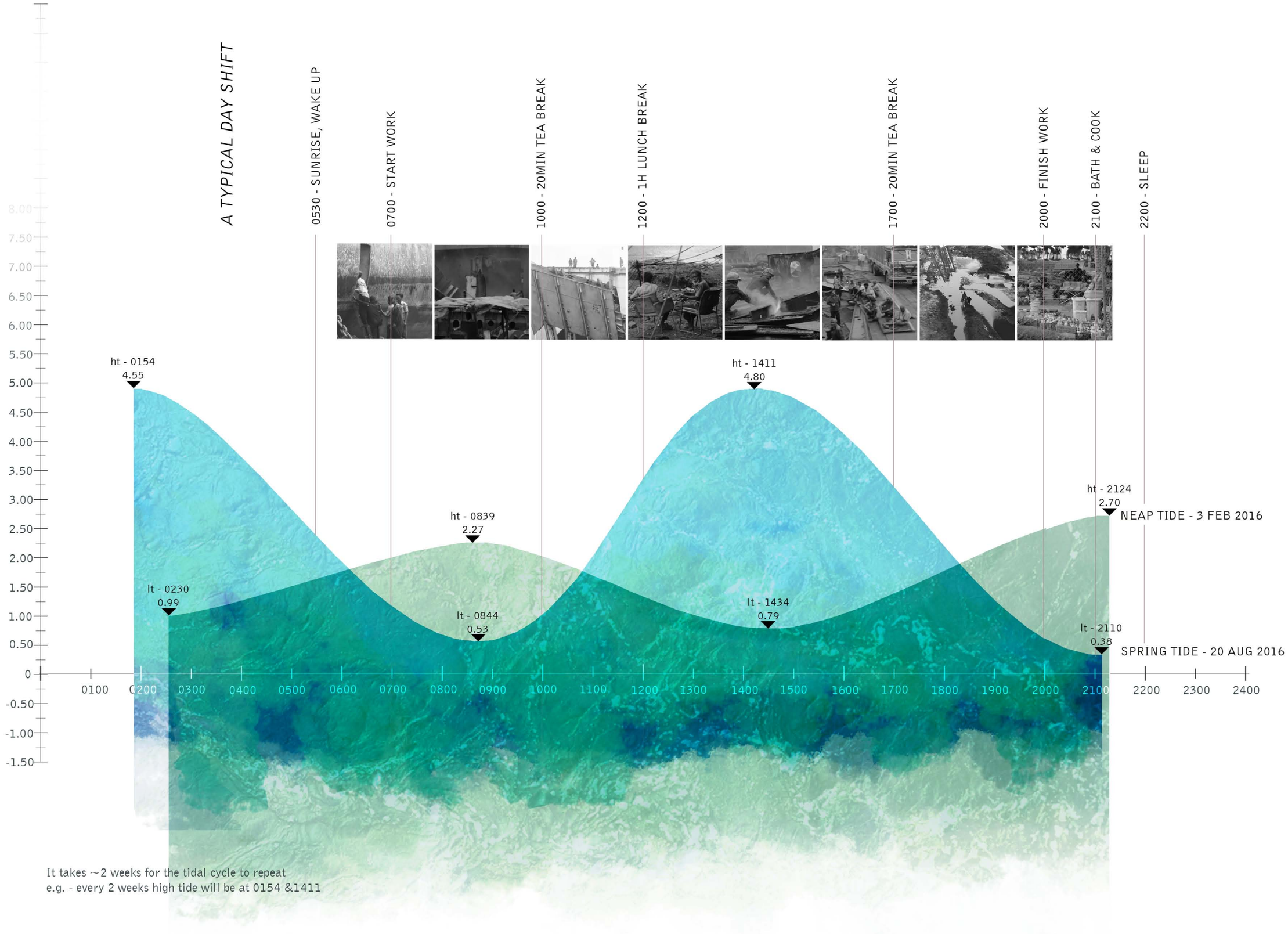


Fig. 3.11 Tidal changes at Chittagong over 2016.

3.04
CARGO SHIPS

The types of ships that are scrapped at Chittagong are diverse in specific function and size. The largest ships these yards are capable of scrapping are comparable to some of the largest ships in existence (Fig. 3.12). The process of dismantlement is done mostly by hand using gas torches.

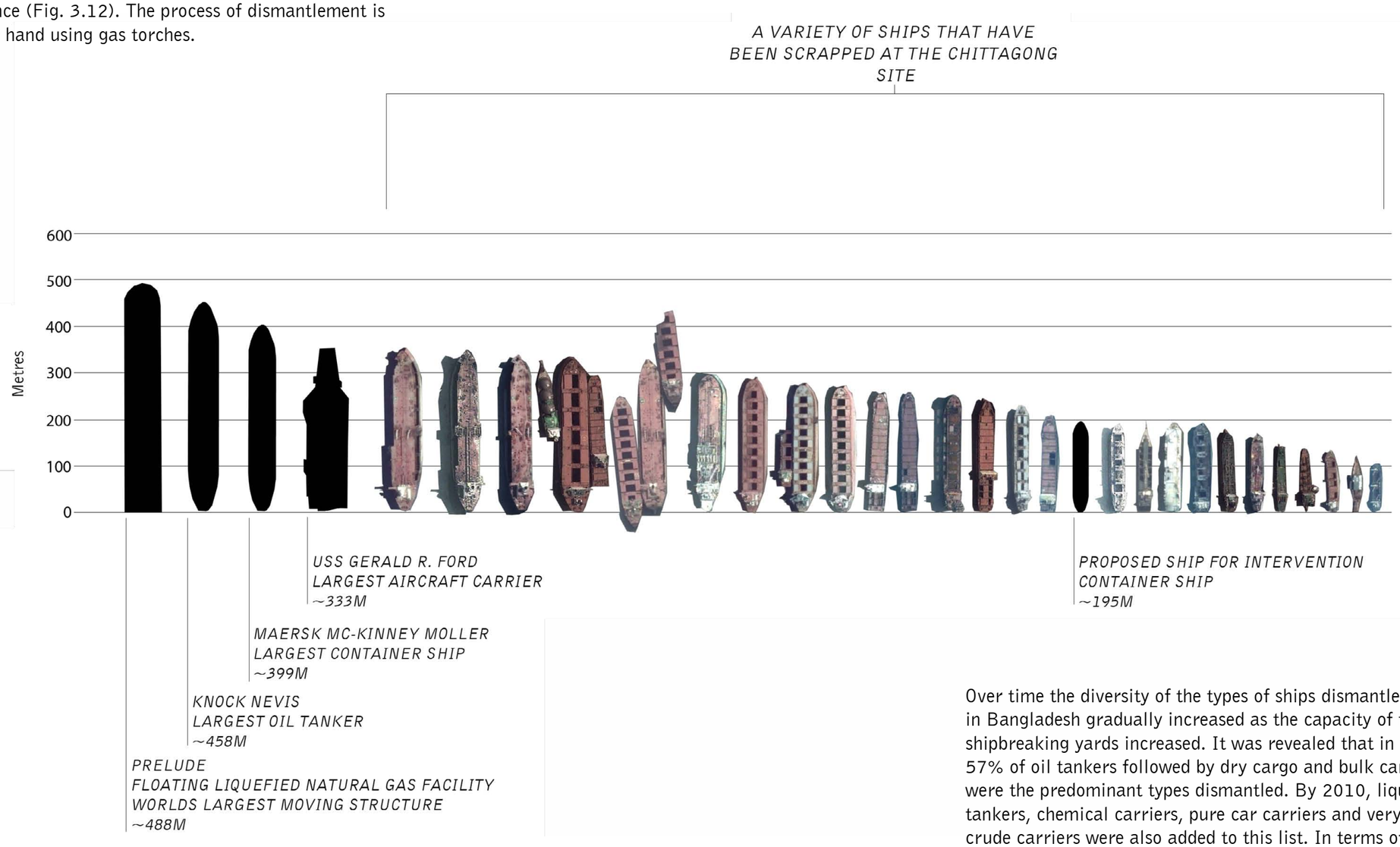
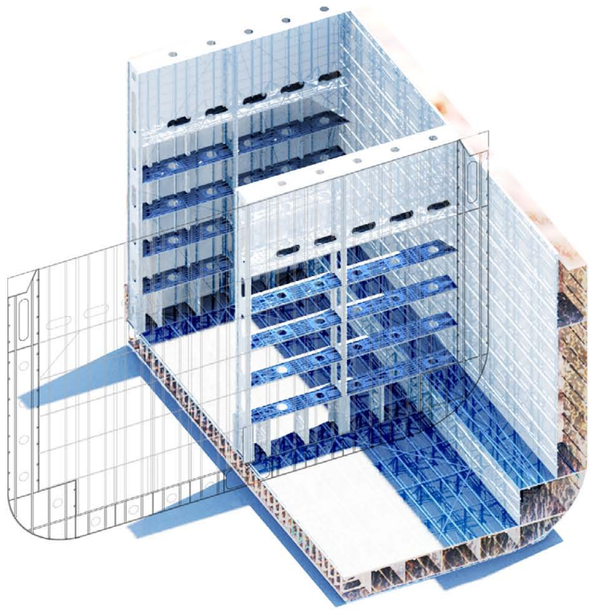


Fig. 3.12 Size comparison of ships scrapped on site.

Over time the diversity of the types of ships dismantled in Bangladesh gradually increased as the capacity of the shipbreaking yards increased. It was revealed that in 2000, 57% of oil tankers followed by dry cargo and bulk carriers were the predominant types dismantled. By 2010, liquefied gas tankers, chemical carriers, pure car carriers and very large crude carriers were also added to this list. In terms of number and weight, oil tankers were the most preferred type of ship in Bangladesh over the entire period (Sujauddin et al., 2015).

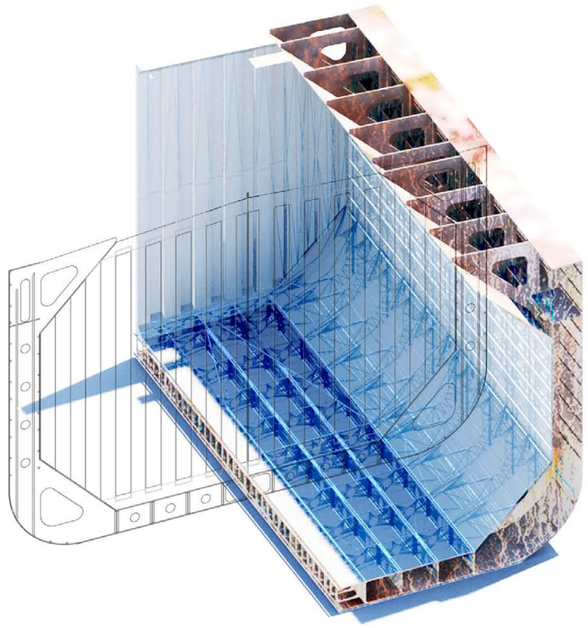
THE (ABRIDGED) PROCESS OF SHIPBREAKING

1. A ship is bought as scrap, often overseas or on its final voyage.
2. Once the ship arrives in the Bay of Bengal (international waters) it is checked and certified by government officials.
3. At high tide the ship is beached.
4. Cutters begin by cutting the vessel into pieces. Larger parts are dragged to the dry part of the shore via winches.
5. Another group of cutters cut the dragged pieces into a transportable size. Heavy equipment such as boilers, motors, etc are moved by crane. Smaller pieces are carried by hand in groups.
6. The pieces are loaded onto trucks to be delivered to different steel recycling facilities.
7. Valuable components such as furniture and cables are sold to the second hand market.



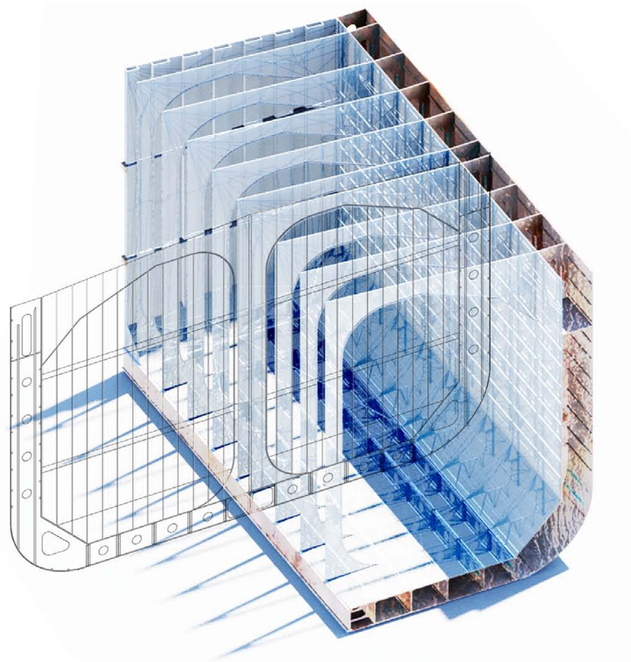
CONTAINER SHIP

Modules based on standard shipping containers
Alternating bulkhead/ watertight bulkhead
Double hull
Arrives without containers



BULK CARRIER

Watertight bulkheads
Carries unpackaged bulk cargo
Grain, coal, cement, ores, etc.
Double hull



OIL TANKER

Oiltight bulkheads
Compartmentalised due to liquids and balance issues
Oil residue makes it very dirty
More ballast tanks
Double hull

Fig. 3.13 Different cargo ship hull profiles.

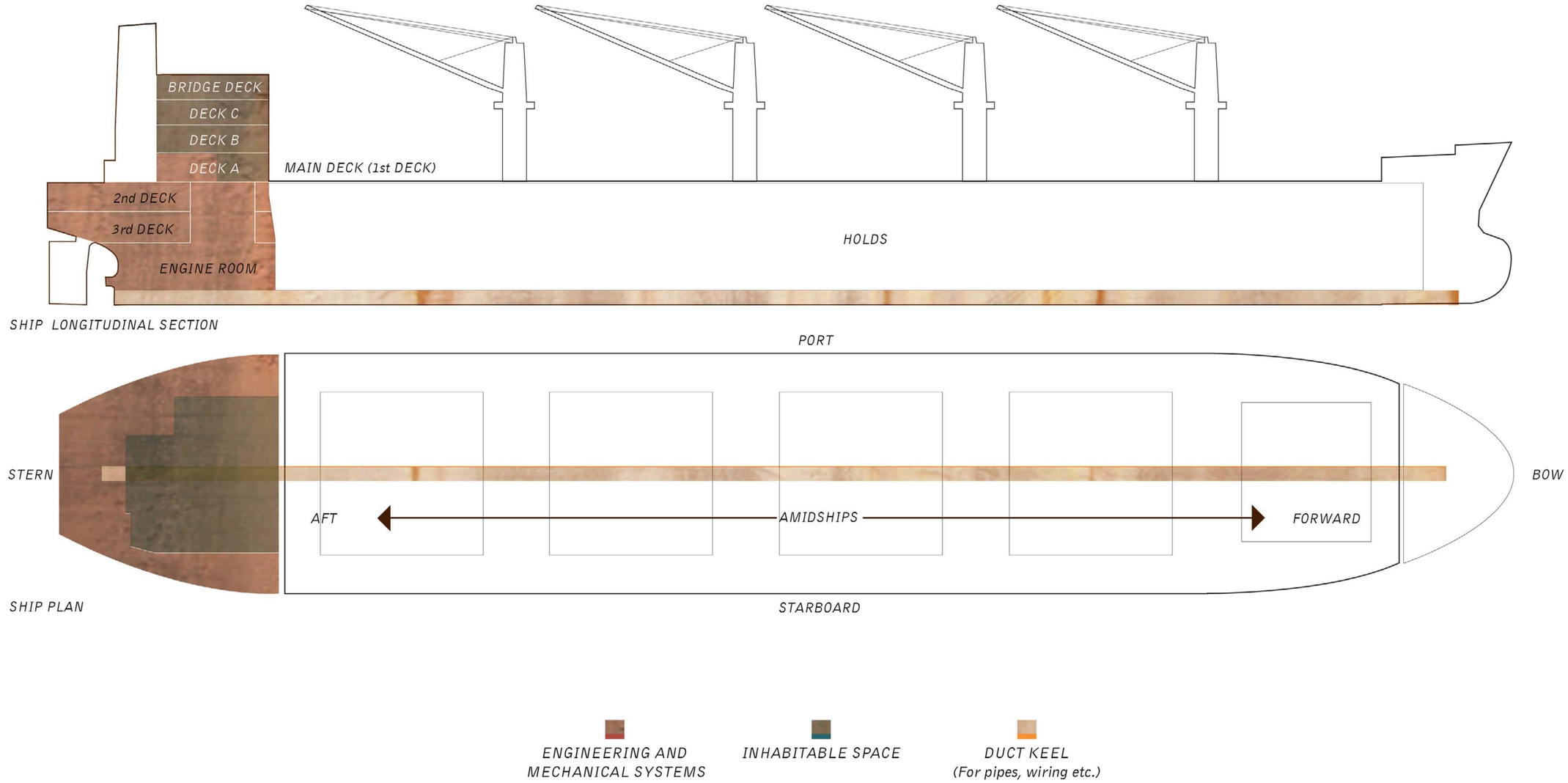


Fig. 3.14 Divisions of space of a cargo ship.

Fig. 3.15 The layers of a container ships hull.

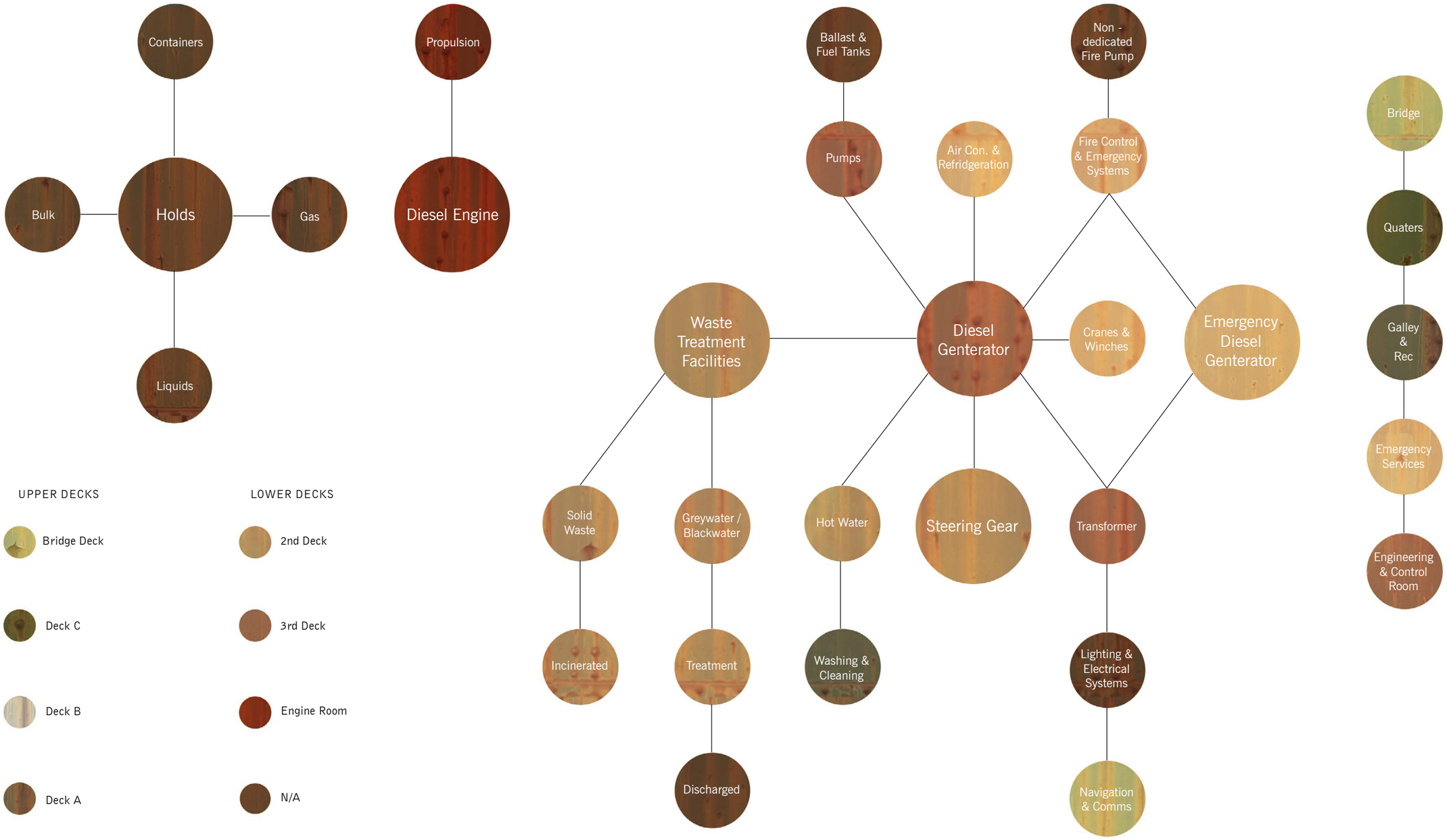
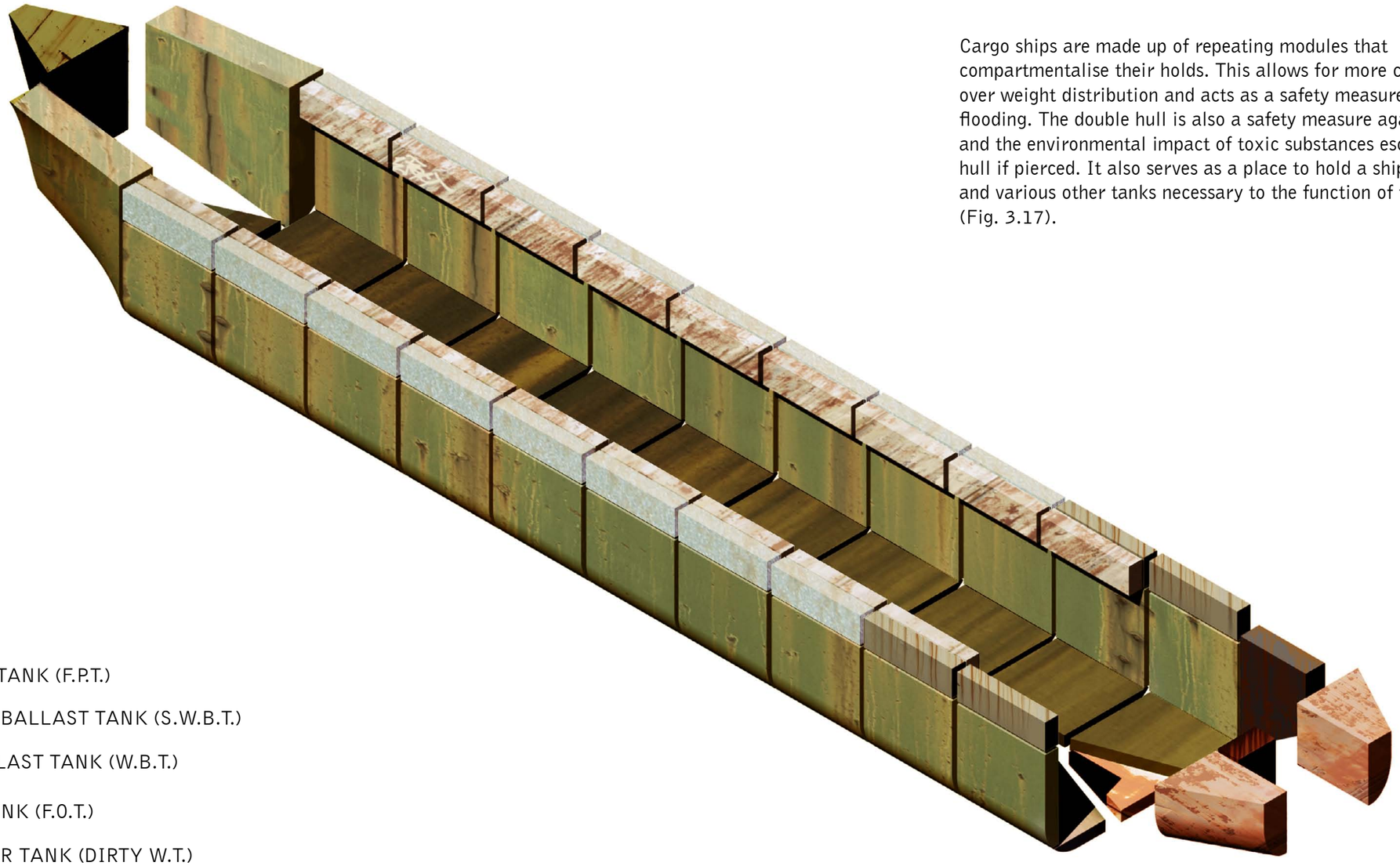


Fig. 3.16 Diagram of relationships between existing services and facilities.

Cargo ships are made up of repeating modules that compartmentalise their holds. This allows for more control over weight distribution and acts as a safety measure against flooding. The double hull is also a safety measure against leaks and the environmental impact of toxic substances escaping the hull if pierced. It also serves as a place to hold a ships ballast and various other tanks necessary to the function of the ship (Fig. 3.17).



FORE PEAK TANK (F.P.T.)
SEA WATER BALLAST TANK (S.W.B.T.)
WATER BALLAST TANK (W.B.T.)
FUEL OIL TANK (F.O.T.)
DIRTY WATER TANK (DIRTY W.T.)
FRESH WATER TANK (F.W.T.)
LUBRICATING OIL SUMP
DRINKING WATER TANK (D.W.T.)
DIESEL OIL TANK (D.O.T.)

Fig. 3.17 Types of tanks found on a container ship.

3.05
INHABITANTS

Approximately 25,000 workers are directly employed by the shipbreaking industry in Bangladesh, of those, roughly 25% live on site in rent free sheds provided by the yard owner. Up to 70 people live in each shed spread over three or four rooms often without electricity or adequate sanitation facilities (World Bank, 2010). It is clear that these facilities are inadequate and the cramped conditions encourage the spread of infection and disease. The remaining 75% live off site in their own accommodation and commute to the site.

It is estimated that up to 95% of the workforce is migrant labourers from Bangladesh's poorest districts. Recruitment for the yards at Chittagong occurs in a number of ways and it is common for men in a particular family to follow older male relatives to the yards. The Chittagong workforce includes both salaried and daily wage employees. Wages are based on the skill required. Workers do eight-hour shifts, with regular overtime of four hours that is paid at the same rate (World Bank, 2010).

The majority of workers are young (Fig. 3.18), male, and largely illiterate; very few women work in the yards (World Bank, 2010). Those that do work in the yard are usually found to be helping with cooking (Hossain & Islam, 2006).

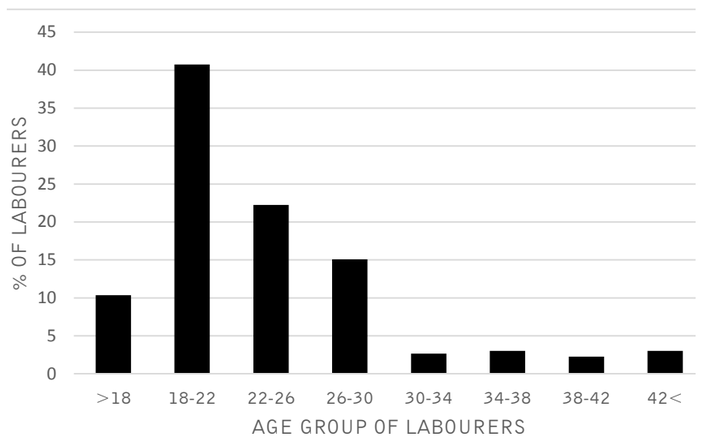


Fig. 3.18 Age Groups of labourers (%) in the yard

	DECK DEPARTMENT	ENGINE DEPARTMENT	BUSINESS DEPARTMENT
OFFICERS			
	1 Captain	1 Chief Engineer	
	1 Chief Officer	1 1st Engineer	
	1 2nd Officer	1 2nd Engineer	
	1 3rd Officer	1 3rd Engineer	
CREW			
	1 Boatswain	1 No. 1 Oiler	1 Chief Cook
	3 Able Seamen	3 Oiler	1 Mess Man
	2 Ordinary Seamen	1 Wiper	
	1 Officer's Spare		
	1 Crew's Spare		
	1 Owner		
	1 Pilot		
	25 Total		

Fig. 3.19 Table showing the typical complement of a 200m cargo ship

SKILLED	SEMISKILLED	UNSKILLED
Foreman	Gas Cutters	Truck Helpers
Fitters	Fitters	Lifters
Gas Cutters	Cutter Helpers	Loaders
Crane Operators		Wire Pullers
Truck Drivers		Cutters
Rhythmic Singers		Loading Helpers
		Pulling Helpers
		Sweepers

25,000 Total (Nationwide)

Fig. 3.20 Table showing the typical complement of a shipbreaking yard

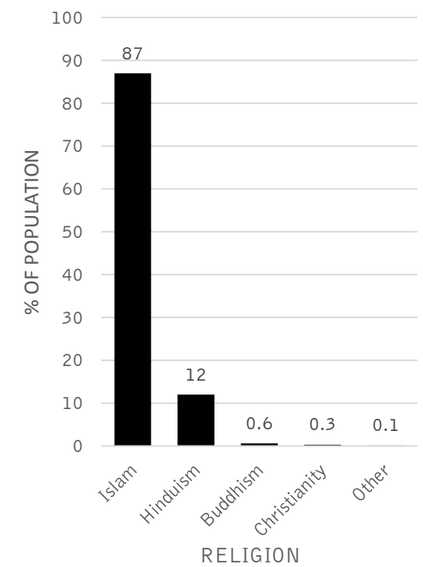


Fig. 3.21 Religion in Bangladesh by % of population

The major religion of Bangladesh is Islam (Fig. 3.21). This is reflected in the religious affiliations of the site workers. Due to this religious and cultural practices should be considered in the design.

Most of the workers on the shipbreaking yards are migrant workers who have moved from the poverty affected northern part of the country (World Bank, 2010). One of the key reasons for moving so far to work in the shipbreaking yard is that the pay and job availability is much better relative to local or factory jobs. Migration is often a necessity to support extended families back home.

At the shipbreaking yard, social hierarchies are informed by two factors. The first of which being job type. The most important job on the yard is the foreman followed by those ranked by the skill required or level of danger, with each having a corresponding rate of pay. Secondly, the length of time worked on the yard plays a role in both pay rate and how much respect the employee is afforded.

SITE HAZARDS

Shipbreaking in Bangladesh is a dangerous and hazardous process where about 88% of workers have suffered some form of injury. The danger of the site is emphasised by the fatalities of approximately 1,200 workers over the last 30 years which is, in part, the result of a complete lack of formal training (World Bank, 2010). New employees will 'shadow' the more experienced workers for months or, in some cases, years. Additionally, there are no worker's unions, formal contracts or enforcement of occupational safety standards.

There is a huge environmental impact associated with shipbreaking caused by lax standards and enforcement when it comes to cleaning the ships and the removal of hazardous substances. During the dismantling process large amounts of toxic material is released onto the beach and washed out to sea with the tides, affecting the environment and those living in the local area.

Hossain & Islam (2006) identify a number of general concerns that affect the site workers at a local level and a systematic level. These include a lack of safety training and accident prevention procedures as well as inadequate emergency, first aid and medical facilities. Inadequate housing and sanitation facilities are also noted and they go on to state that the problem is not so much the lack of legislation - but rather, the nonenforcement of existing legislation, and the weakness of remedies. Fig. 3.25 contains more specific hazards as identified by Hossain & Islam (2006).

SERIOUS ACCIDENTS	Fire/ Explosions
	Struck by falling objects
	Crushed by heavy objects
	Snapping cables/ ropes
	Handling of heavy objects in poor access areas
	Falls from a height
	Struck by moving objects
	Slipping
	Sharp objects
	Oxygen deficiency in confined spaces
HAZARDOUS SUBSTANCES	Asbestos fibres (older ships)
	Heavy/ toxic metals
	Organometallic substances
	Lack of hazard communication
	Batteries, fire fighting liquids
	PCB's and PVC
	Welding fumes
	Volatile organic compounds
	Inhalation in confined and enclosed spaces
	Compressed gas cylinders
PHYSICAL HAZARDS	Noise
	Vibration
	Extreme temperatures
	Poor illumination
MECHANICAL HAZARDS	Trucks and transport vehicles
	Scaffolding, portable ladders
	Impact by heavy or sharp tools
	Power driven hand tools
	Shackles, hooks, chains
	Cranes, winches, hoisting and hauling equipment
	Lack of safety guards in machines
	Poor maintenance of machinery and equipment
BIOLOGICAL HAZARDS	Toxic marine organisms
	Animal bites
	Communicable diseases transmitted by tents
	Infectious diseases
PSYCHOLOGICAL HAZARDS	Excessive workload
	Awkward postures
	Mental stress
	Long working hours
	Shift work
	Night work
	Temporary employment
	Poverty
	Low wages
	Under age workers
	Lack of education and social environment
	Repetitive strain injuries

Fig. 3.25 Table of hazards found at shipbreaking yards

Fig. 3.22 A worker without safety gear at risk of falling

Fig. 3.23 Gas cutting in enclosed spaces without adequate ventilation

Fig. 3.24 Workers carrying heavy steel plates by hand with minimal footwear

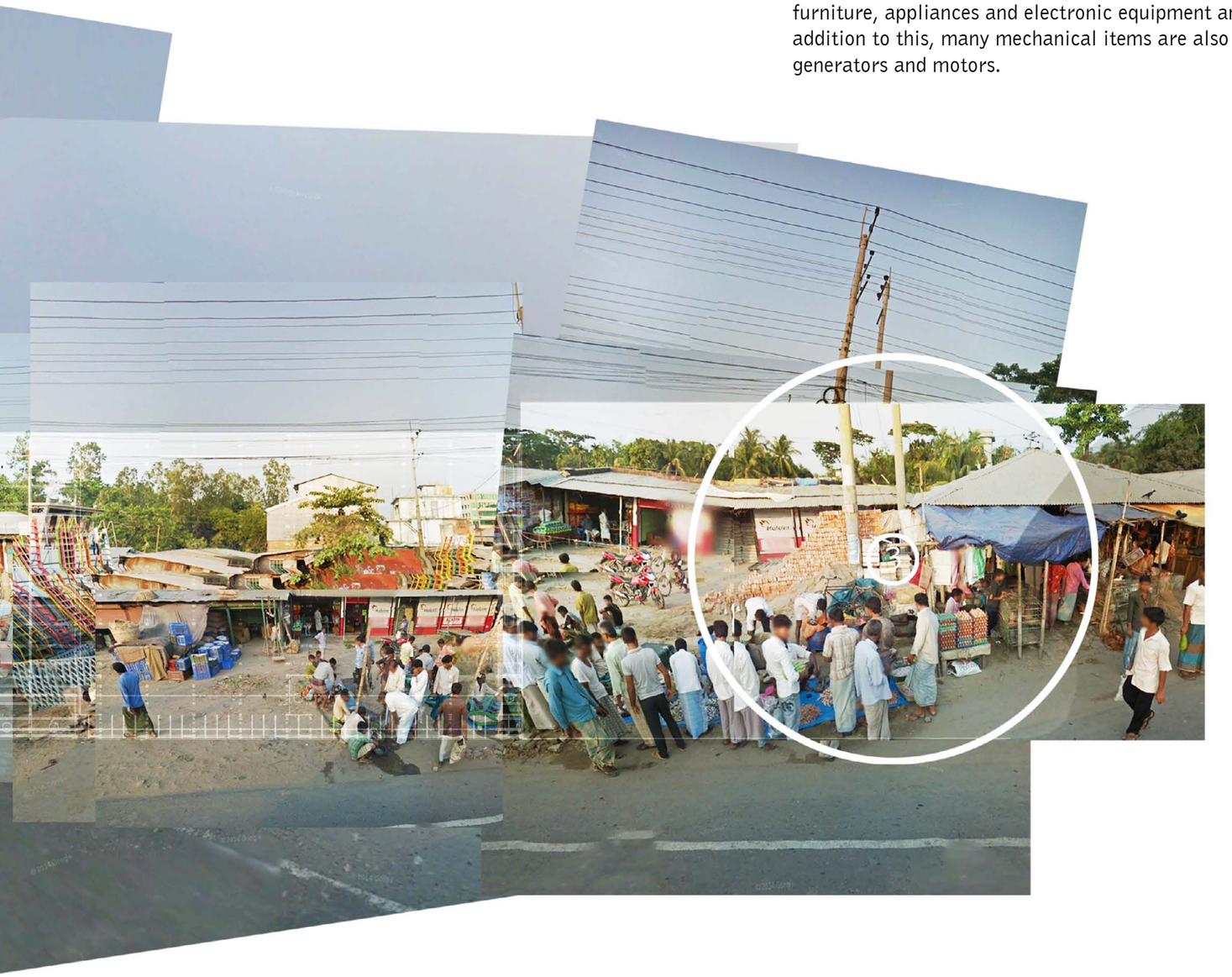
DHAKA - CHITTAGONG HIGHWAY - RESELLERS

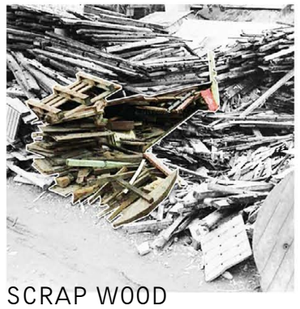
Many different components and items can be found located near the shipbreaking yard that have been considered as a library of the objects and materials that could be used in the design project.

Fig. 3.26 The roadside near the yard.

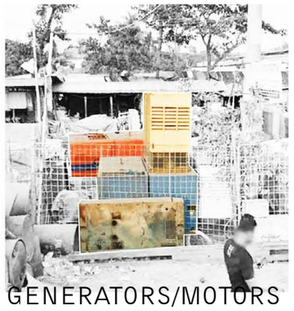
1

There are many different resellers located along the Chittagong-Dhaka Highway who buy and sell the miscellaneous items that cannot be recycled as scrap steel. These items often come from the habitable decks of the ship and include panelling, furniture, appliances and electronic equipment among others. In addition to this, many mechanical items are also resold such as generators and motors.



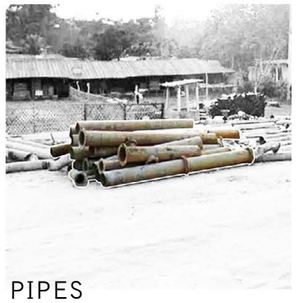


SCRAP WOOD

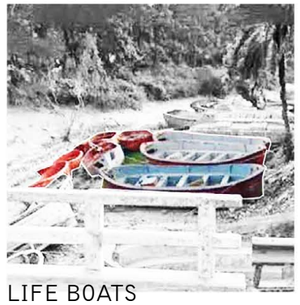


GENERATORS/MOTORS

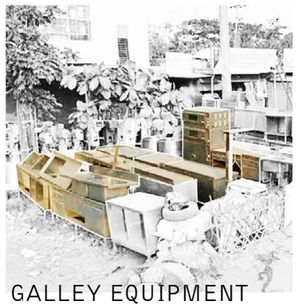
STAINLESS STEEL FIXTURES



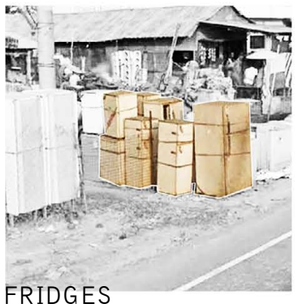
PIPES



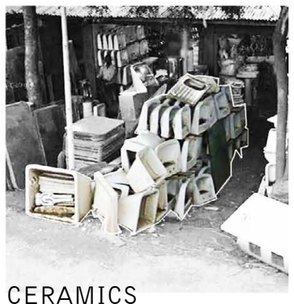
LIFE BOATS



GALLEY EQUIPMENT

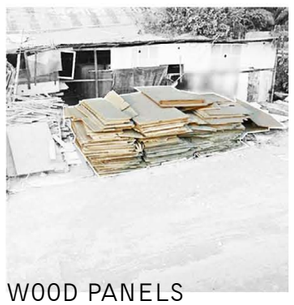


FRIDGES



CERAMICS

GAS/FUEL TANKS



WOOD PANELS

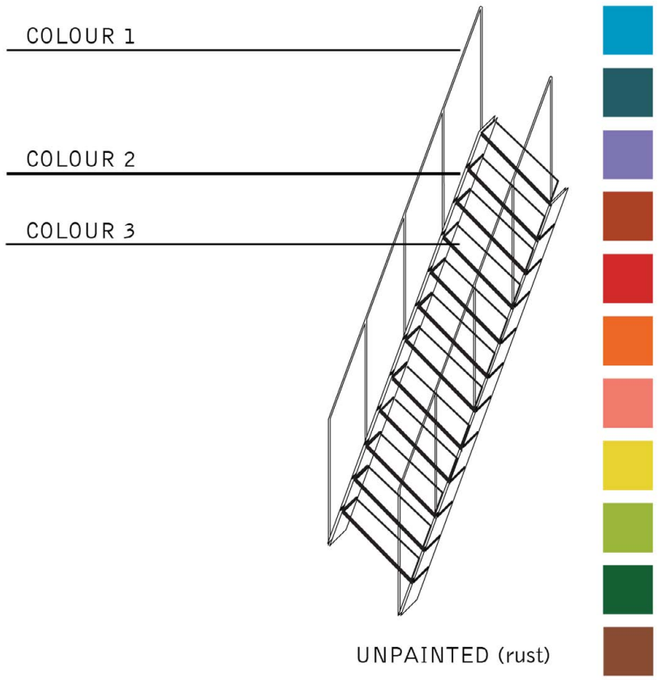


Fig. 3.27 Ships' ladders and their colour palette.

2

Ladders that are salvaged from the ships are also resold. They are often repainted in bright colourations that differentiate the railing, tread and stringer. These bright colours contrast with the streetscape and the duller tones of the ships. They can be used to augment the circulation of the design.

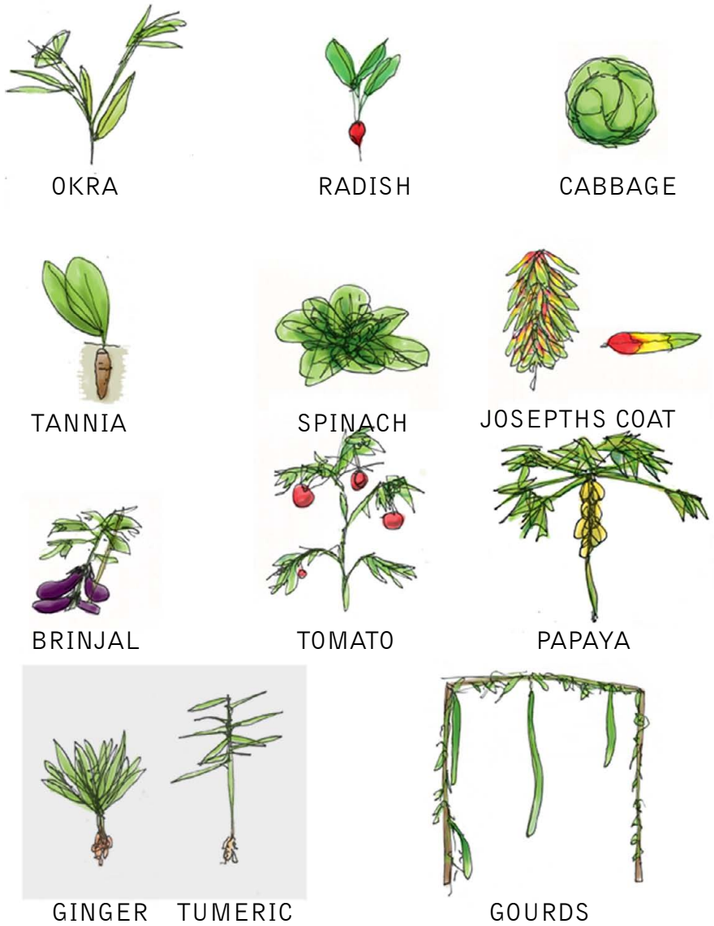


Fig. 3.28 Types of produce found in the local area.

3

There are many markets along the roadside where workers would usually buy food. Above are some of the common plants found in the local area and throughout Bangladesh. They are relatively low maintenance and typically high yield plants that are well suited to the local climate. It is uncommon for the workers to eat much meat as it too is expensive.

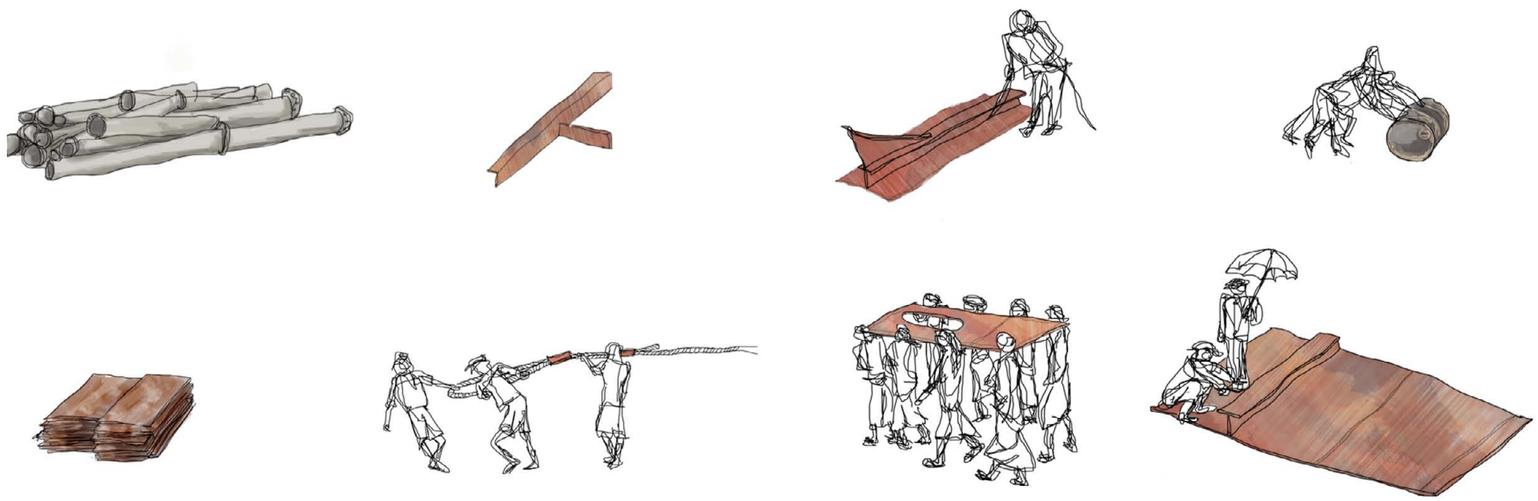


Fig. 3.29 Sketches of parts broken down into a carryable forms.

4

One of the parts of the shipbreaking process involves cutting down sections of the ship into pieces and sizes that more easily movable. These parts need to be cut down so that they can be moved by hand and easily stacked for transport. Workers use gas cutters to separate the parts. During this process there is an opportunity to cut structural members, sheets and stiffeners to a desirable length and size for the use in the design.

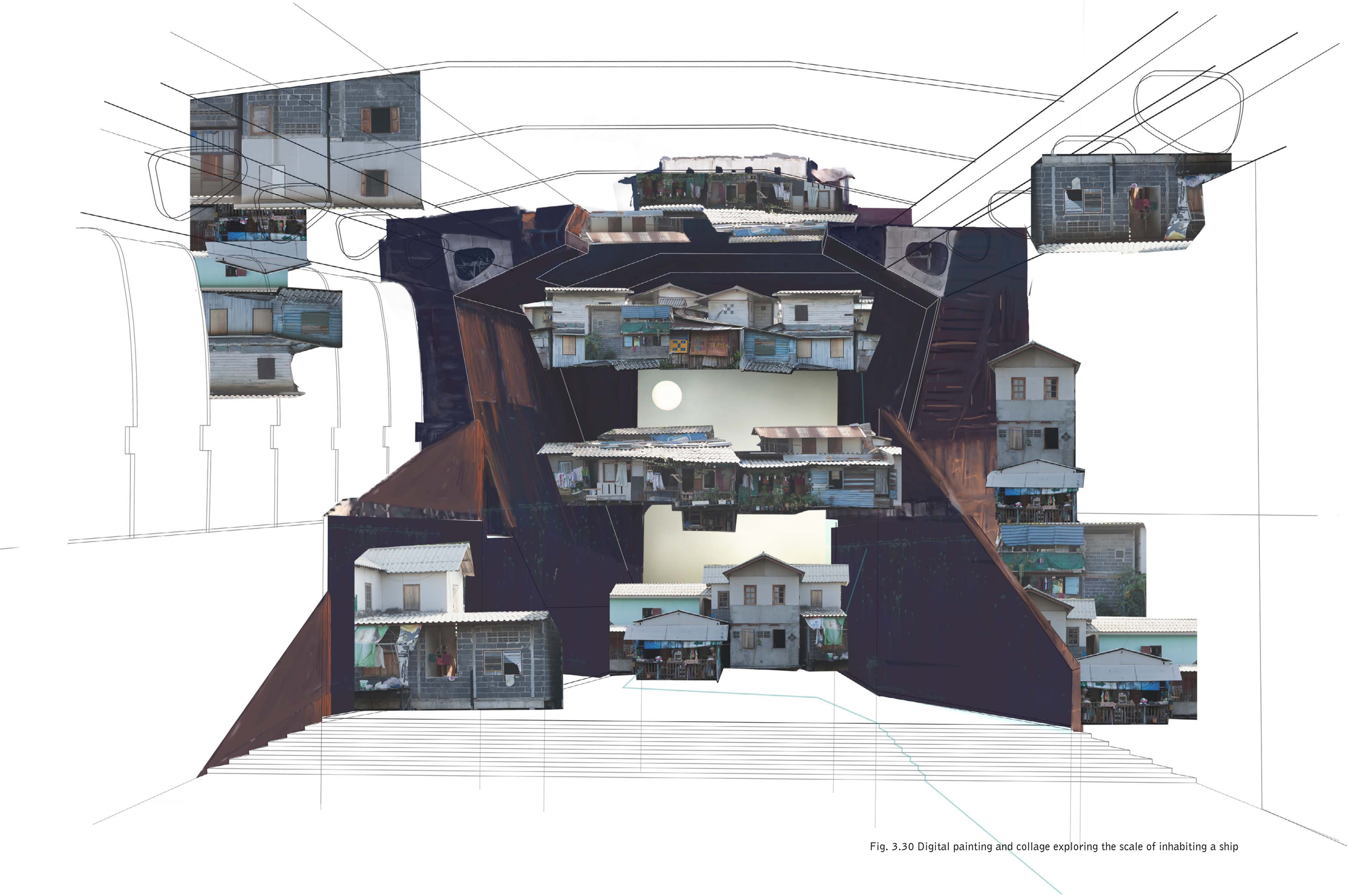


Fig. 3.30 Digital painting and collage exploring the scale of inhabiting a ship

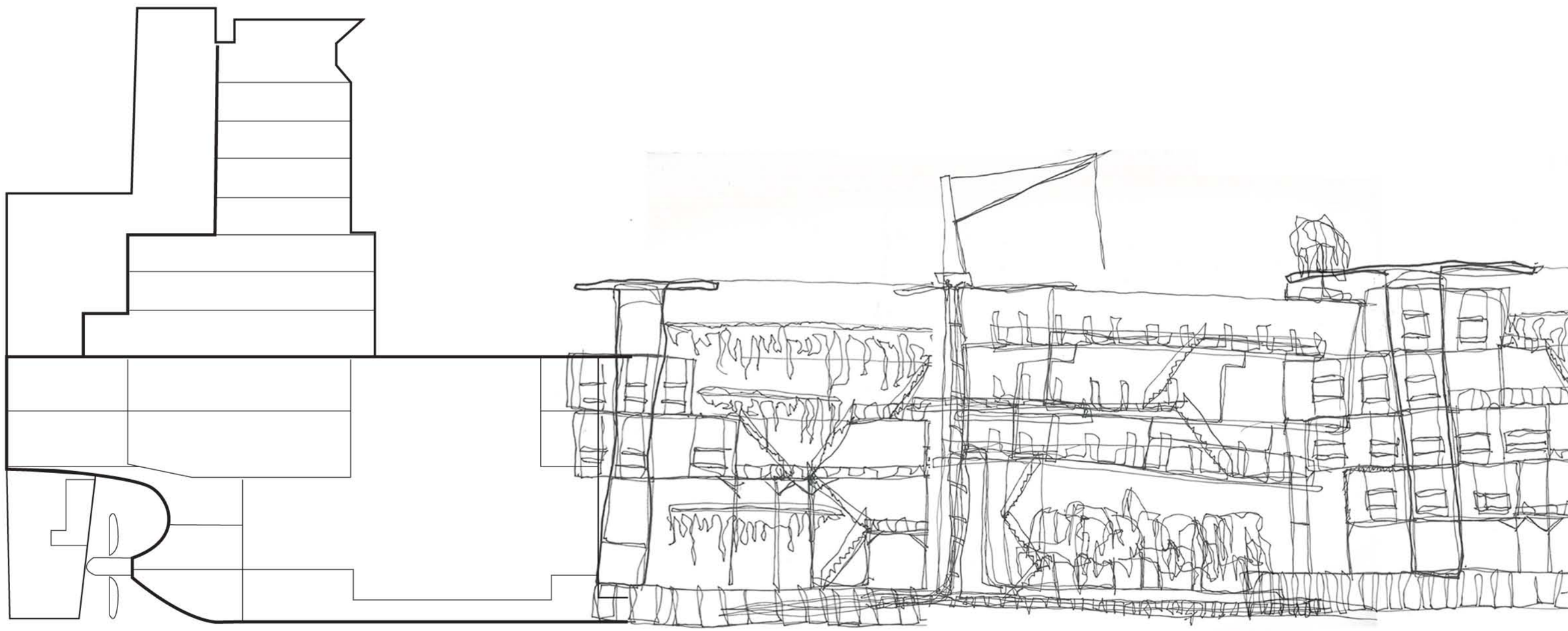
CHAPTER 4.00

EXPERIMENTATION

4.01
INTRODUCTION

This chapter looks at the initial design and further research for the adaptive reuse of the ship. For ease of presentation and discussion it is split into sections with each looking at a different space or aspect of the ship that helps to synthesise the overall atmosphere and direction of the research project. It covers Services & Spatial Planning, The Market Deck, Interior - Commons and Interior - Cabins followed by a conclusion summarising the findings of these experiments.

In terms of design and the heuristic process undertaken this chapter investigates the interior conceptually and broadly and makes some large gestures that dictate the feel of the design and spatial arrangements. As such, these experiments lack design detail which are addressed in chapters 5.00 and 6.00.



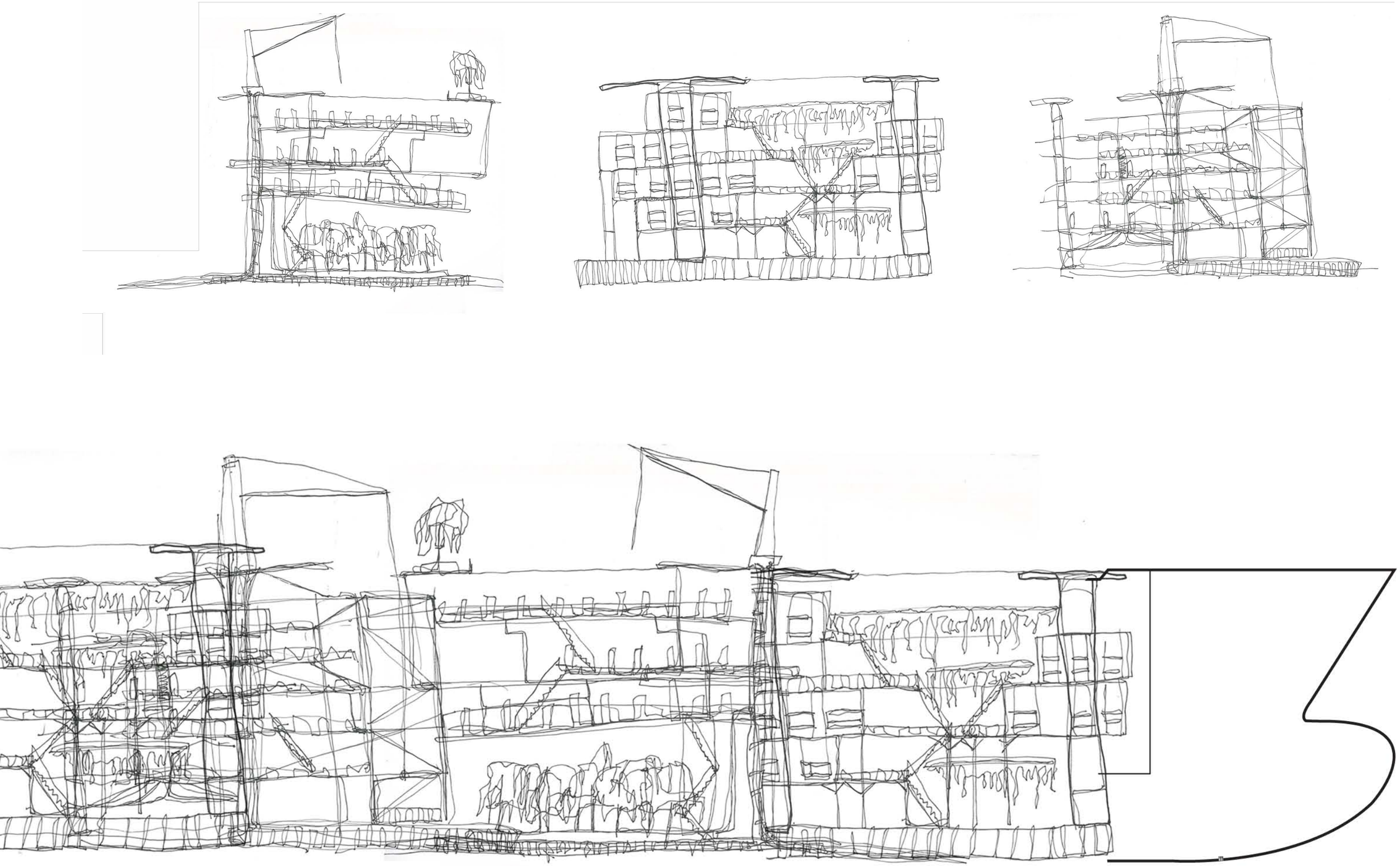
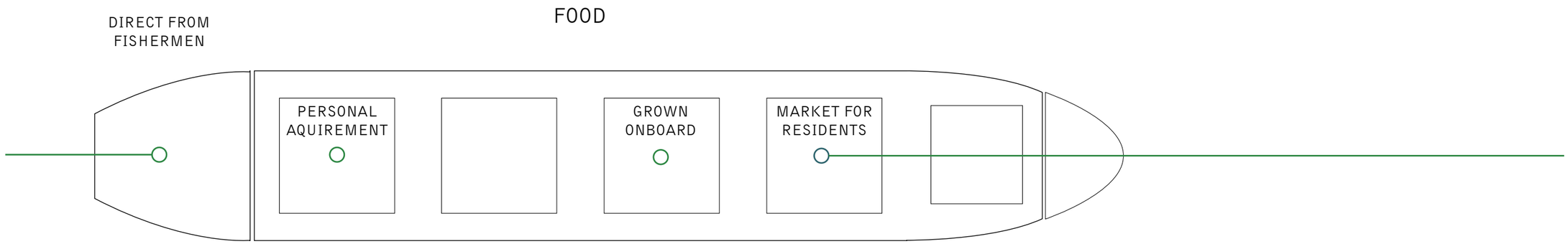


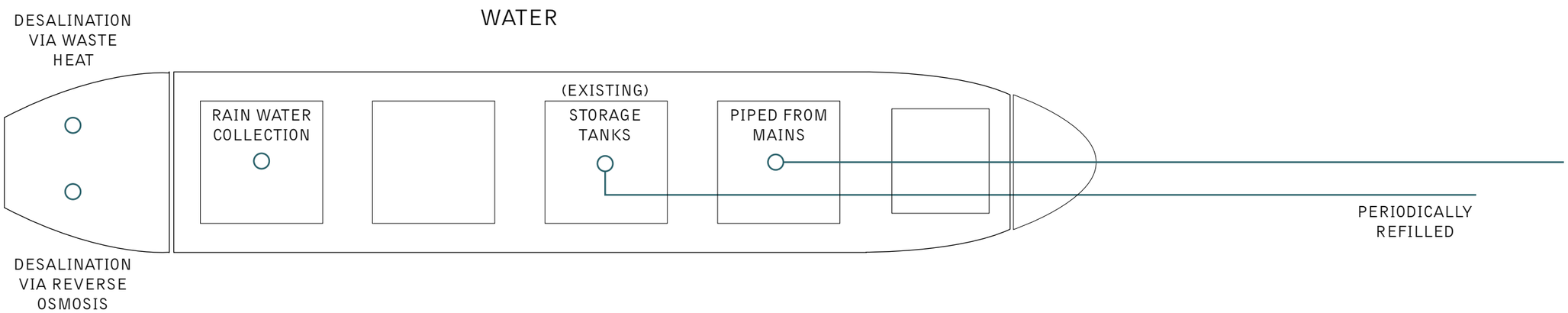
Fig. 4.01 Conceptual sketches of inhabitation of the ship.

4.02

SERVICES & SPATIAL PLANNING

Efficiency and reusing recyclable material is an important aspect of the shipbreaking yard and it is important to make use of the existing facilities that the ship offers. These were explored through the initial planning where the existing layout helped direct how the spaces are organised. The ballast tanks, for example, could easily be re-utilised. In addition to this existing spaces such as the engine room already house many of the amenities that can be adapted to a new use. Although these spaces fall outside the scope of this project what they offer to the rest of the design is still relevant and has been considered.





These diagrams (Fig. 4.02) look at where services and resources could potentially be sourced from and begins to explore where they could be incorporated into the design.

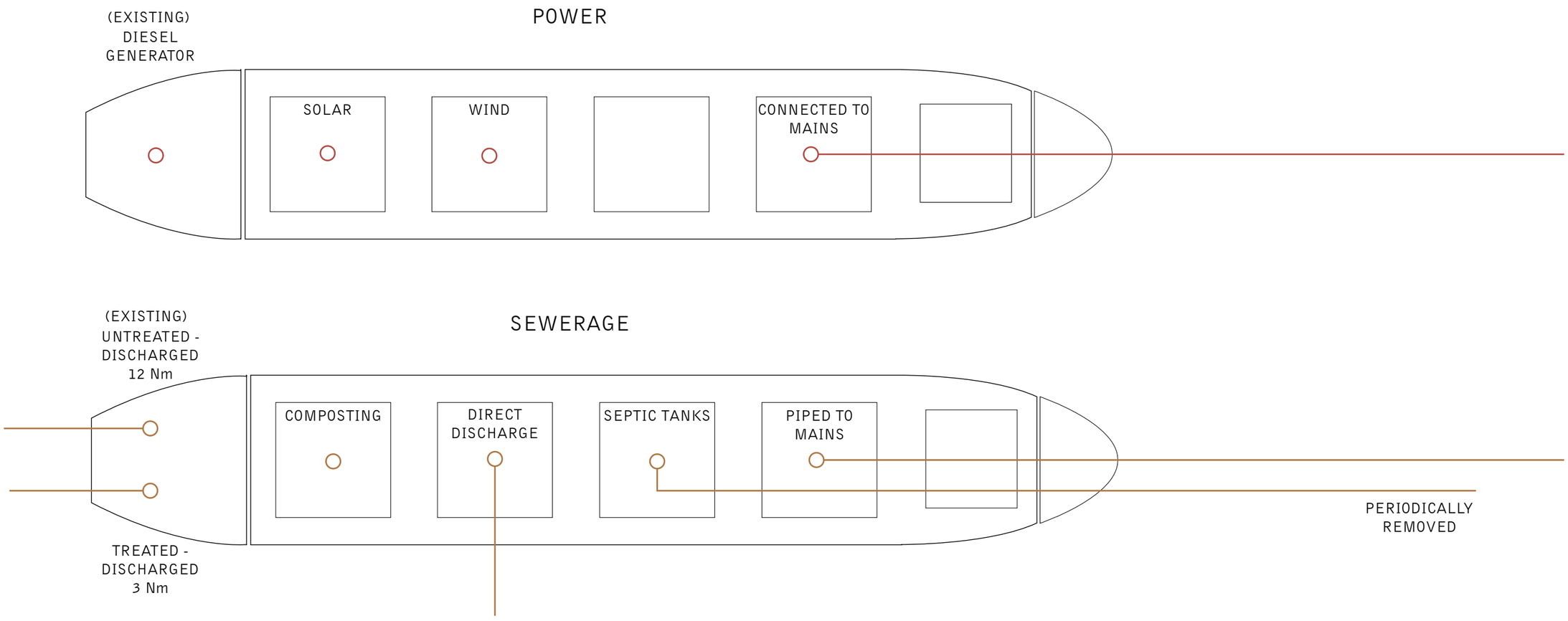


Fig. 4.02 Exploring the different services and how they could be incorporated into the design

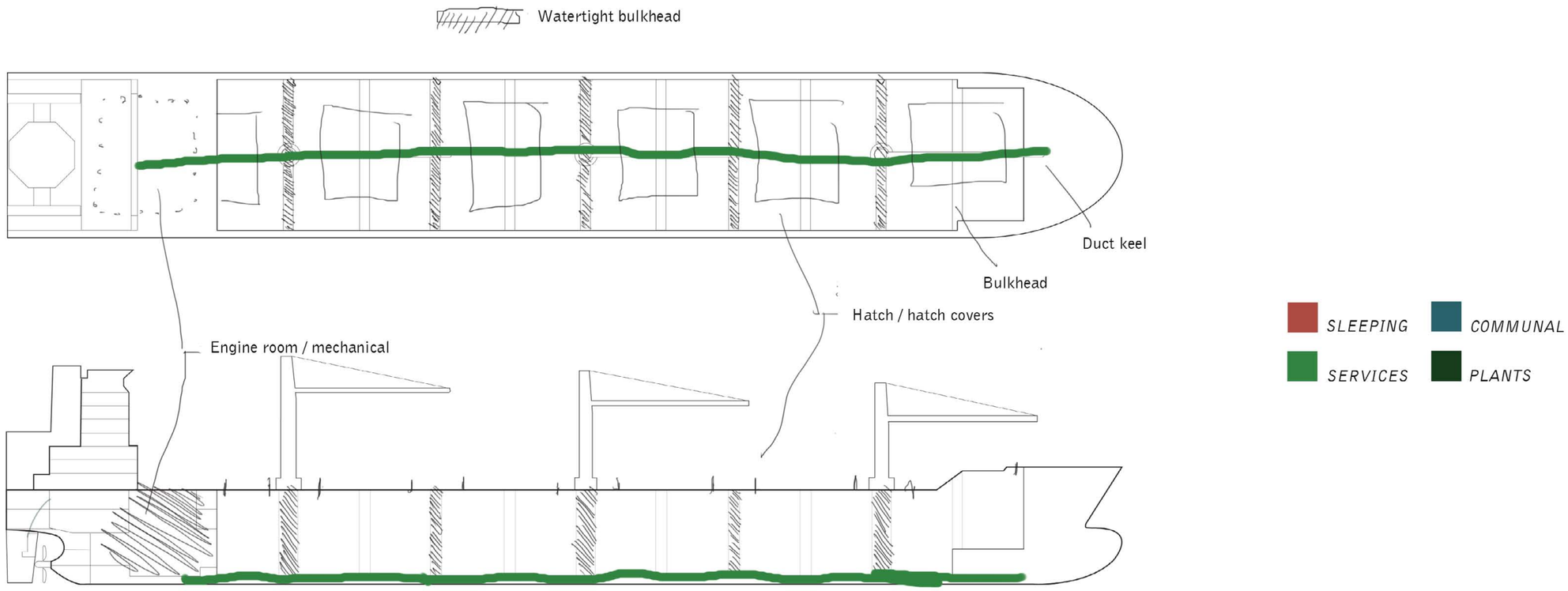
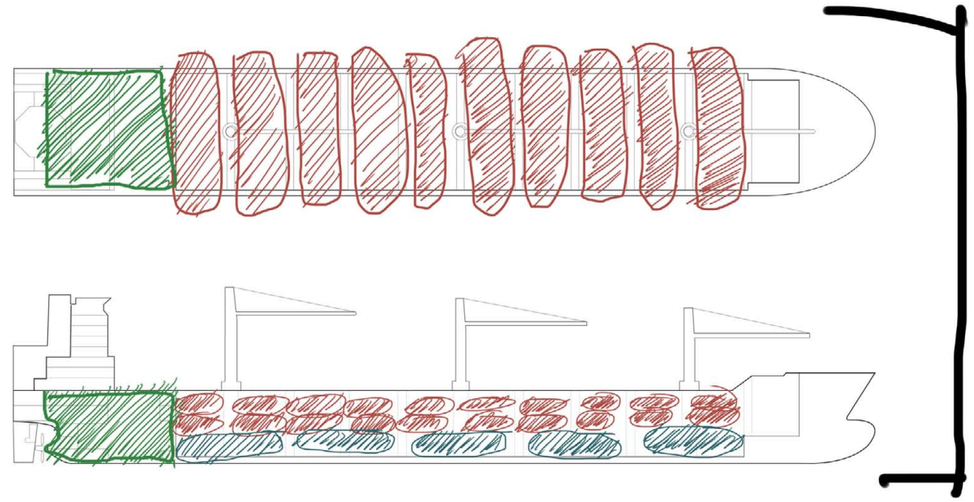


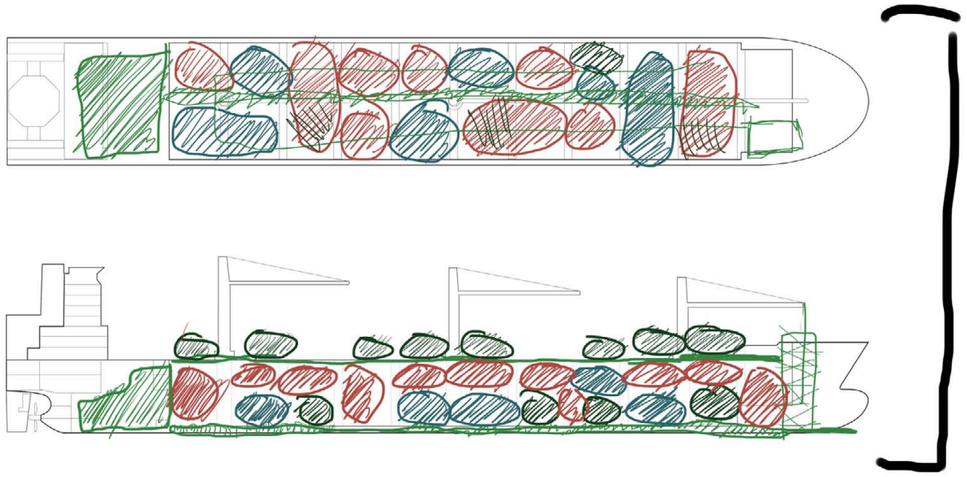
Fig. 4.03 Options for different layouts.



1

- Living space separated into sections, split between holds

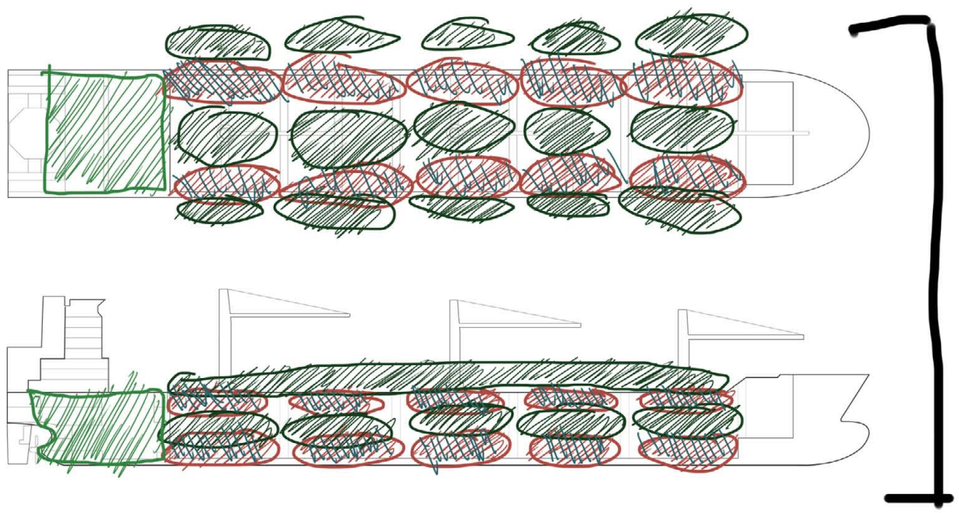
- Community spaces below to service living spaces



2

- Gaps filled with small scale crops/ fruit trees

- Areas located around key community spaces and services



3

- More regulated space

- Separated spaces for smaller community groups
  - Both community and living spaces together
  - Personal space for growing. cultivating food

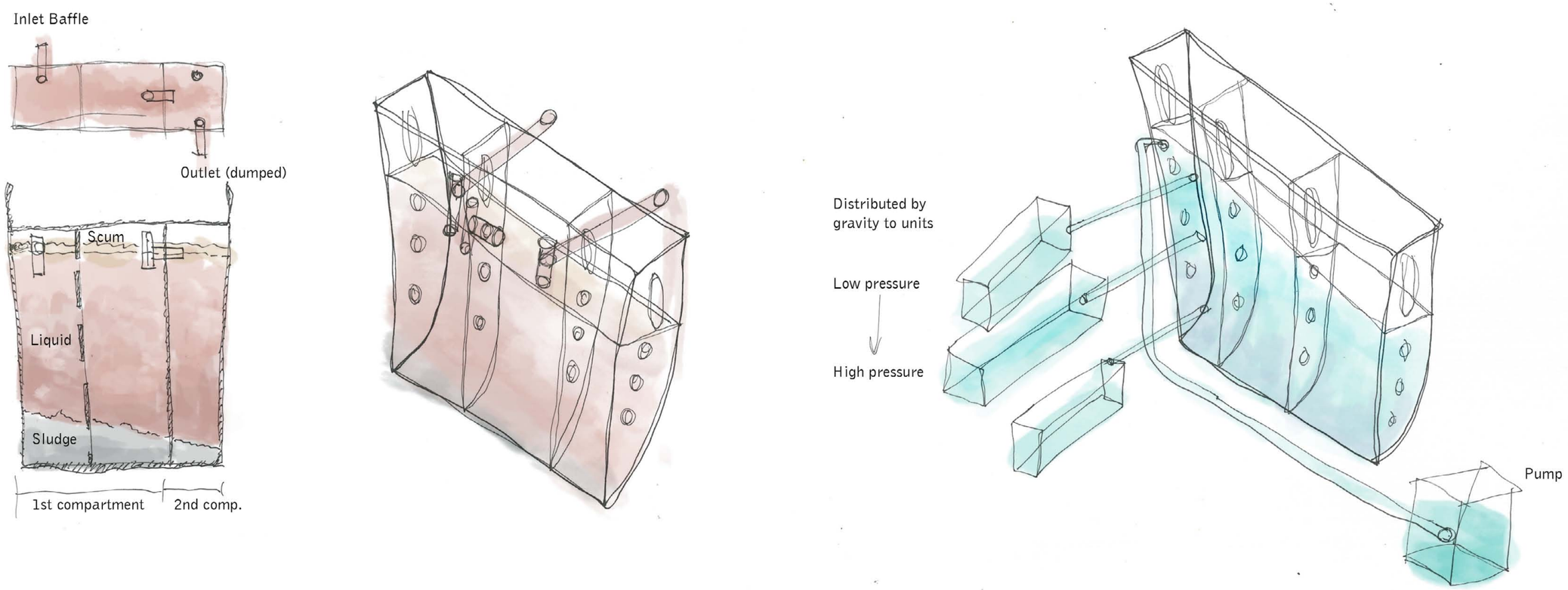
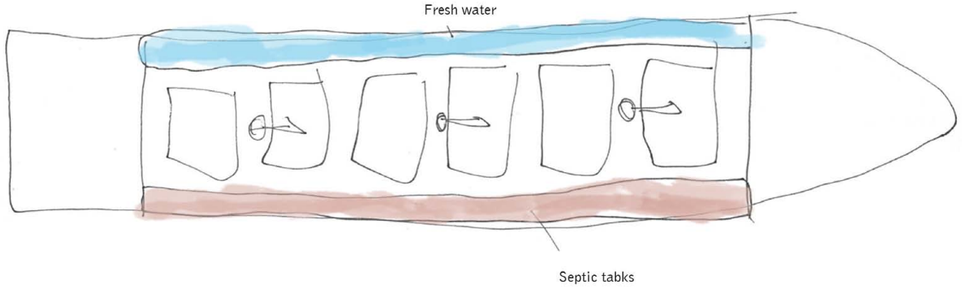


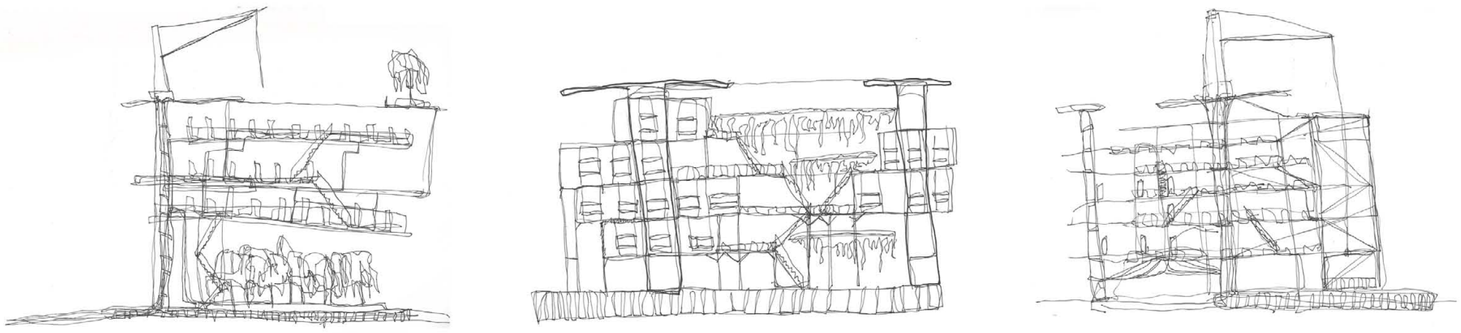
Fig. 4.04 Sketches showing the utilisation of ballast tanks for new uses.

The specific context of the site and its lack of enforced regulations allows for some freedom in terms of what could reasonably and conceptually exist. For example, when dealing with human waste there is no reason to connect the ship to the mainland sewerage system due to cost and the lack of an existing sanitation system. This is simply a reality of the site and it makes little sense to have it meet western standards. Given this, the best alternative may be to redirect it somewhere that the resulting harm will be minimised.

However, it is important to the utilisation of the ship in terms of the research question to be transformative. Therefore, the ship should have space dedicated to solving this issue (and others like it) despite it being seen as excessive in comparison to the status quo.



In Fig. 4.04 the ballast tanks have been repurposed to become septic tanks which would periodically be removed via truck or pumped out to sea.



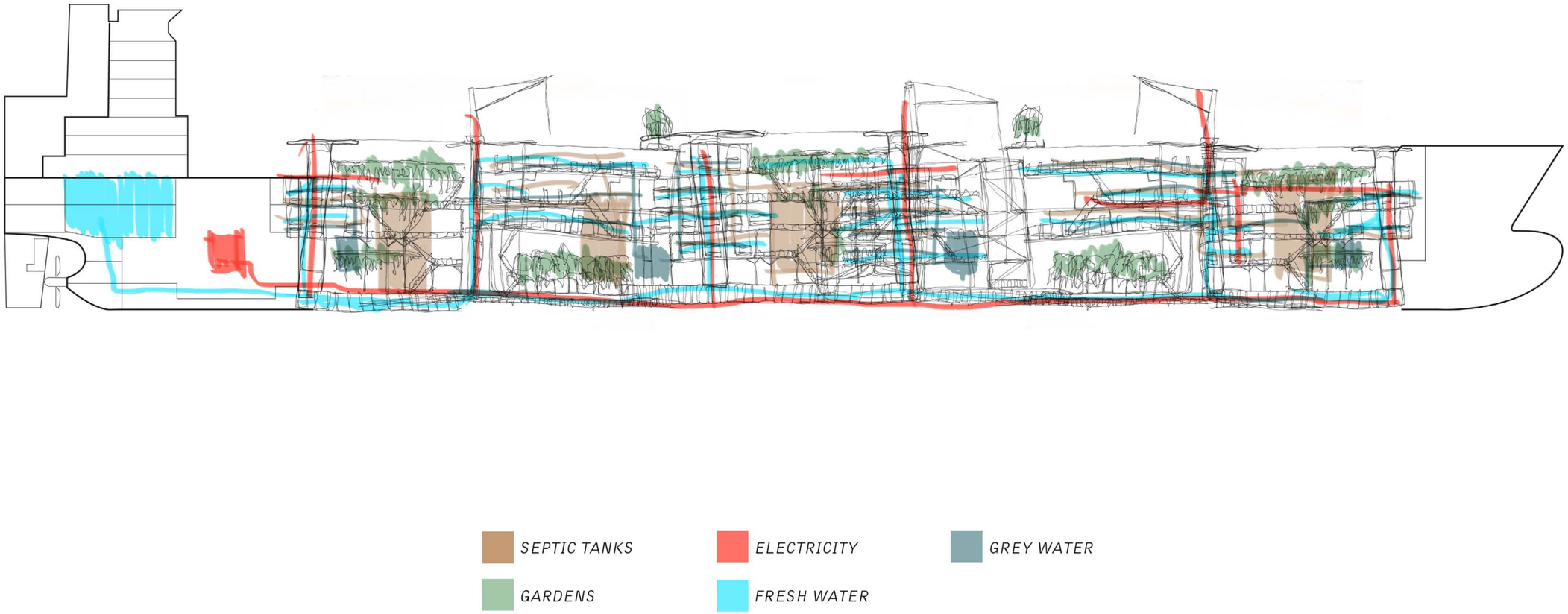


Fig. 4.05 Locating services and how they could be arranged within the ship.

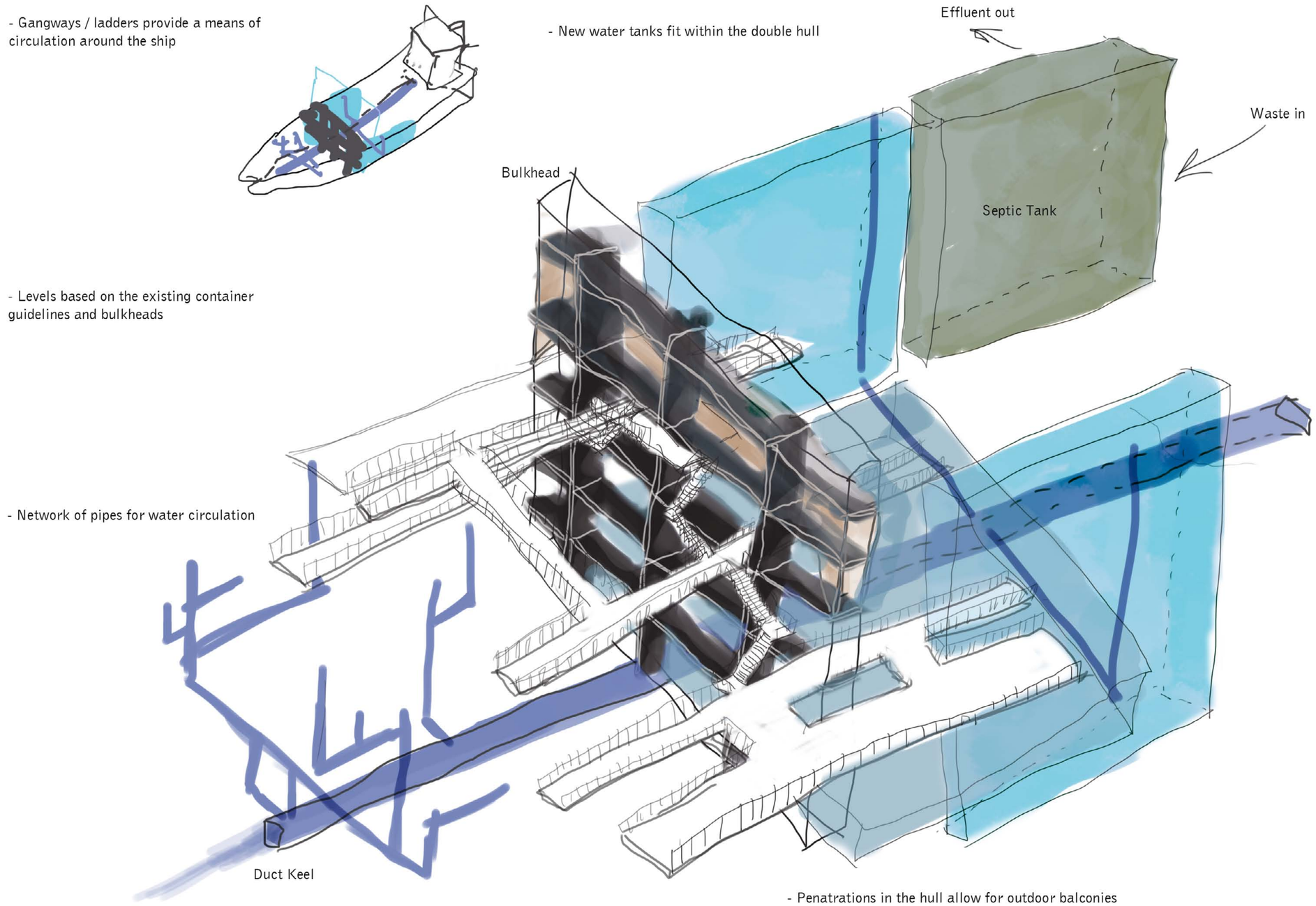


Fig. 4.06 Bulkheads, circulation and ballast tanks sketch.

One of the key ideas behind the layout of the design of this ships interior is the transition from the beach of the shipbreaking yard to the interior of the ship. The intention is that the interior becomes a 'sanctum' where the inhabitants can escape the chaos and danger of the yard to a place where they can forget about their day-to-day hardships. One of the challenges of accomplishing this will be in addressing the irony of creating this kind of space with a ship; the subject of the inhabitants' adversities.

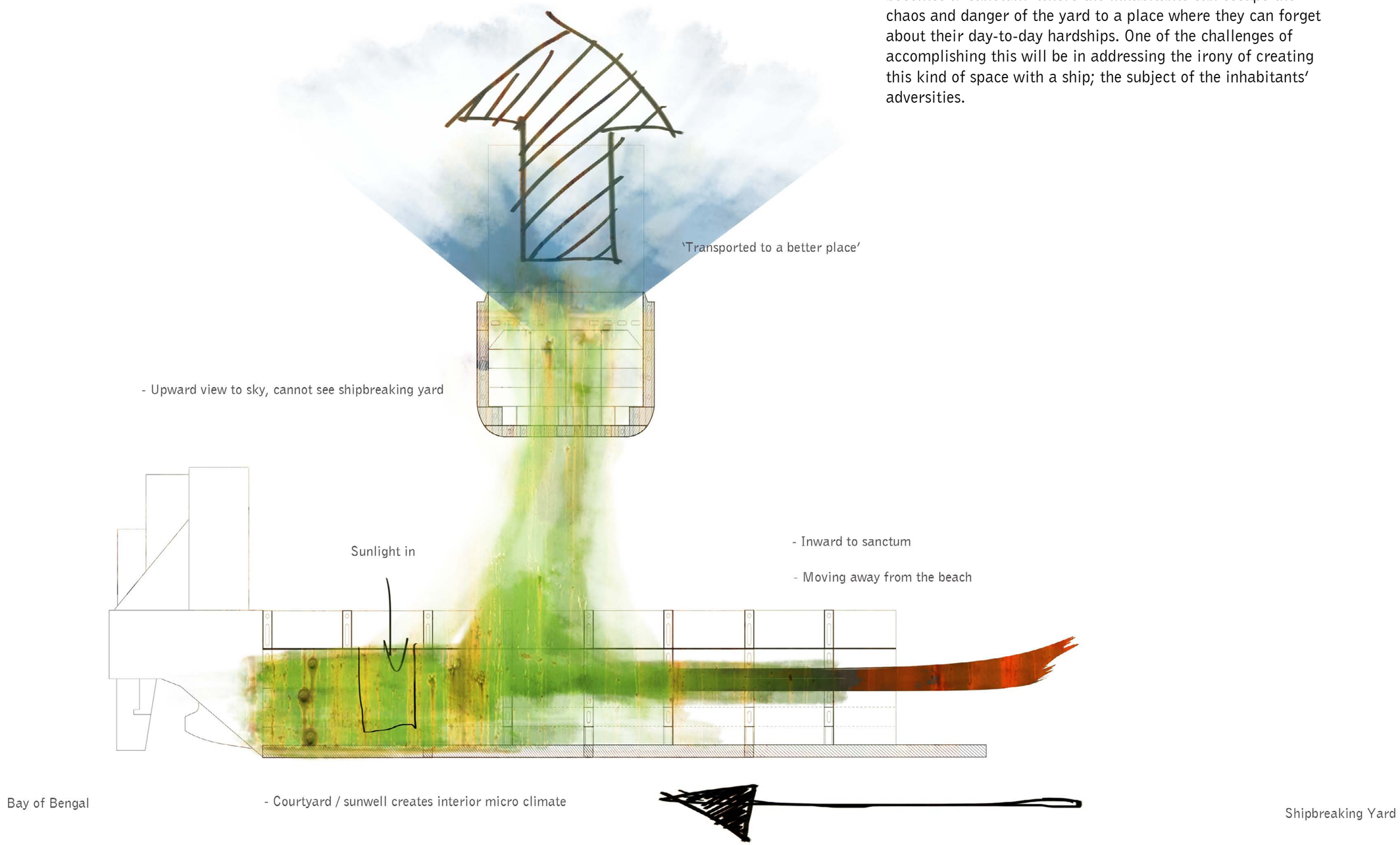


Fig. 4.07 Development of the idea of the sanctum.

4.03
MARKET DECK

At the beach end of the ship an open deck area is formed that acts as a buffer and threshold between the shipbreaking yard and the interior. The purpose of this space is to create a market area where vendors can come and sell items directly to the inhabitants or yard employees. This is a community space that focuses on the needs of the worker.

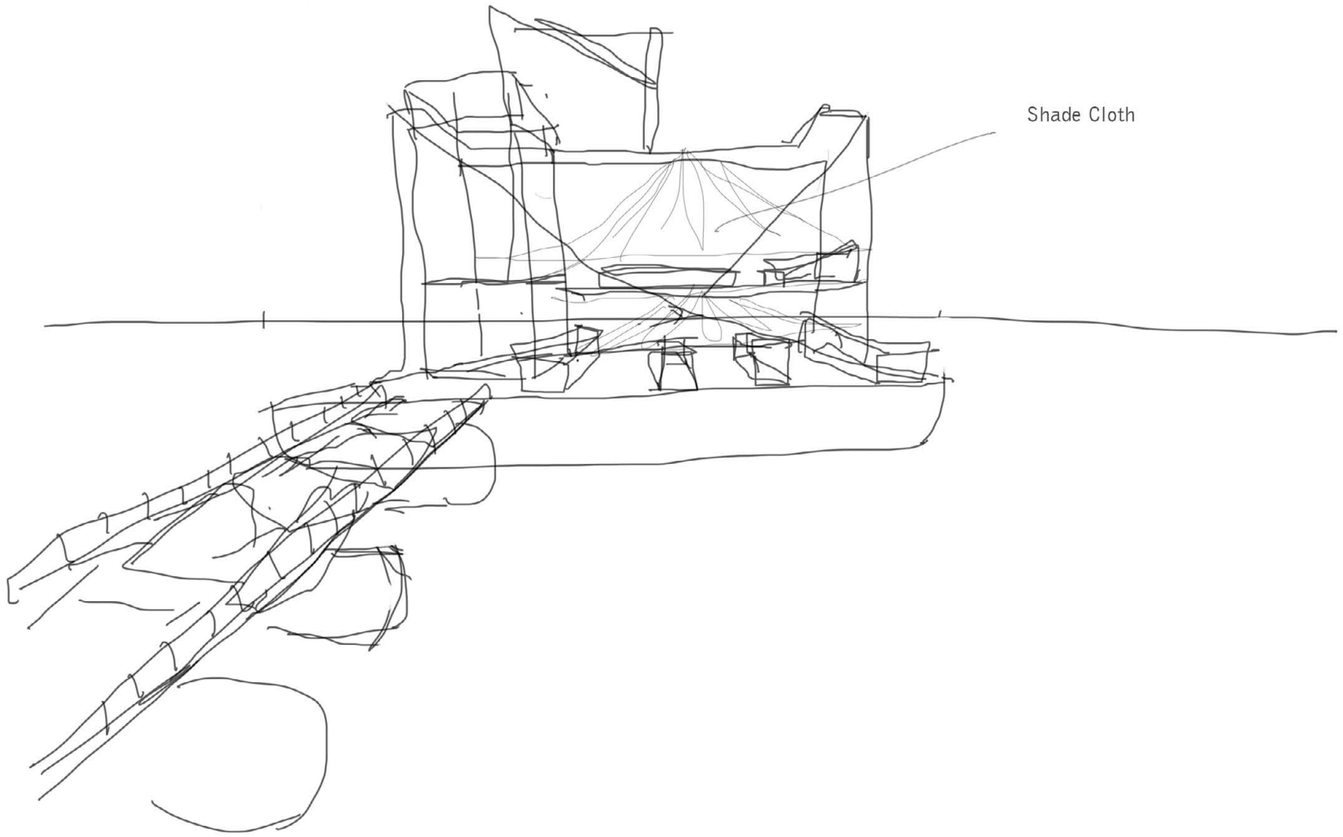


Fig. 4.08 Sketch perspective concept of the market deck.

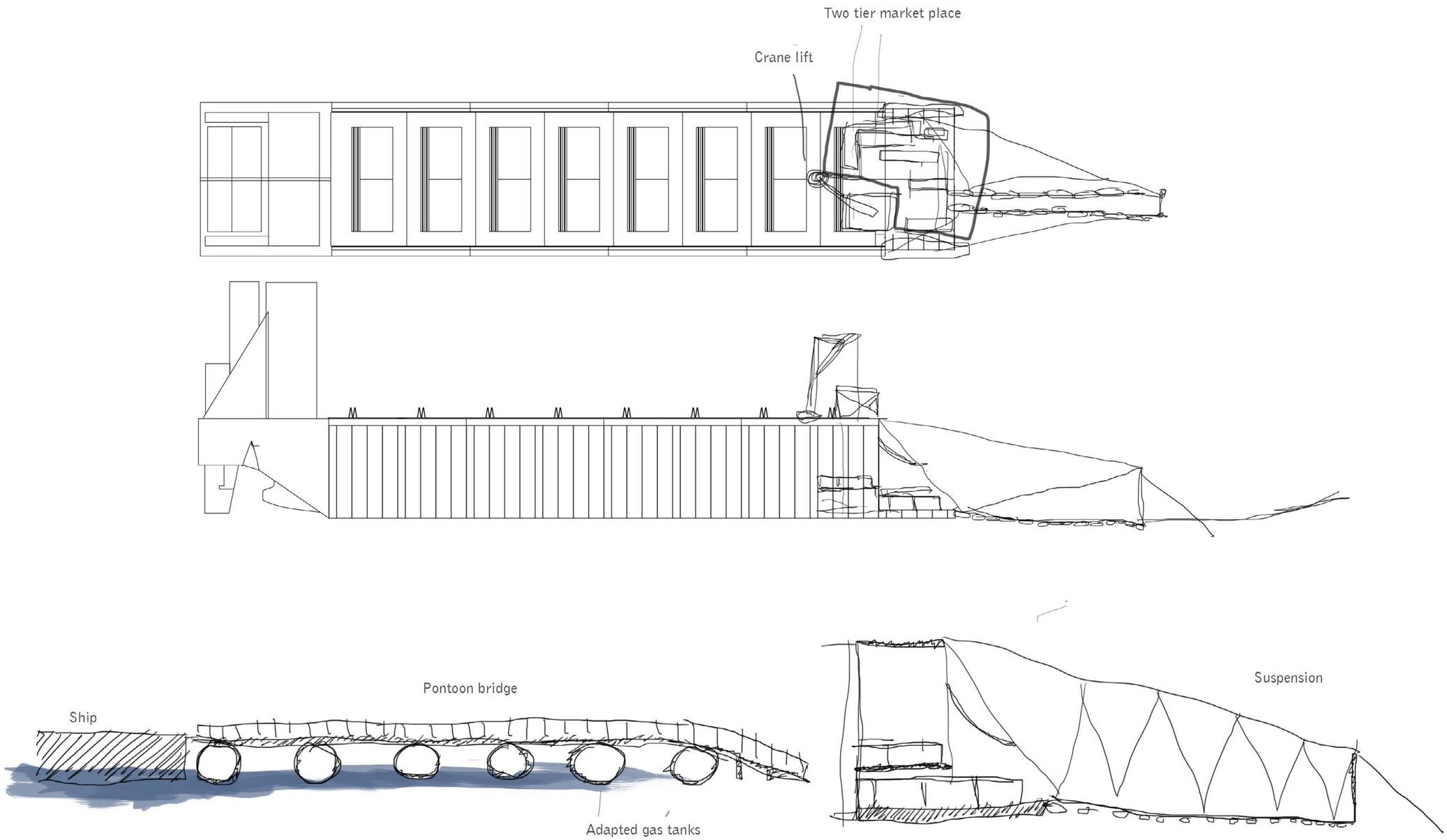


Fig. 4.09 Market deck sketches.

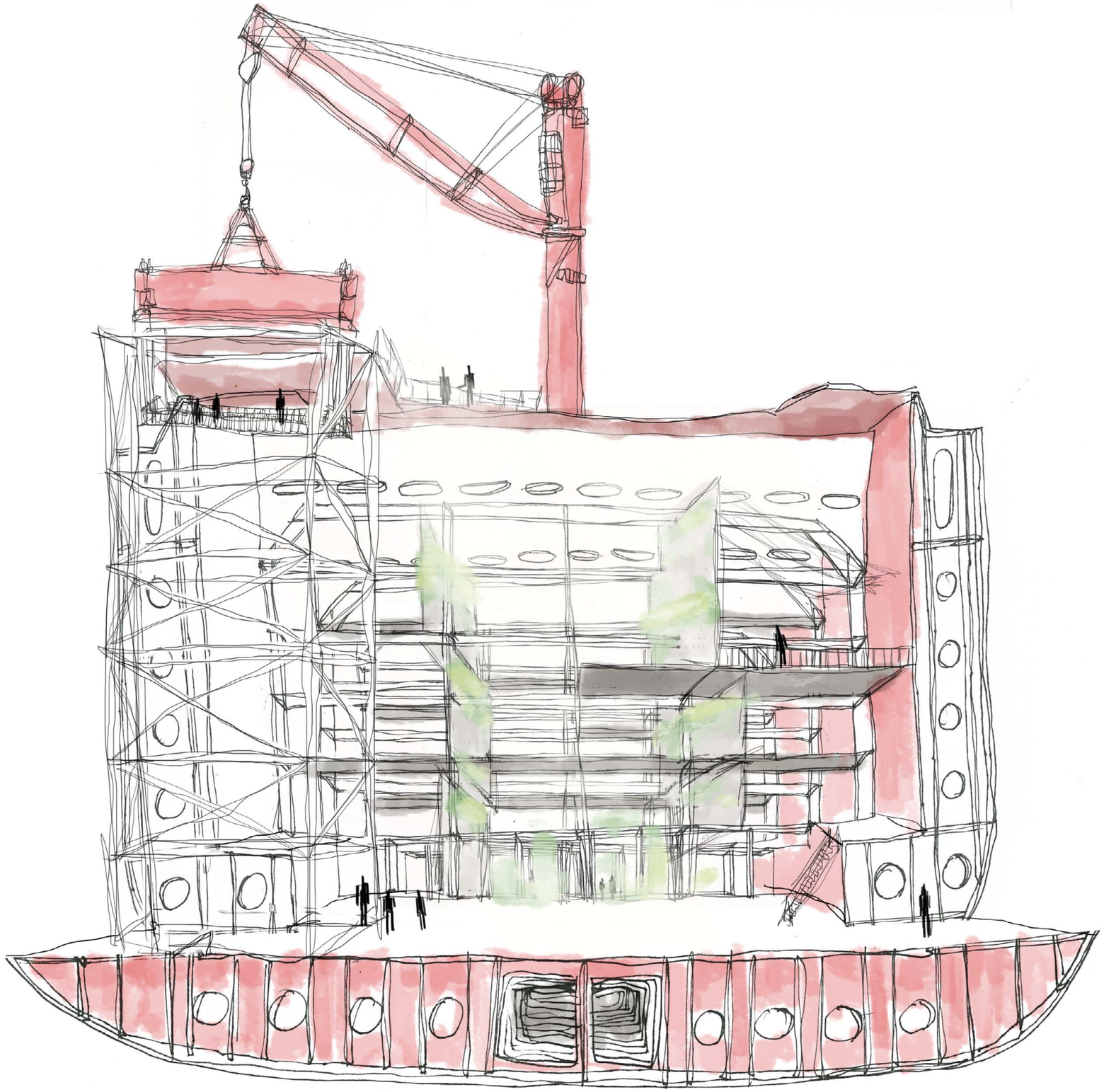


Fig. 4.10 The market deck and the transition to the ships interior.

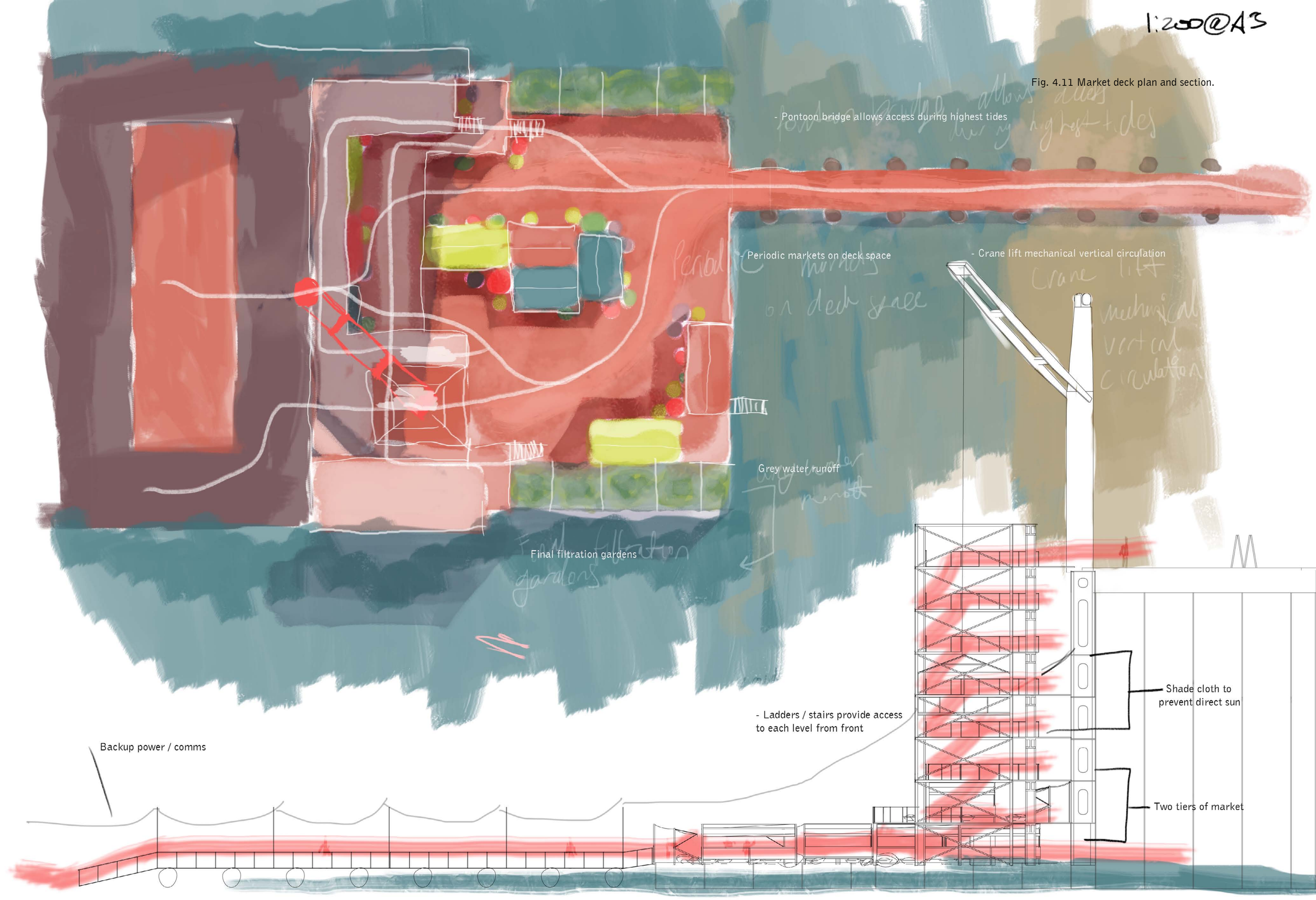


Fig. 4.11 Market deck plan and section.

One of the major benefits of this space is that it fosters community interaction, through this involvement a sense of ownership of the space is established. This experiment however, fails to represent this idea clearly and perhaps focuses too much on the overall atmospheric qualities. In part this may be an issue with how the space has been represented when the surrounding context and the actual griminess and disorder of the site has been obfuscated.

Fig. 4.12 Rendered perspective of the market deck.

4.04

INTERIOR - COMMONS

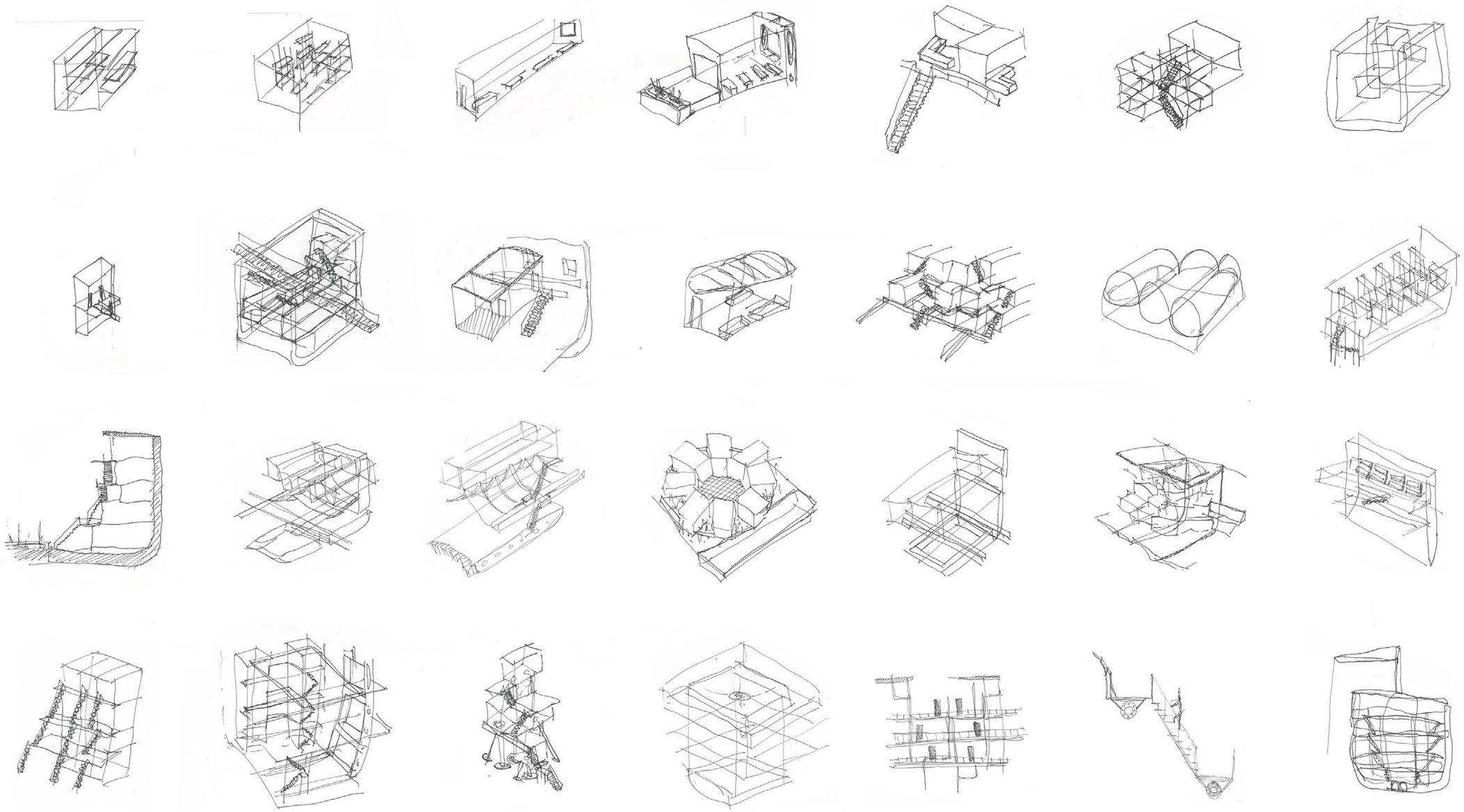


Fig. 4.13 Concept sketches of interior spaces within the ship.

The social areas located around the space serve as areas where the occupants can meet and go about their everyday tasks, such as cooking, that are made easier through communal engagement. This is the reason why many of these spaces in the initial iterations of the design (or design elements) are focused on facilitating self-sufficient food production. This would also double as a heat sink and a way to soften the aesthetic hardness of the, primarily steel, hull. Initially this experimentation involved integrating these areas into the hull of the ship. However, this made the orientation of the cabins difficult to articulate as they required a more complex circulation system.

Eventually the accommodation was shifted towards the sides of the hull with the communal areas being in the centre of each hold. This way light can filter down more effectively to aid with plant growth and enhance natural lighting conditions. This orientation made it easier to control the light and was better at letting light penetrate to the lowest levels of the ship.

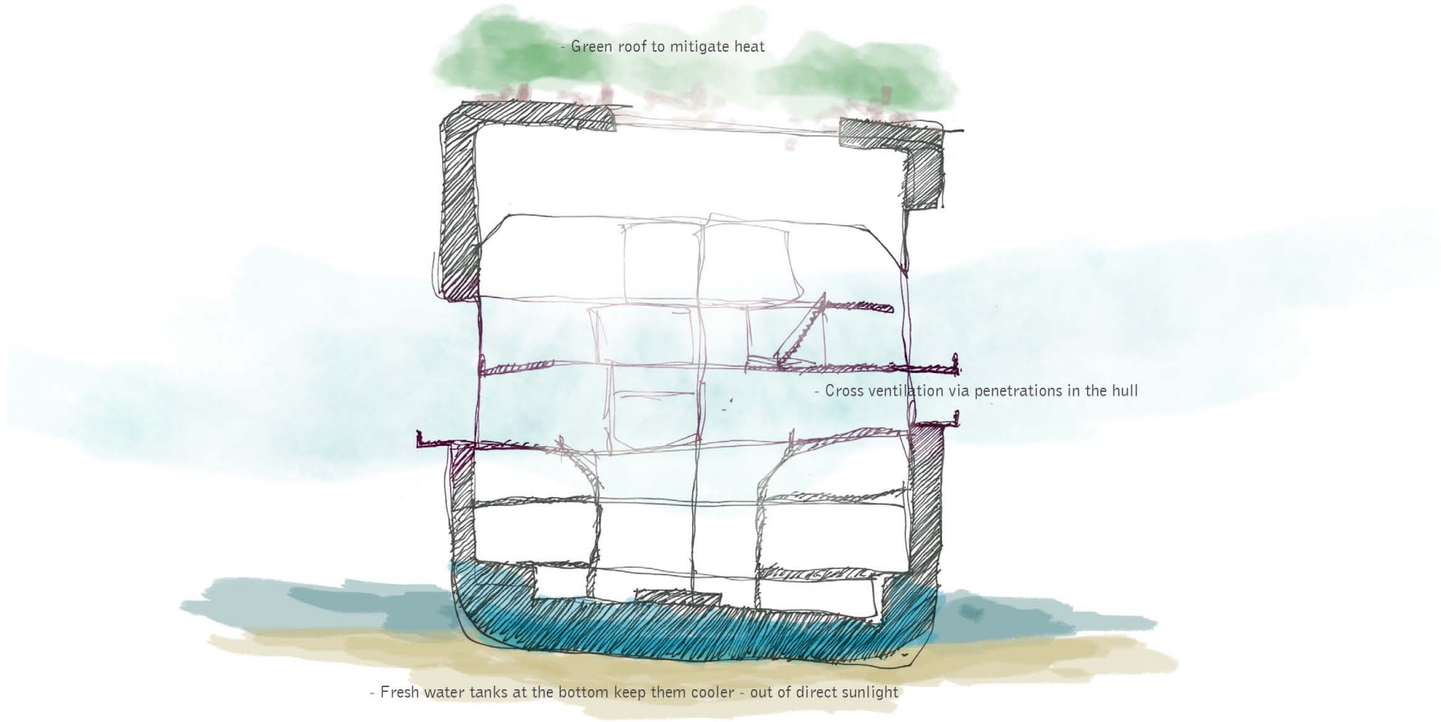
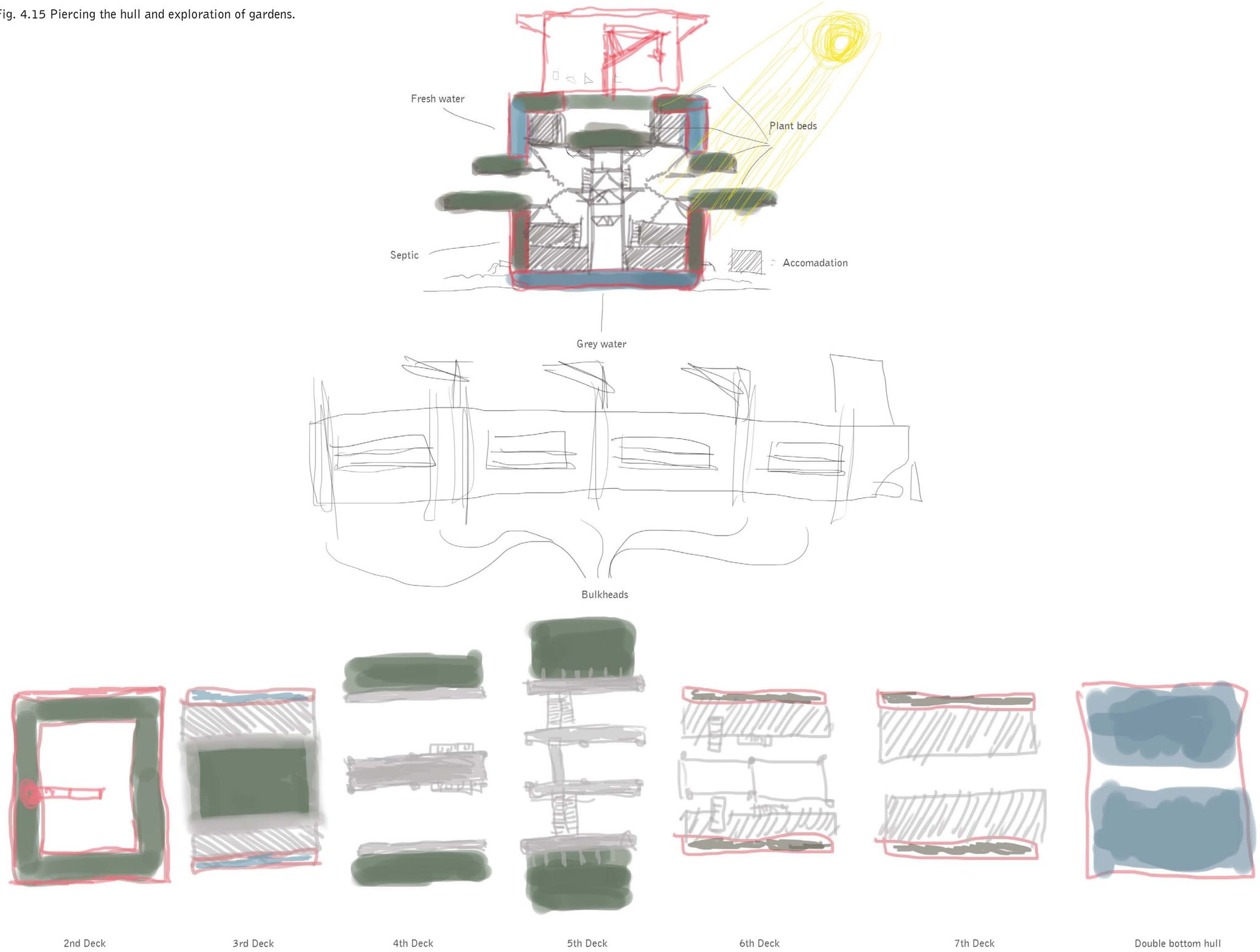


Fig. 4.14 Exploration of cross ventilation and light well.

Fig. 4.15 Piercing the hull and exploration of gardens.



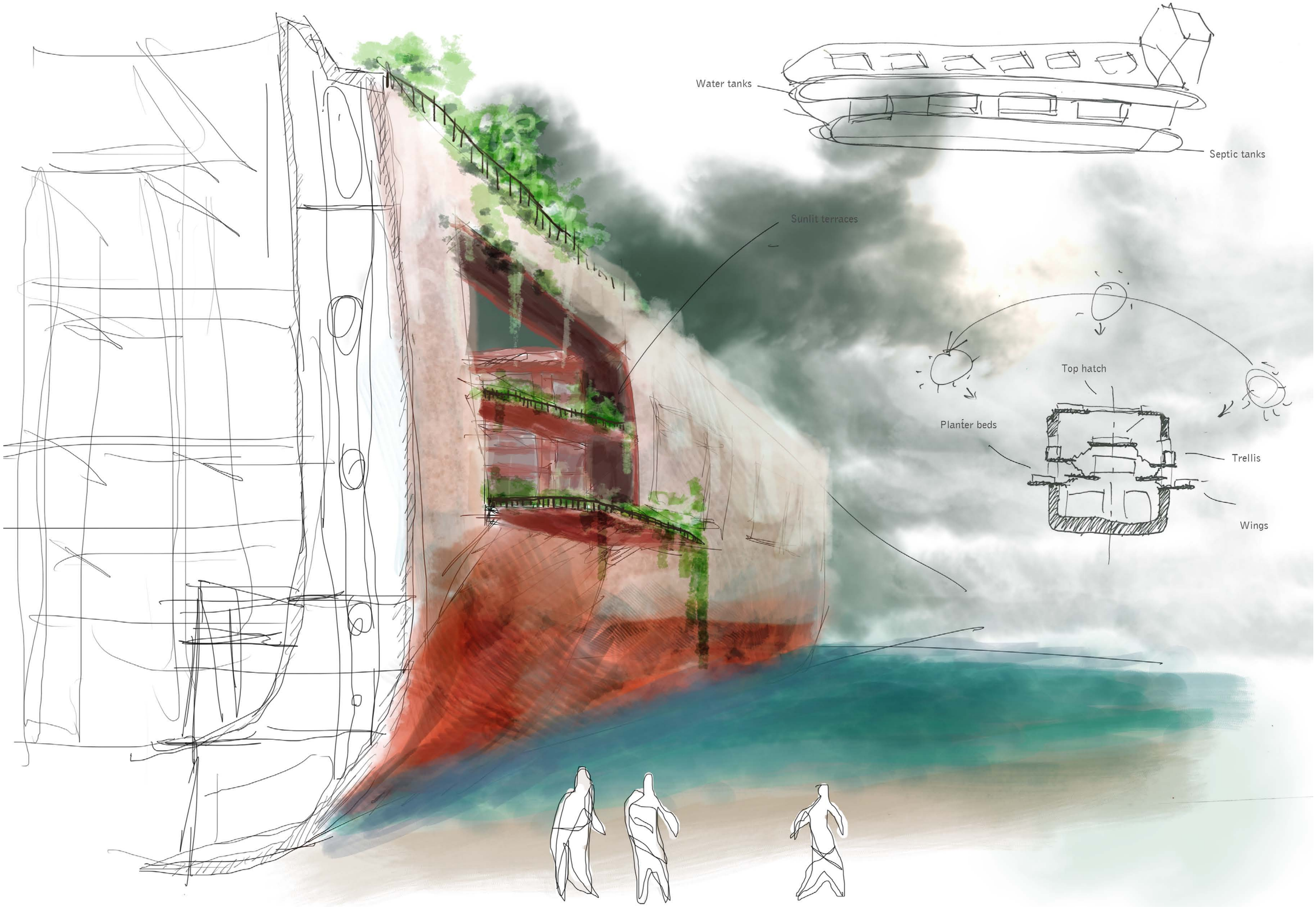


Fig. 4.16 Perspective showing how the hull is pierced.

Hatch
Double hull
Outer hull layer
Inner hull layer
light via hatch
- Cut and bend hull walls to form planter beds
- Fully penetrate the hull to allow in sunlight

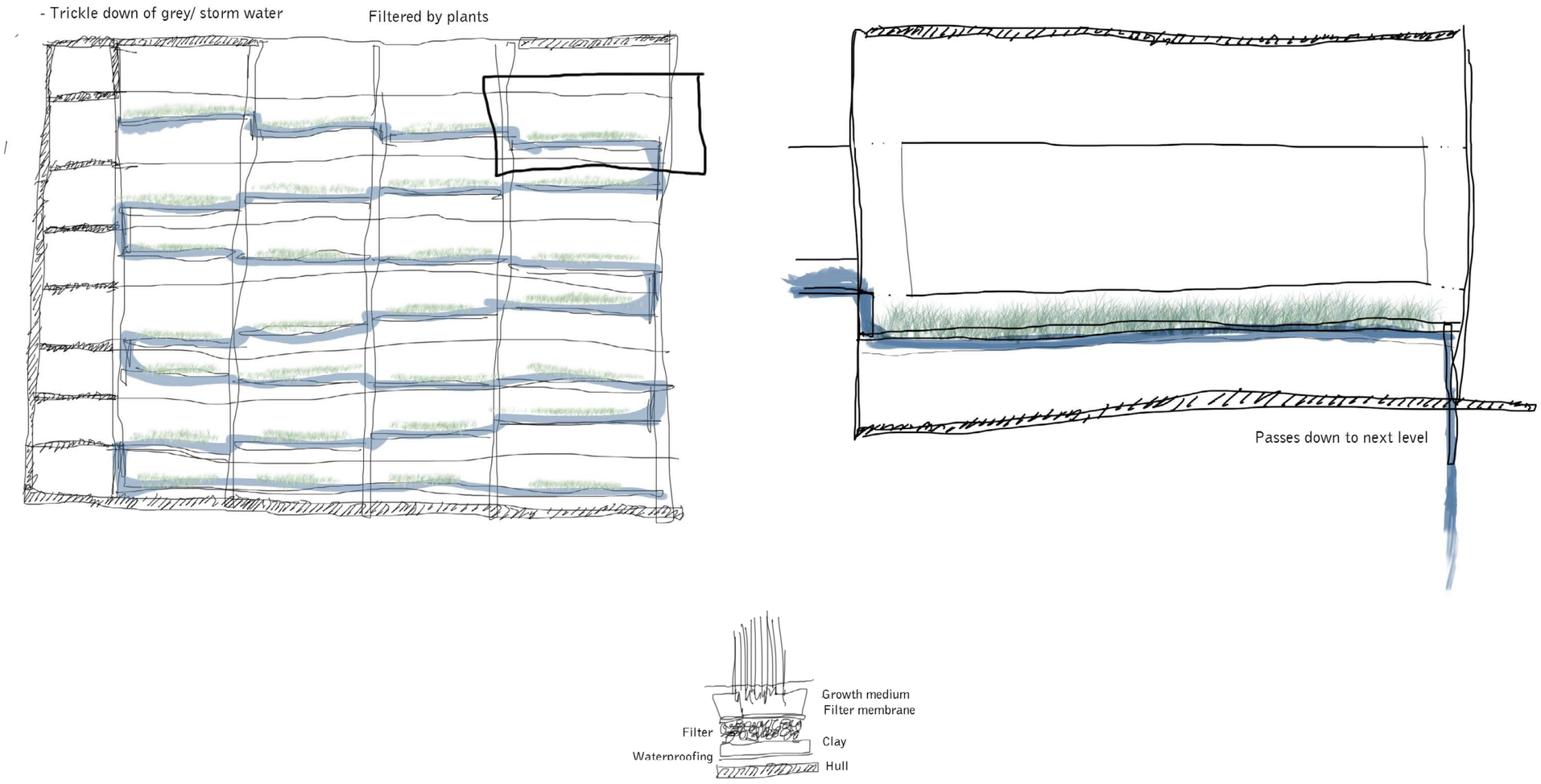


Fig. 4.17 Additional options for how to use the hull.

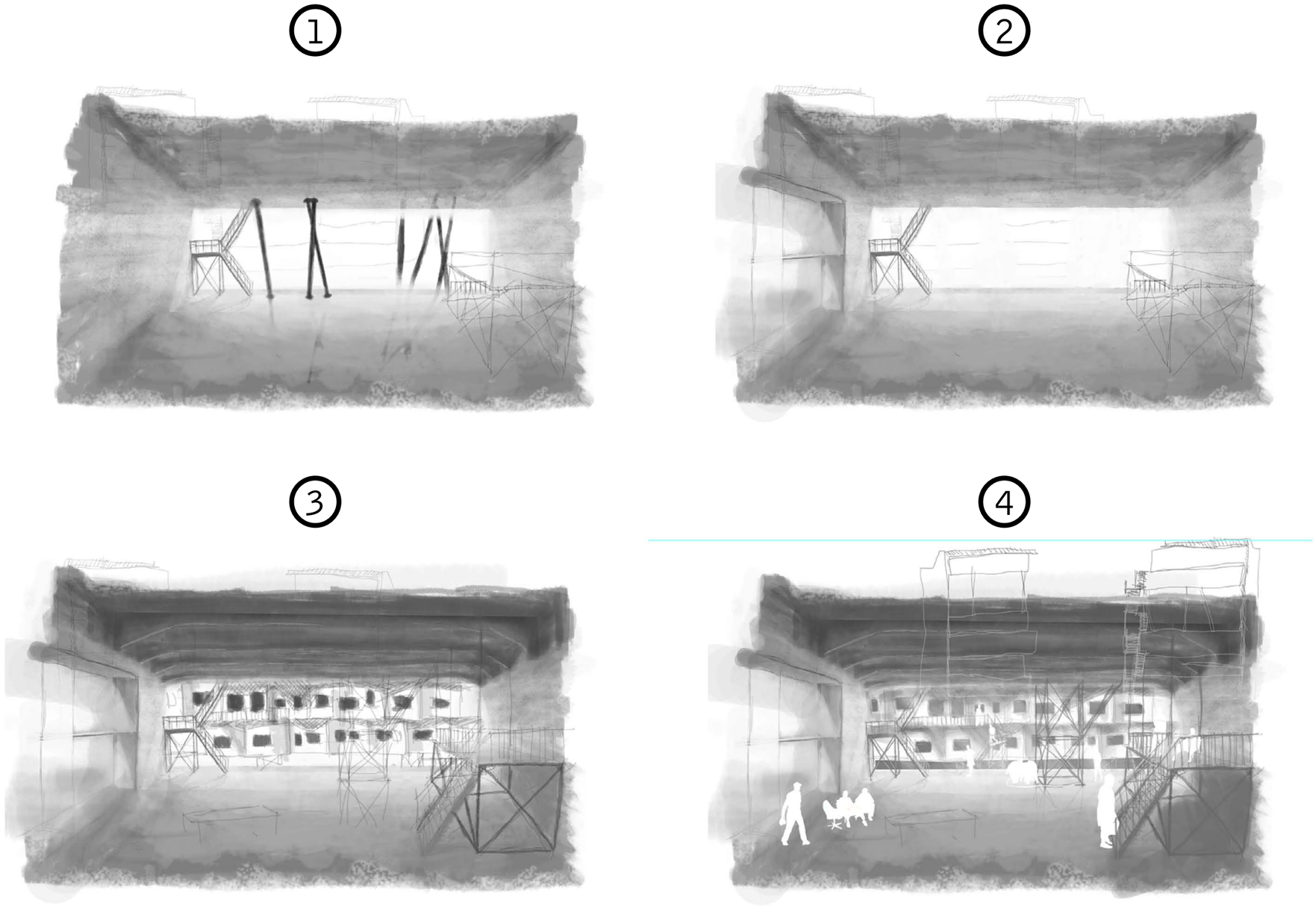


Fig. 4.18 Drawings developing the communal areas.

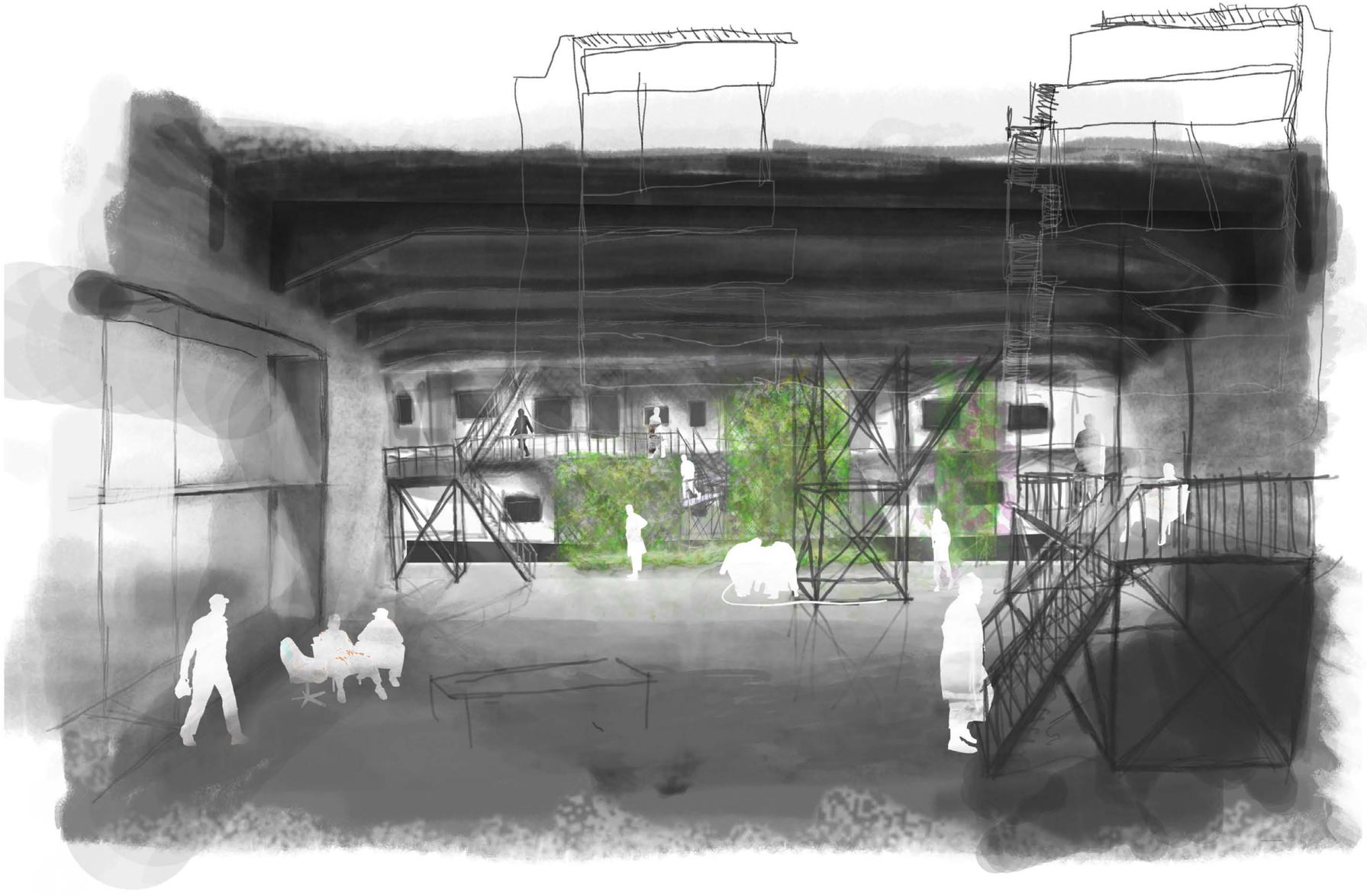
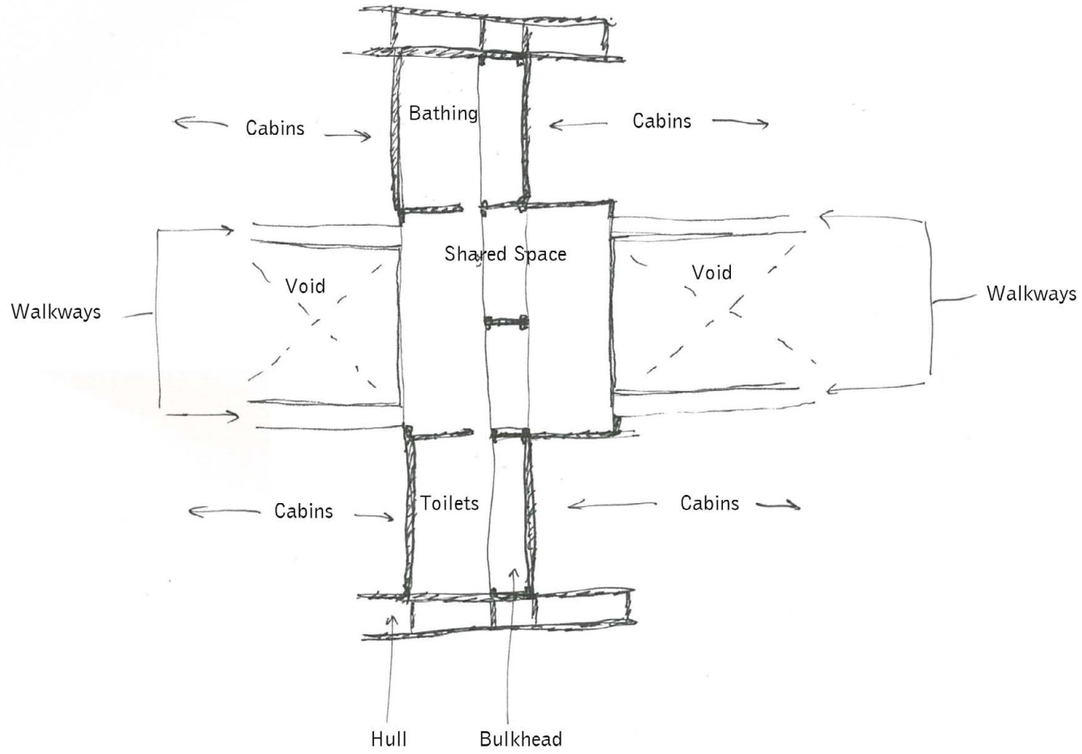
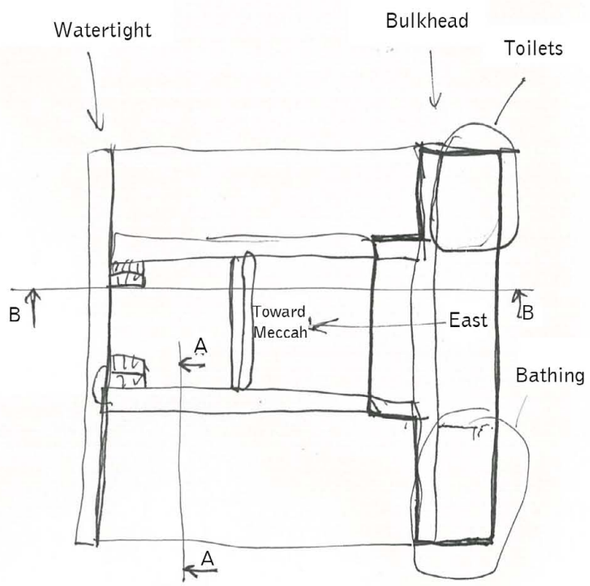
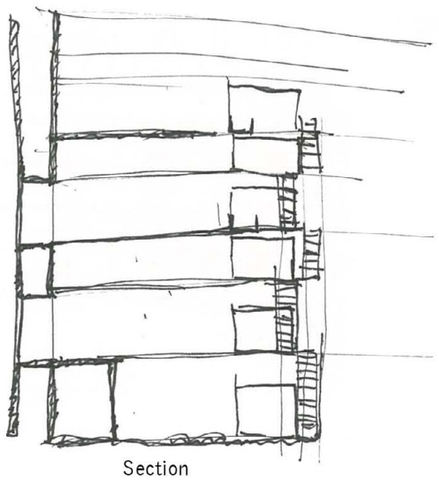


Fig. 4.19 Communal space concept.

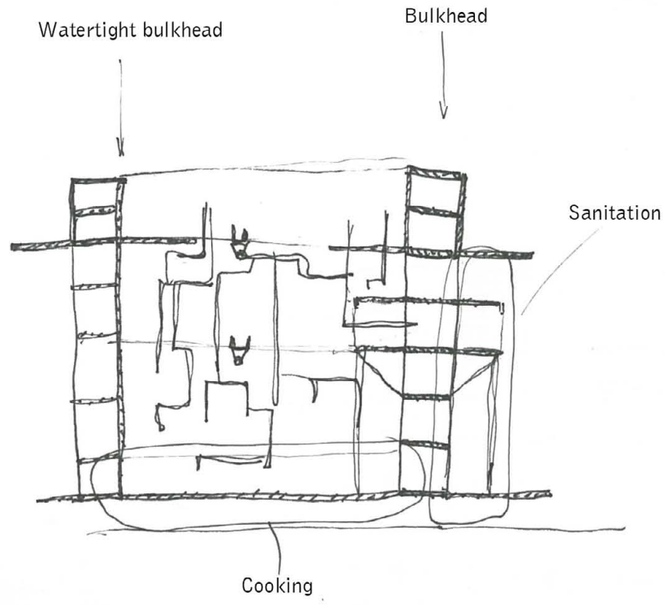
Fig. 4.20 Communal space development sketches.







Section
A -A



Section
B - B

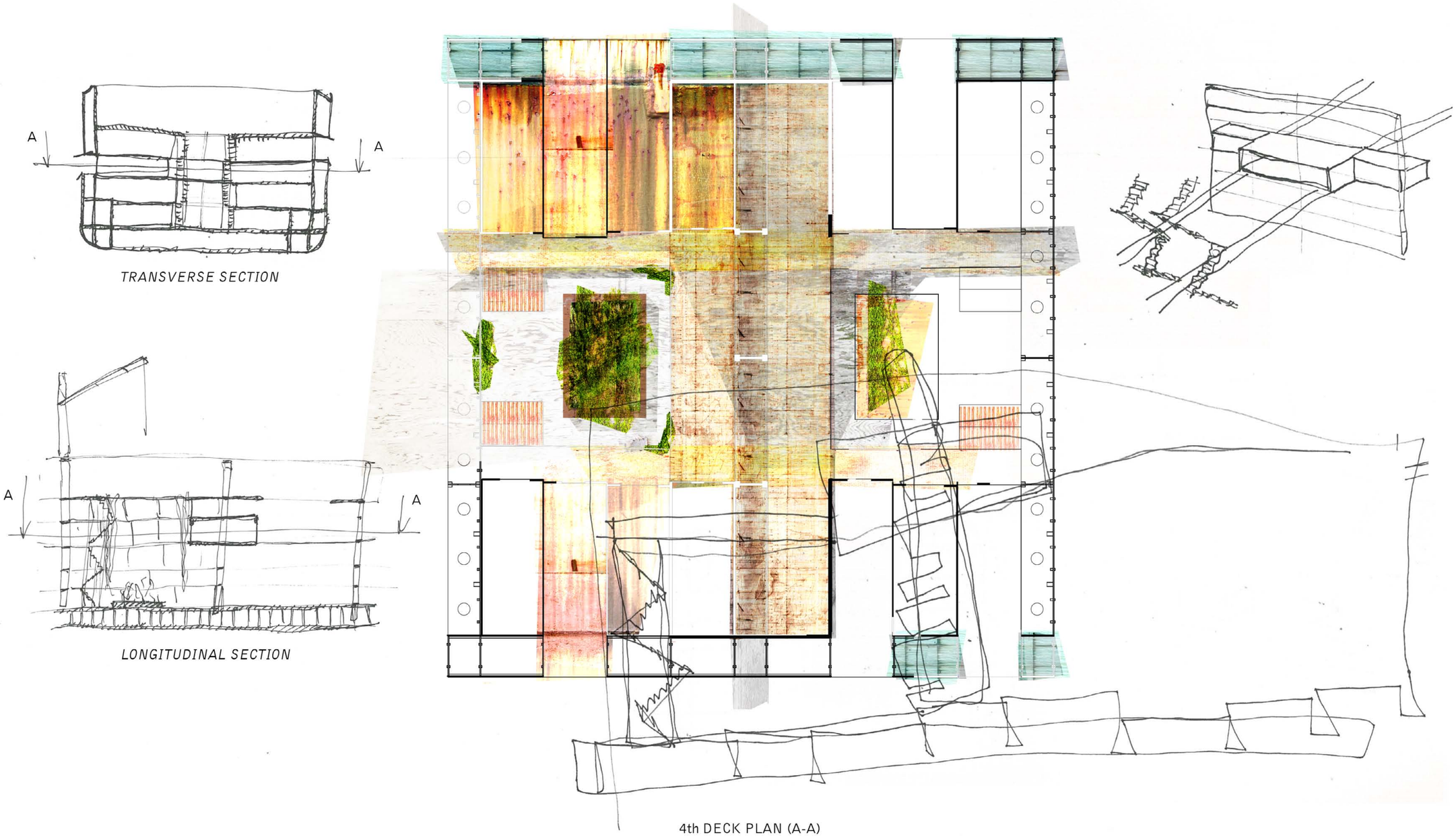
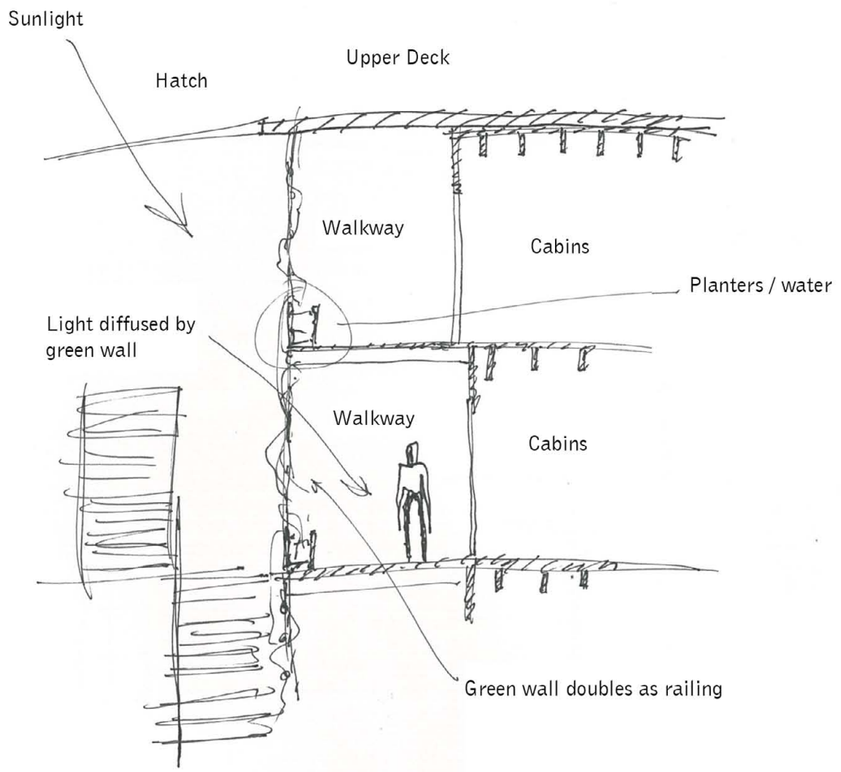


Fig. 4.21 4th deck communal space plan.

Integrating the walkway balconies with trellis for growing gourds helps to decrease direct sunlight and maximises the area that the occupants are able to grow produce. Gourds are suitable and sustainable for the inhabitants of the ships as they are a relatively low maintenance food source. One of the issues with this is that for certain times of the year parts of the light well that these trellis balustrades face will not receive much light.



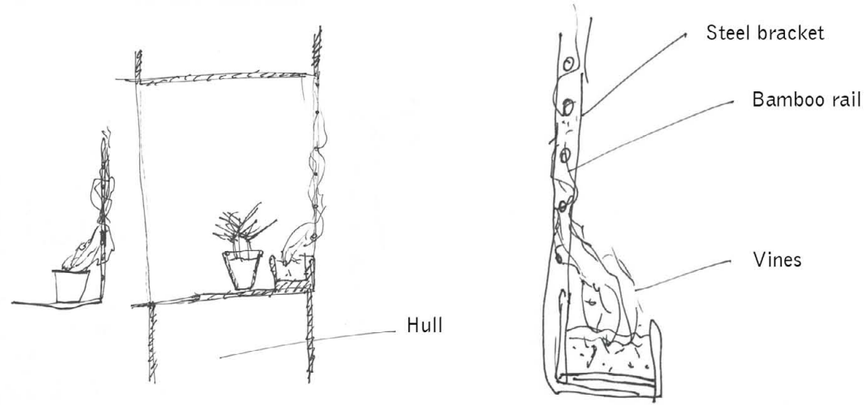


Fig. 4.22 Walkways and balustrades concept.

Fig. 4.23 Balustrade elevation with vines growing through it.

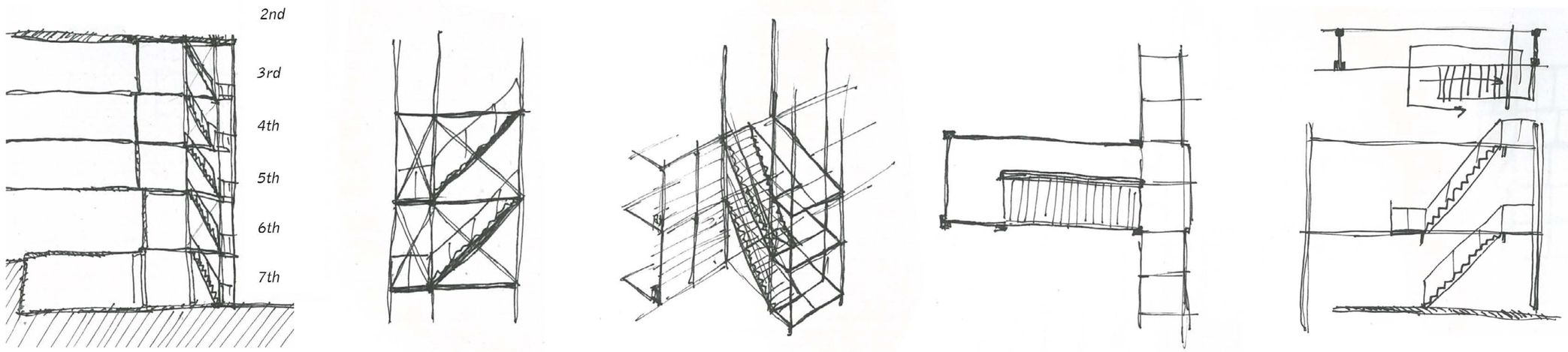
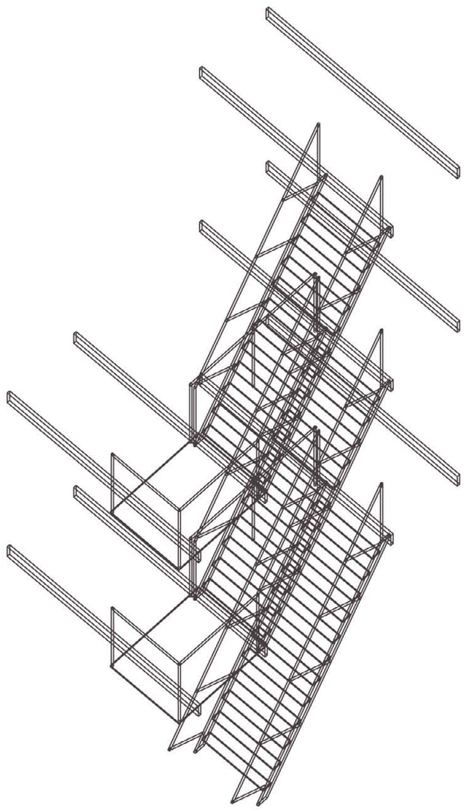
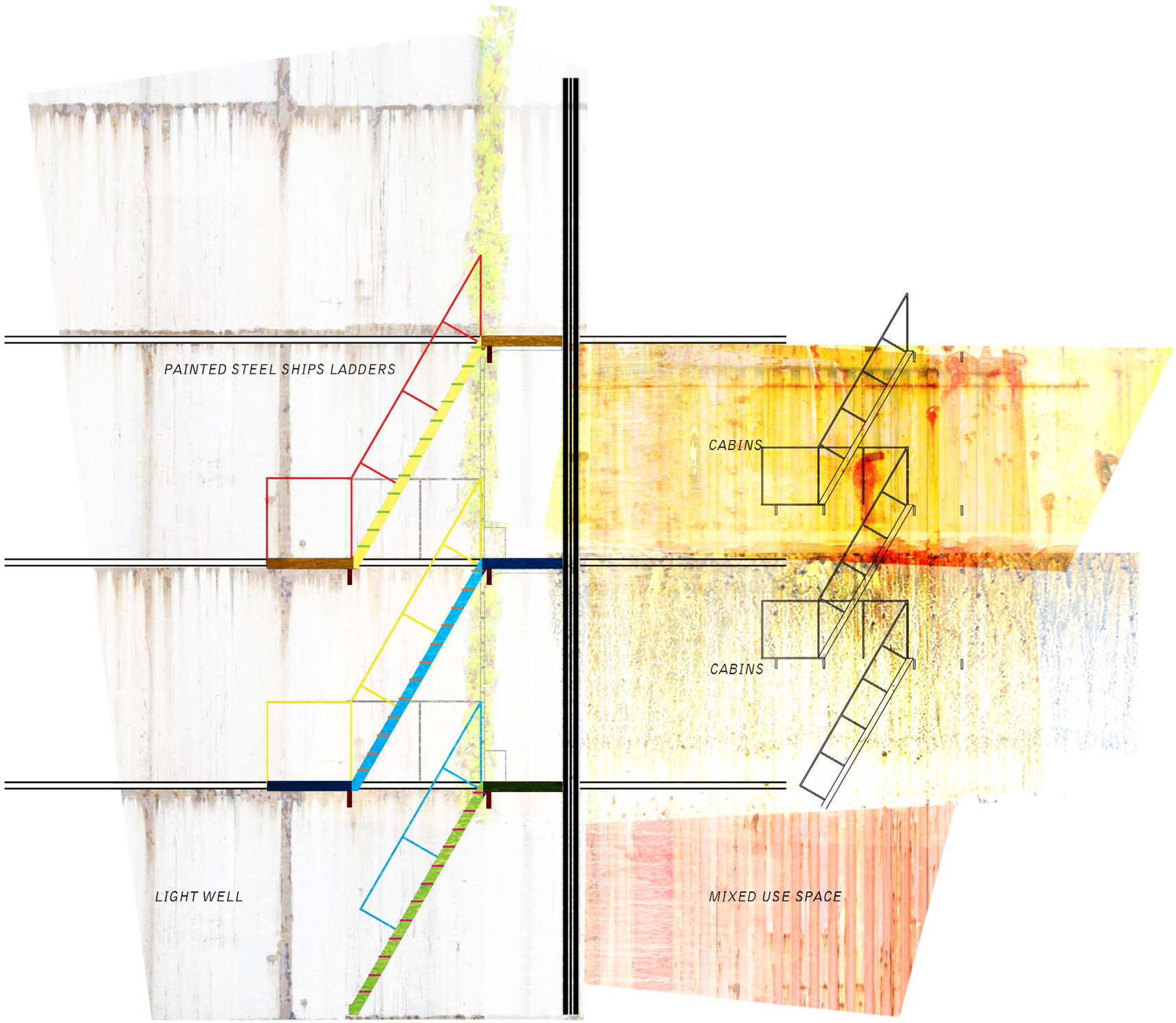


Fig. 4.24 Stair well concept sketches.





TRANSVERSE SECTION EXPLORING VERTICAL CIRCULATION

Fig. 4.25 Stair well section with coloured ladders.

The following iteration of the design is beginning to capture the atmosphere that was envisioned for the space. The combination of greenery and light through the light well attempts to transport the inhabitant to a space outside of the realm of shipbreaking and negativity associated with the site. It allows for the inhabitant to look inward and upward so that they may forget, even for just a little while, that they are in such a dangerous and oppressive environment.

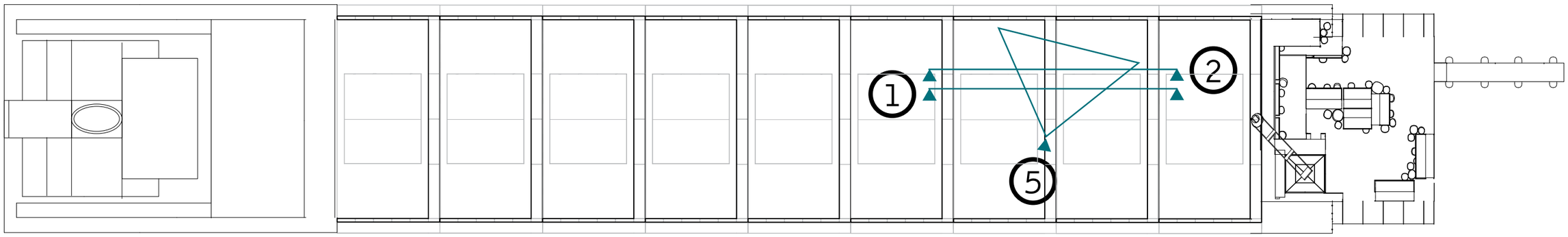
The steel ladders/ stairs that can be found on the ships and at the nearby scrap resellers are whimsical in their bright colouration. They stand out conspicuously from the dull rust and dirt of the surrounding area. Due to their aberrant qualities and their alignment with the idea of 'transporting' the inhabitant, it makes sense to include them as they are.

The 7th deck floor plan shows the base level of the ship. In the first hold, after entering the ship there is a transitional area where the workers can clean themselves and their work gear as well as a place where it can be stored. Culturally, this ablution represents the purification threshold in Islam and in practical terms it reduces the amount of dirt that would be transmitted into the ship thereby increasing the overall cleanliness of the subsequent spaces. On this floor there are other more general communal and social areas that are more open plan so that the occupants may use them as they desire. This would be an appropriate place for groups to cook and eat, for example.

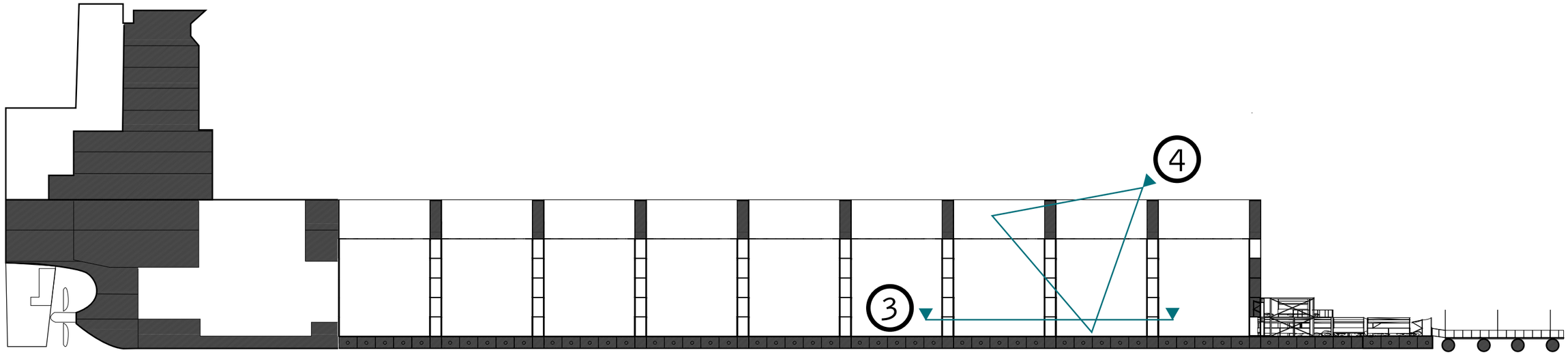
Higher up on the ship on the 4th deck there are higher quality spaces including more refined ablution facilities and areas where inhabitants can pray. This space is positioned higher up in the ship to take better advantage of the light well and reflect its greater importance and value.

SCALE
1:500

Fig. 4.26 Key plan / section of commons experiments.



PLAN



SECTION

1 LONGITUDINAL LIGHT WELL SECTION 1 (pg. 78)

2 LONGITUDINAL LIGHT WELL SECTION 2 (pg. 79)

3 7th DECK FLOOR PLAN (pg. 80)

4 LIGHT WELL PERSPECTIVE (pg. 81)

5 WALKWAYS PERSPECTIVE (pg. 82)

SCALE
1:100

①

Fig. 4.27 Longitudinal light well section 1

②

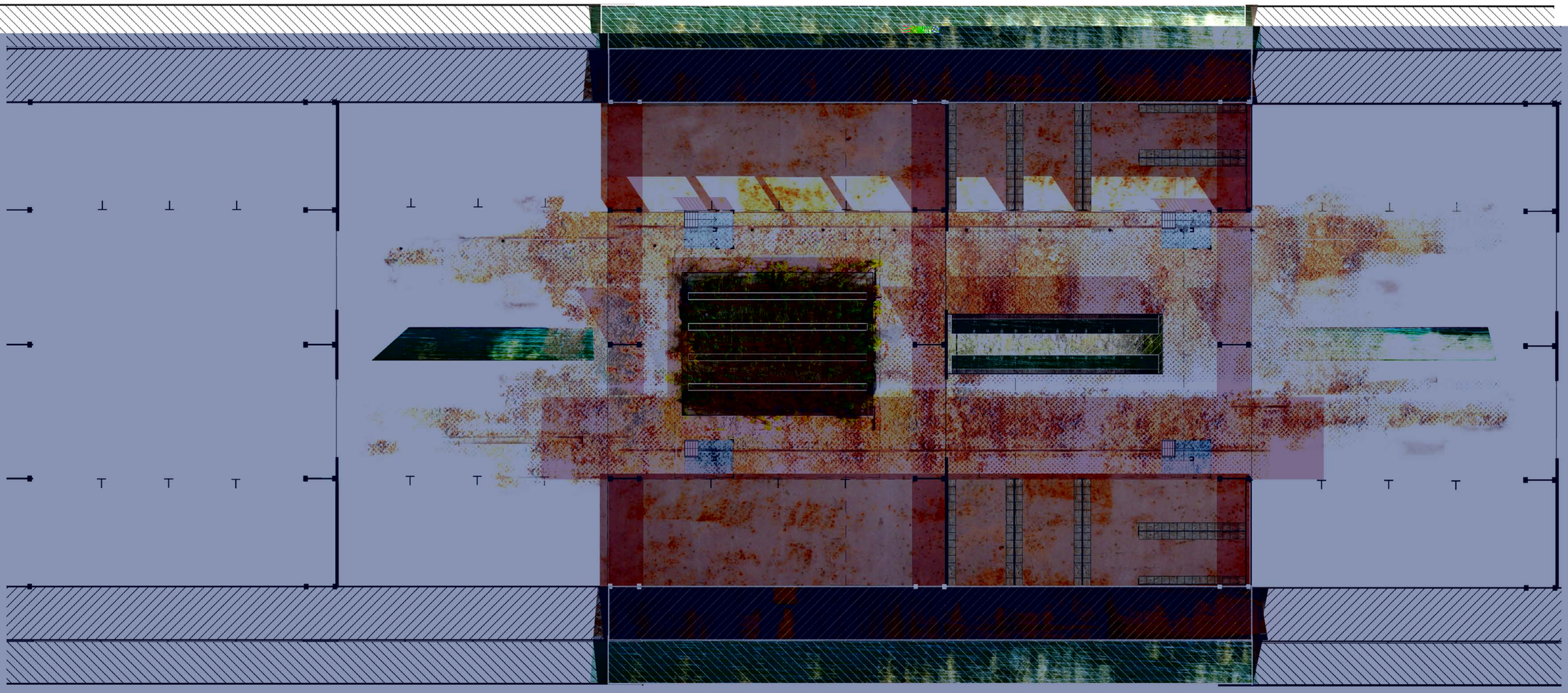
SCALE
1:100

Fig. 4.28 Longitudinal light well section 2

SCALE
1:150

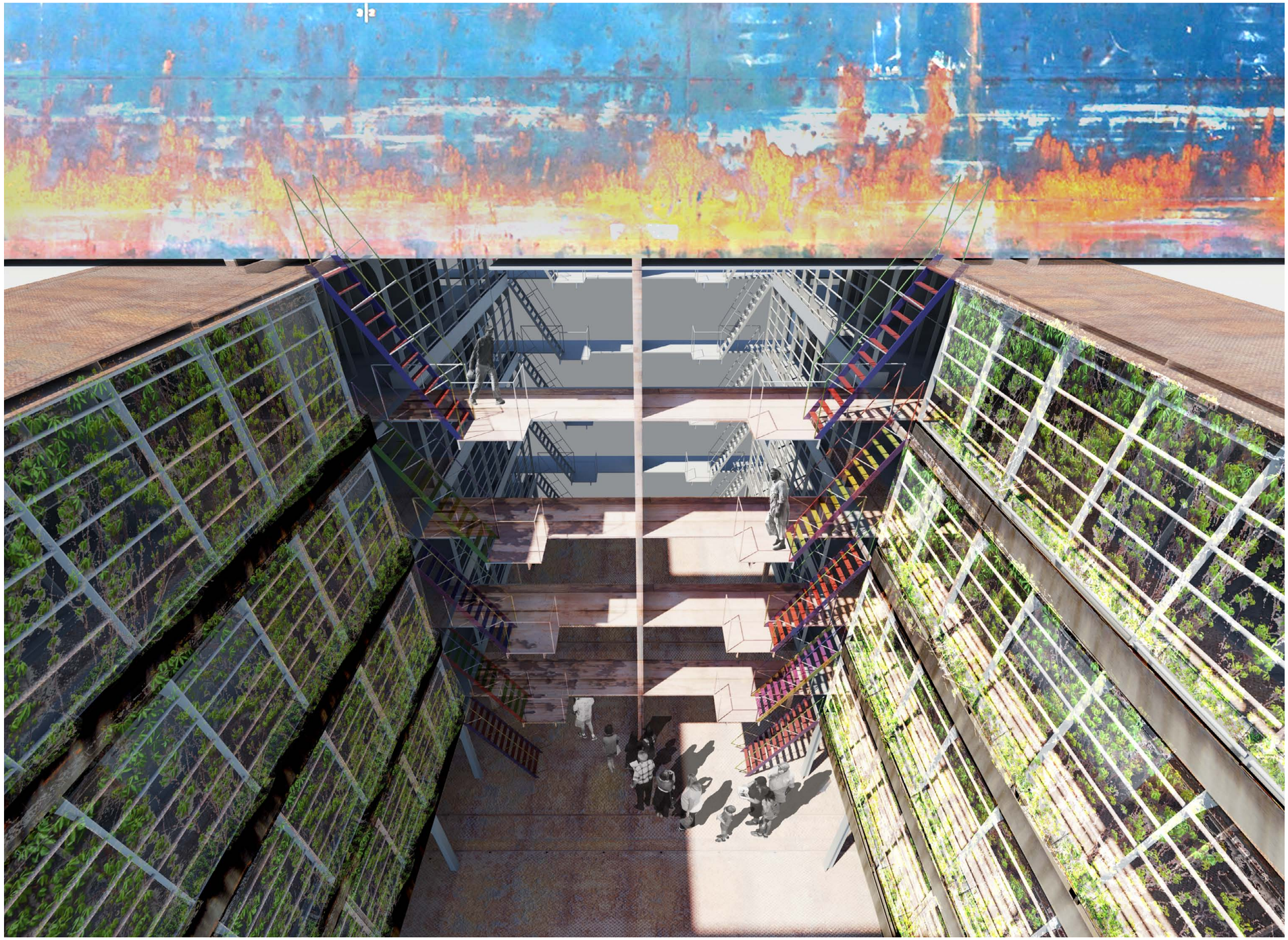
3

Fig. 4.29 7th deck floor plan



④

Fig. 4.30 Light well perspective



5

Fig. 4.31 Walkways perspective.

name : ABUL KASEM
age : 17
job : CUTTER HELPER
time on yard : 9 MONTHS
reason for working : TO SUPPORT HIS MOTHER AND FAMILY AT HOME IN NORTHERN BANGLADESH.
reason for working in shipbreaking : "BECAUSE MY FATHER AND UNCLE WORK HERE AND BECAUSE OF HOW DANGEROUS THE JOB IS I CAN EARN MORE THAN I WOULD IN MY HOME TOWN".

ABUL KASEM'S TYPICAL DAY

0530

SUNRISE
WAKE UP
PRAY
PREPARE BREAKFAST

0700

START WORK

1000

20MIN TEA BREAK
PRAY

1200

1H LUNCH BREAK
RETURN TO ROOM
PREPARE LUNCH
PRAY

1700

20MIN TEA BREAK
PRAY

2000

FINISH WORK

2030

BATH AND CLEAN
STORE GEAR
RETURN TO ROOM

2100

PREPARE DINNER
SOCIALISE/ RELAX
PRAY

2200

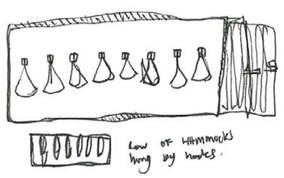
SLEEP

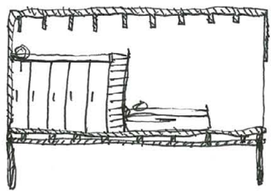
4.05

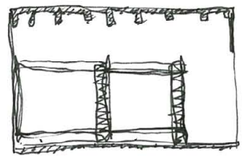
INTERIOR - CABINS

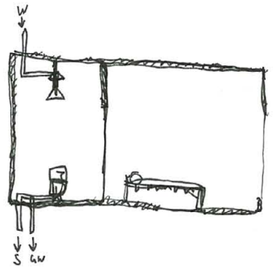
One of the main factors that influenced the design and layout of the more private living spaces (cabins) was the social dynamic of the family group on the site. Younger male family members, such as sons or nephews, would often follow their relatives into shipbreaking work once they reach a suitable age. Due to this, family members and groups of friends come together as a way of making life easier by pooling their resources for tasks such as cooking. As such, it is appropriate to design a living space where these groups can live together and help facilitate their communal actions. This is, in part, accomplished by leaving aspects of each cabin, such as the facade, to be self built by the inhabitants.

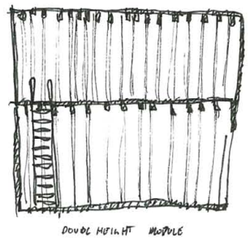
Another factor that has had major implications on the design is the fact that women do not live or work on site. In many cases the workers have had to travel great distances to the site; they send their earnings home to their wives and families. Due to this, the traditional/cultural separation of female and male spaces has been affected. It is unnecessary to include these spaces as they will not be used.

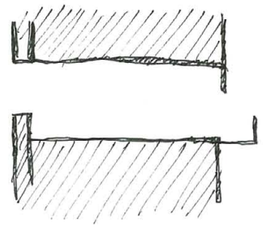


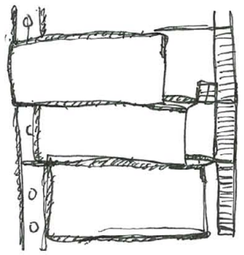


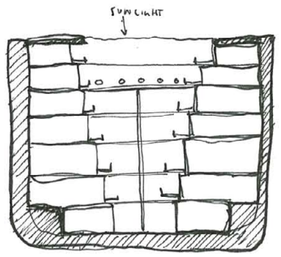


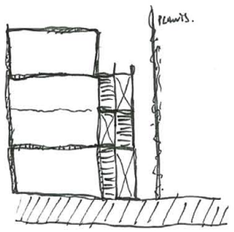


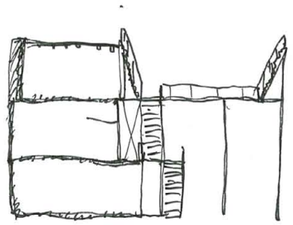


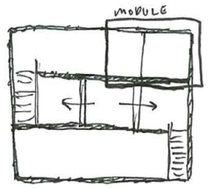


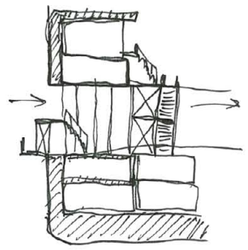












To help facilitate ventilation a number of cabins pierce through the hull and form an exterior balcony. The cabins that do not have this balcony have an equivalent space in front of the neighbouring cabin. The cabins are situated around two centralised communal spaces on the 4th and 7th decks to which shared bathrooms are connected.

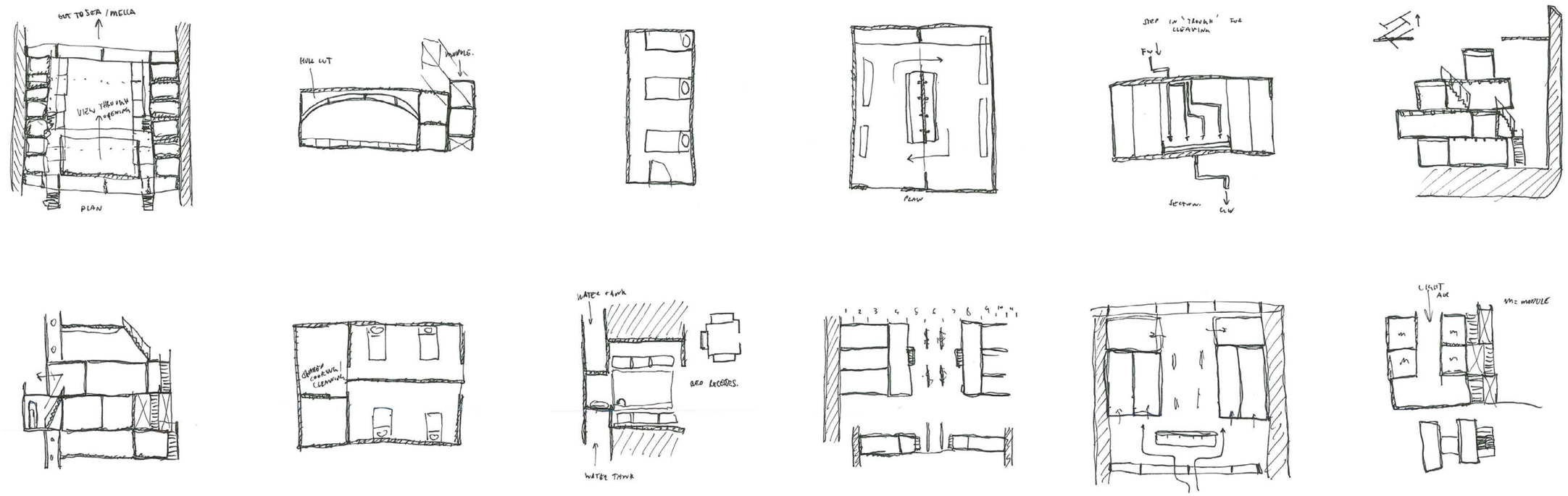


Fig. 4.32 Concept sketches of cabins

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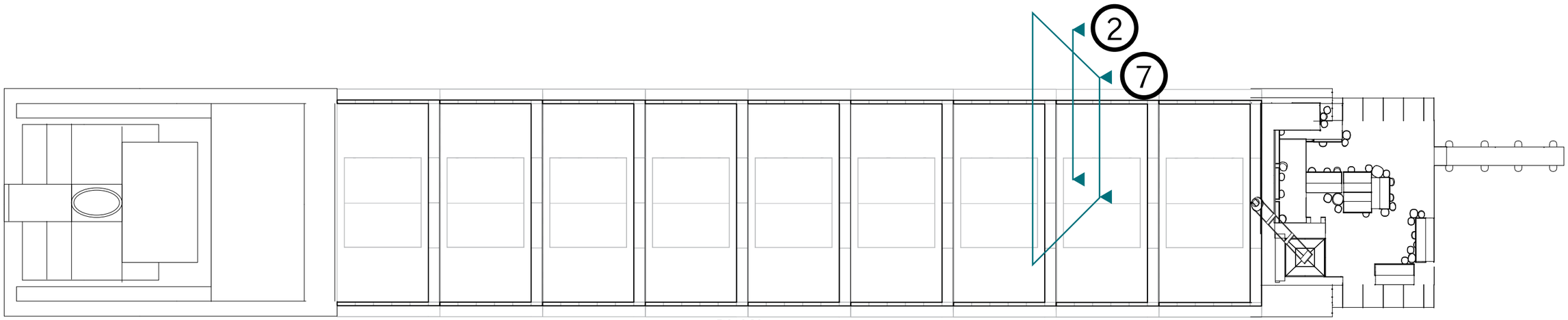
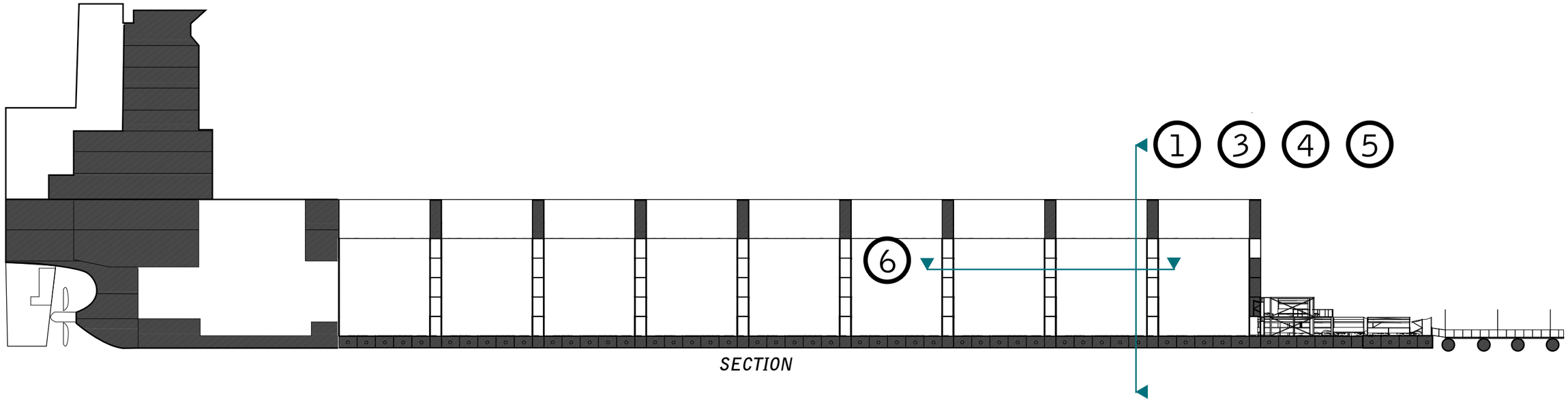
KEY PLAN / SECTION OF CABIN EXPERIMENTS



PLAN



SECTION

1. TRANSVERSE SECTION - CABIN LAYOUT EXPERIMENT (pg. 87)
2. CABIN EXPERIMENT (pg. 88)
3. CABIN RELATIONSHIPS EXPERIMENT - UPPER DECKS (pg. 89)
4. CABIN RELATIONSHIPS EXPERIMENT - LOWER DECKS (pg. 90)
5. TRANSVERSE SECTION - CABIN RELATIONSHIPS (pg. 91)
6. 4th DECK PLAN (pg. 92)
7. CABIN SECTION PERSPECTIVE (pg. 93)

1

SCALE
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Fig. 4.33 Transverse section - Cabin layout experiment

②

Fig. 4.34 Cabin experiment

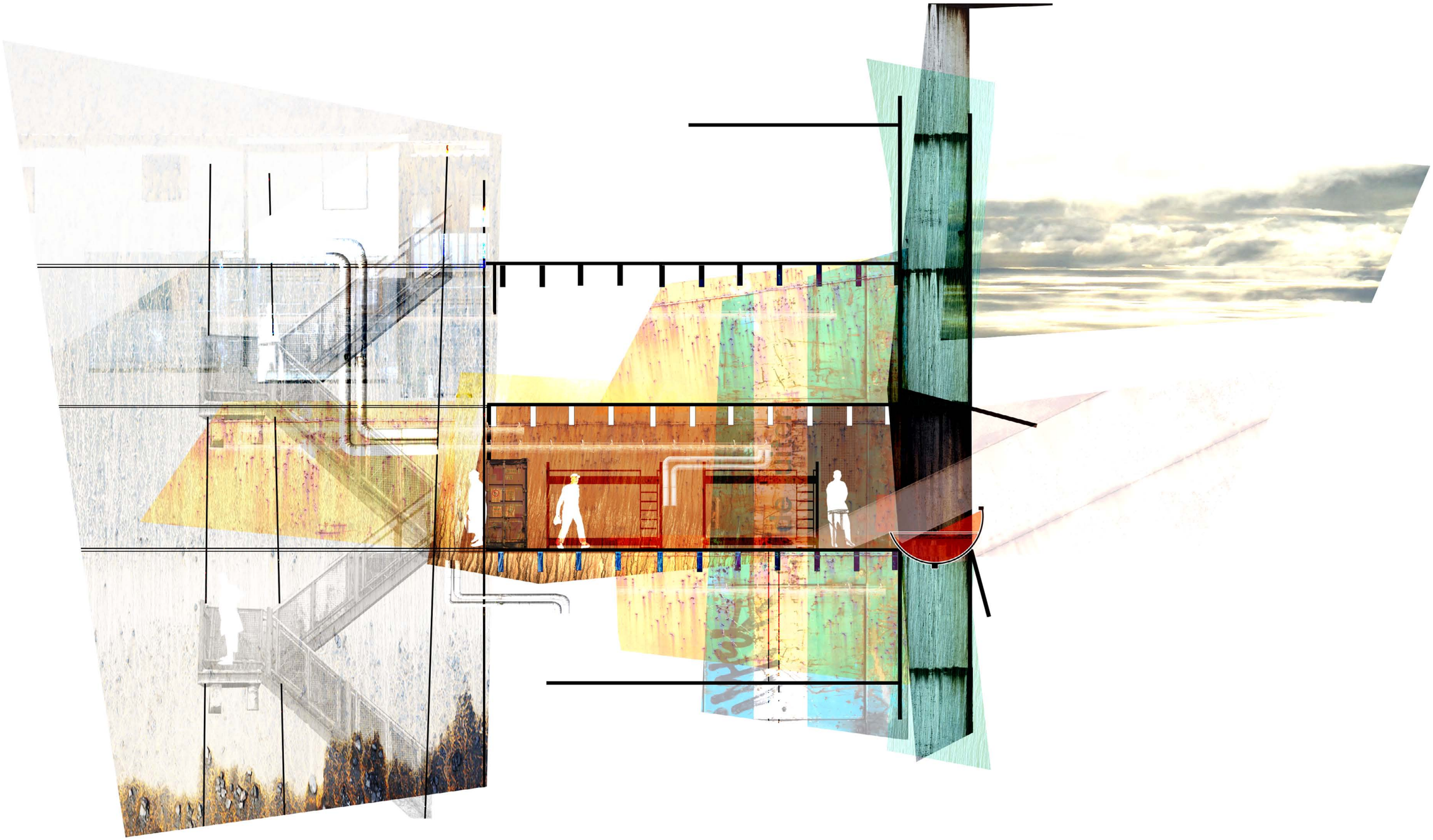

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Fig. 4.35 Cabin relationships experiment - Upper decks

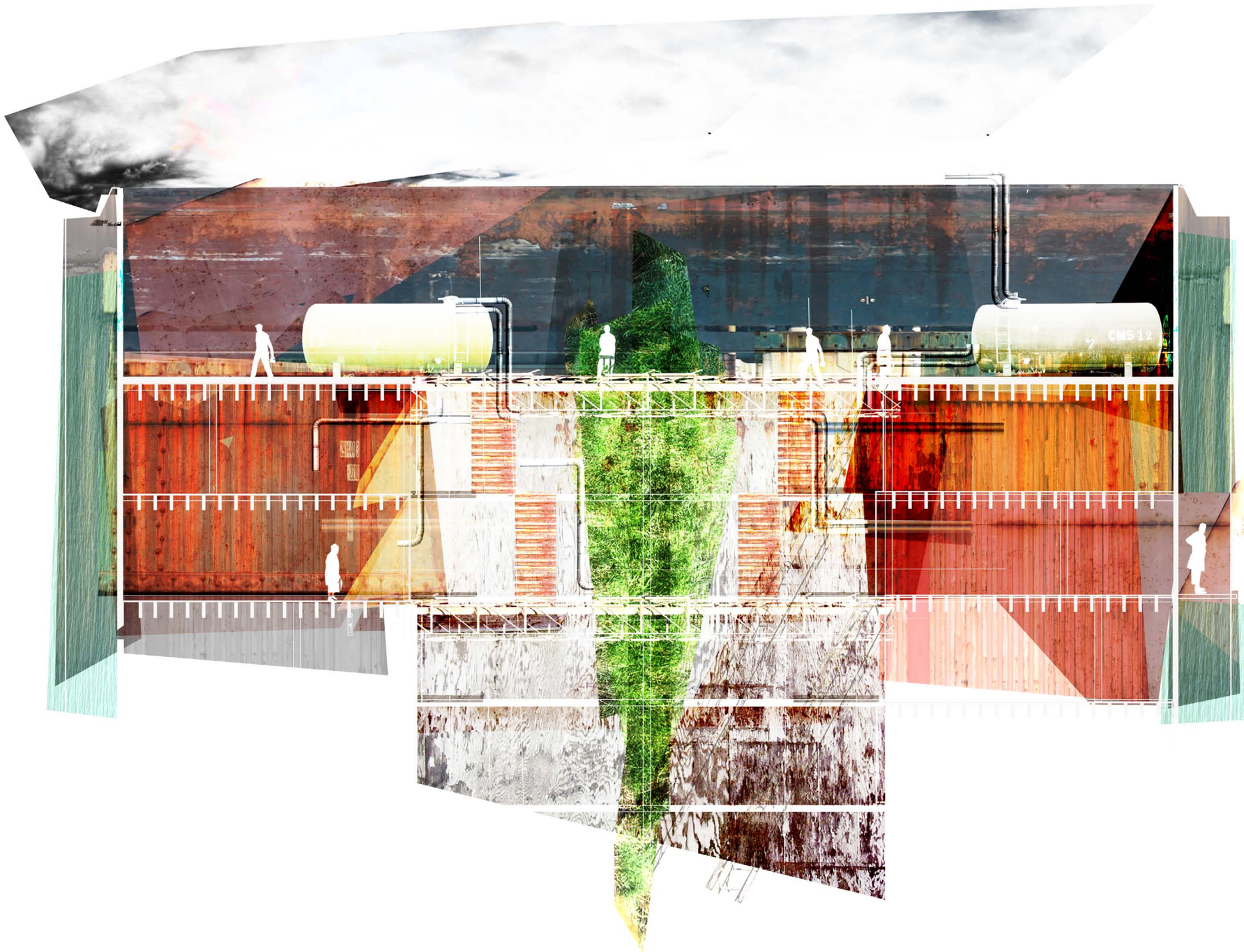

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Fig. 4.36 Cabin relationships experiment - Lower decks.

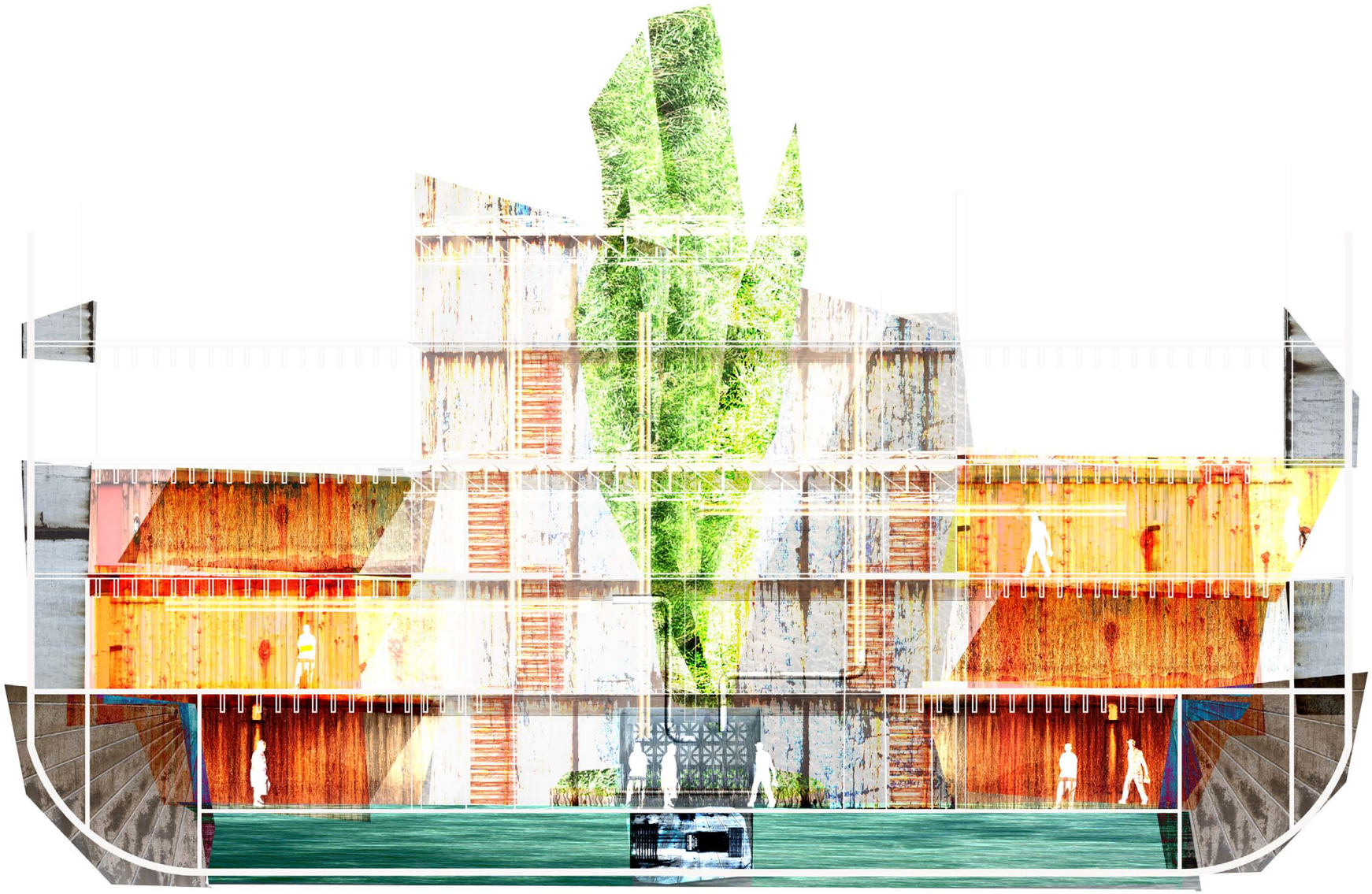

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Fig. 4.37 Transverse section - Cabin relationships

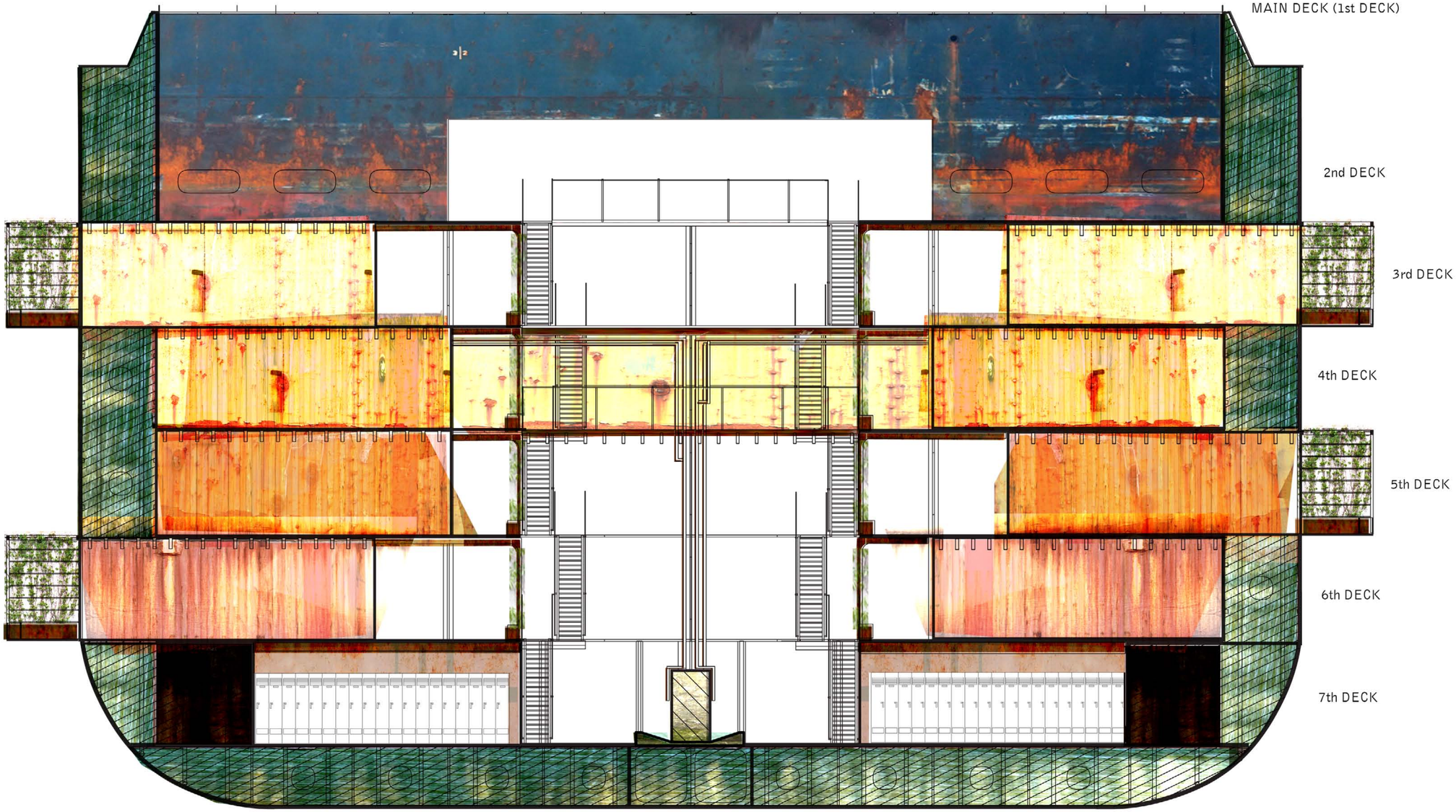

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Fig. 4.38 4th deck plan

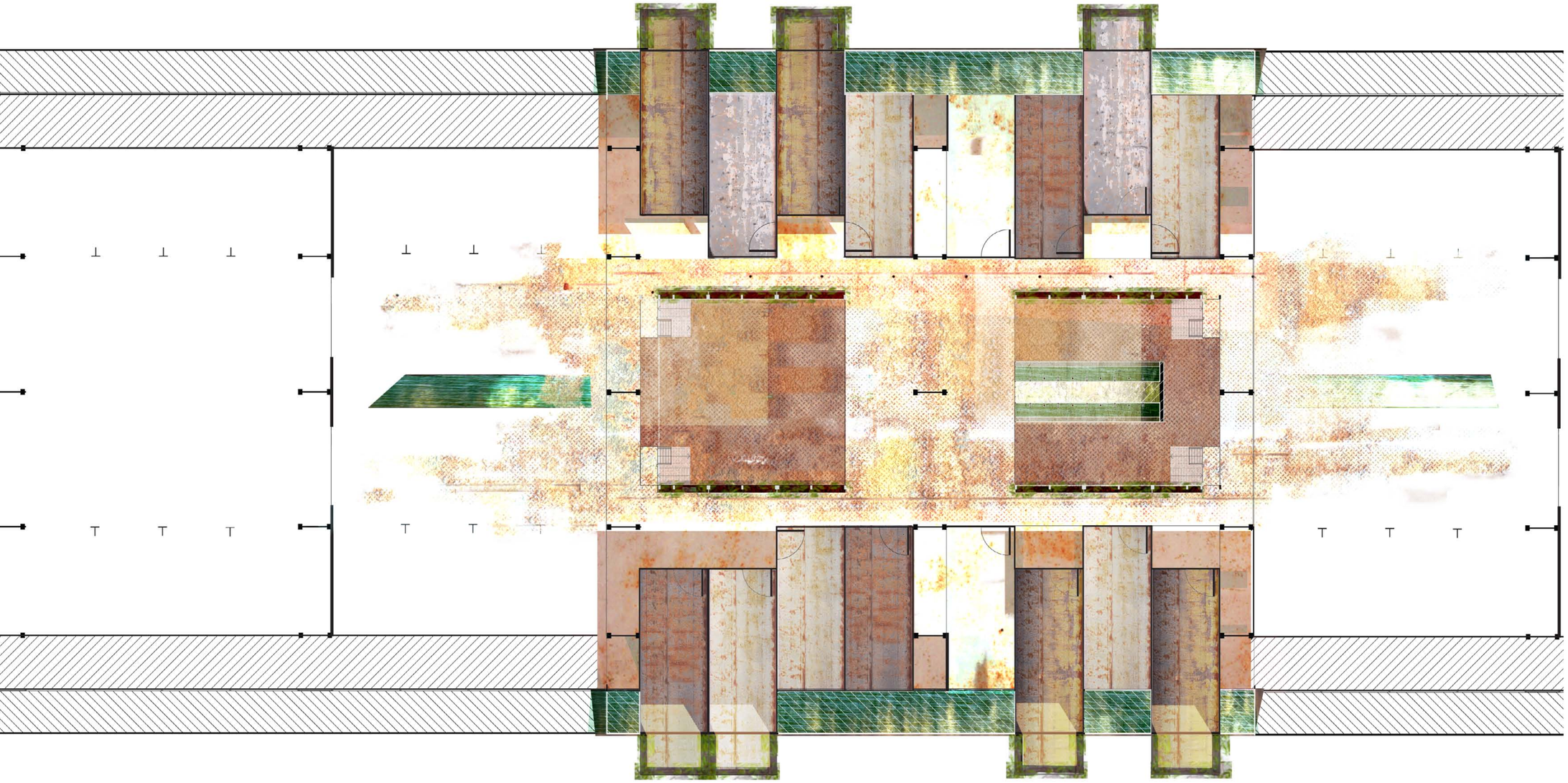

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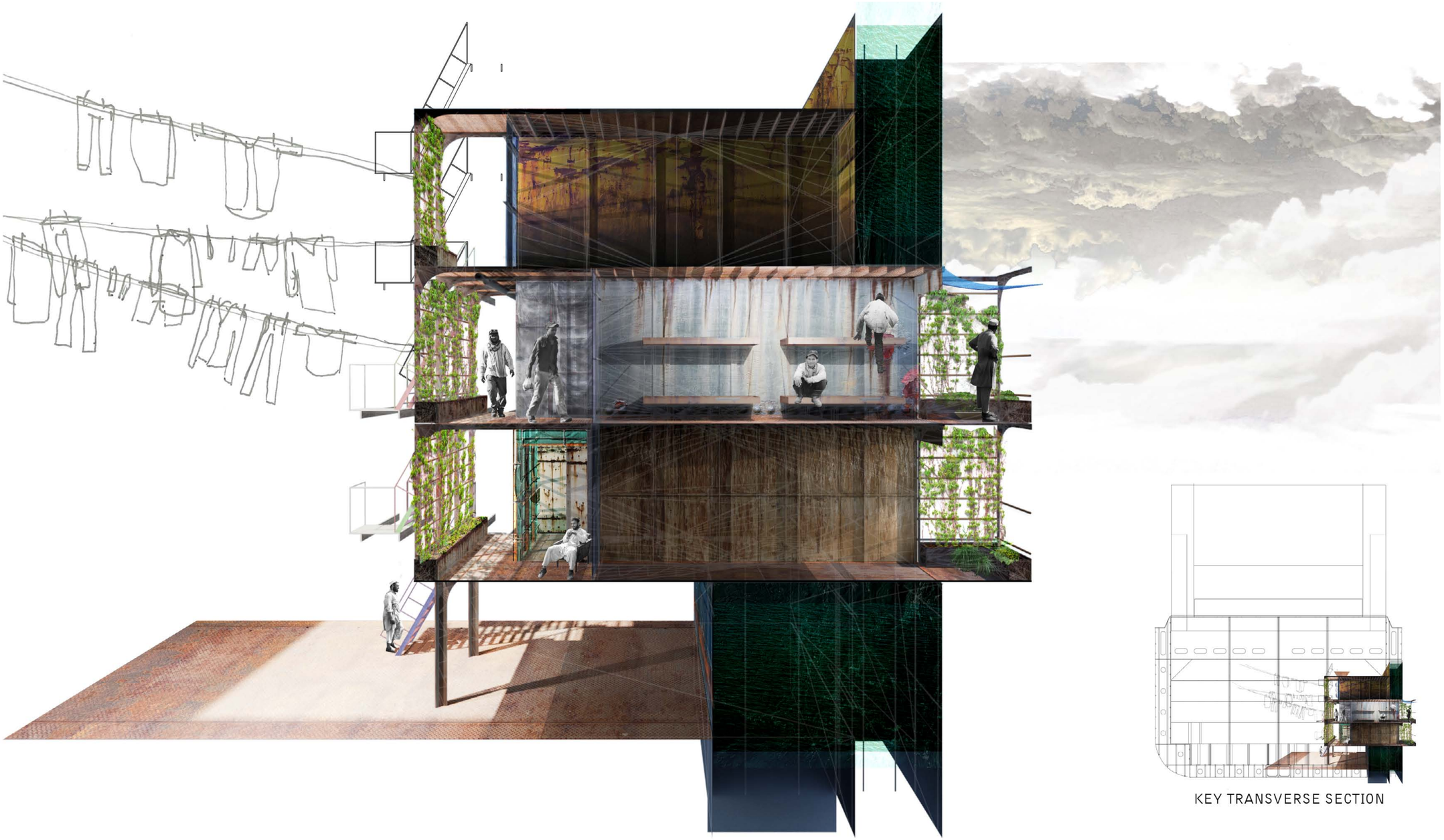
Fig. 4.39 Cabin section perspective.



KEY TRANSVERSE SECTION

4.06
CONCLUSION

Through the development of this particular iteration of the design it has become clear that the atmospheric and aesthetic qualities of the space do not reflect the idea of the sanctum/ sanctuary that is trying to be created. These qualities created an oppressive atmosphere where the light well space could aptly be described as 'prisonesque'. This is an issue since the interior of the ship needs to act as an escape from the hostility of the shipbreaking yard. This was caused by the stacking, steel and linearity of the vine balustrades when assembled within the light well space.

Although the vine balustrade has been causing problems it did succeed at addressing a number of challenges. It acted as a way to disrupt the harshness of the steel due to its organic form and natural colouration as well as providing a screen that would diffuse direct sunlight and help to moderate any breeze.

The rigidity and grid-like structure of the ship is disrupted by the individuality that self-construction brings and is also found in the chaos of construction with reconstituted and adapted parts.

Moving forward, reorienting the entire space to make better use of the sun will aid food production and eliminate darker, shadowed areas. This could be achieved by opening up the starboard (south) side of the ship. This allows for a less obstructed view of the coast away from the majority of shipbreaking yards as well as better orientation for natural lighting.

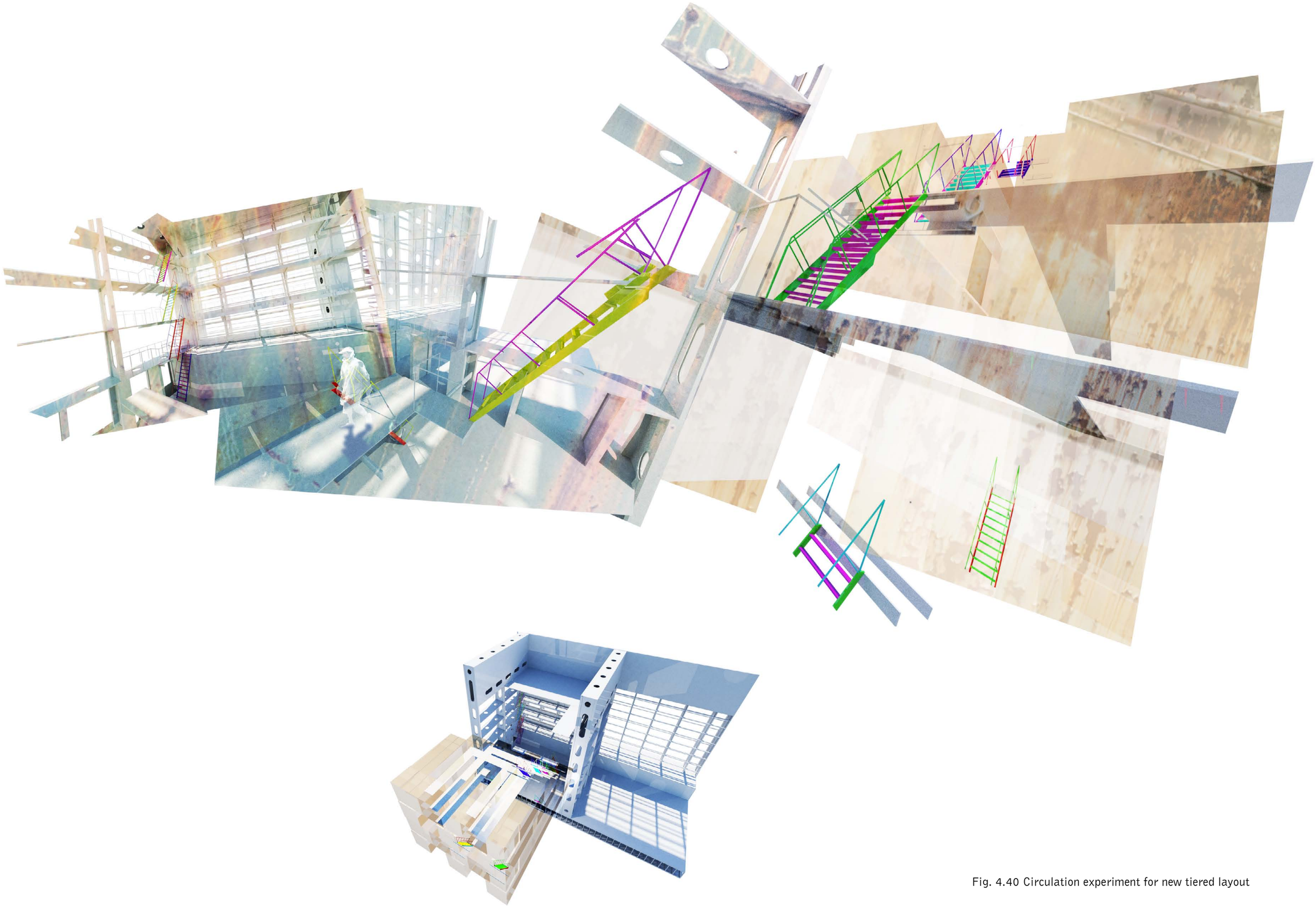


Fig. 4.40 Circulation experiment for new tiered layout

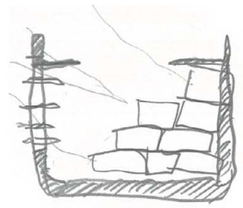
CHAPTER 5.00

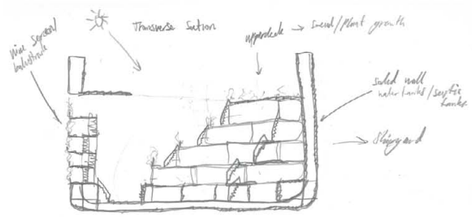
FURTHER DEVELOPMENT

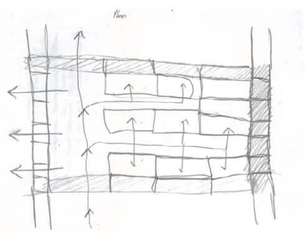
5.01
INTRODUCTION

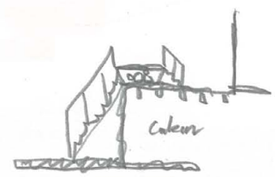
This chapter investigates the further development of the cargo ships interior with an explanation of what has been explored. This chapter is also tied to Chapter 6.00: CONCLUSION, where the implications of the design are critically analysed.

Following the results of the last experiment more emphasis is being placed on the idea of the sanctum. A reorientation of the space has occurred to better suit the environment and to better protect the occupants from psychologically dangers of the shipbreaking yard. One of the main challenges that is considered in this chapter is the resolution of the contradictions between the treatment of the ship as a sanctum and the shipbreaking process that they are being protected from. Through the transformative power of adaptive reuse a solution can be explored.









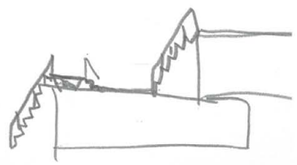


Fig. 5.01 Transverse section collage exploring a new layout

5.02
CABINS 2.0

Improving the layout of the cabin units to better enable the function of the new interior as a sanctum means reorienting the views from within the ship southward and away from the shipbreaking yard while opening up the southern side of the hull (Fig. 5.02). This gives occupants an unrestricted view of the coast past the edge of the yard. In addition to this the main deck has been lowered and can be used as an enclosed rooftop garden area that serves a dual purpose of facilitating self-sufficiency and acts as a heat sink. The open southerly facing hull and light well let in more natural light while still allowing for trellis and vine plants to grow vertically.

The cabins themselves are arranged in terraced blocks that create a number of balconies. They are spaced apart so that light can penetrate to the lowest levels of the ship. The balconies allow for more personal, semi-outdoor space. The units themselves are designed based off of the module of the shipping container, this is because the existing structure of the ship is already setup to support containers. Each standard unit is intended to hold four occupants with space for storage and a small space for cooking. Like the rest of the intervention, these components are also recycled from other ships. This gives the occupant an opportunity to craft and build their own space so that it will be personalised and foster a sense of ownership.

Fig. 5.02 Views from the ship point away from the shipbreaking yard

SCALE
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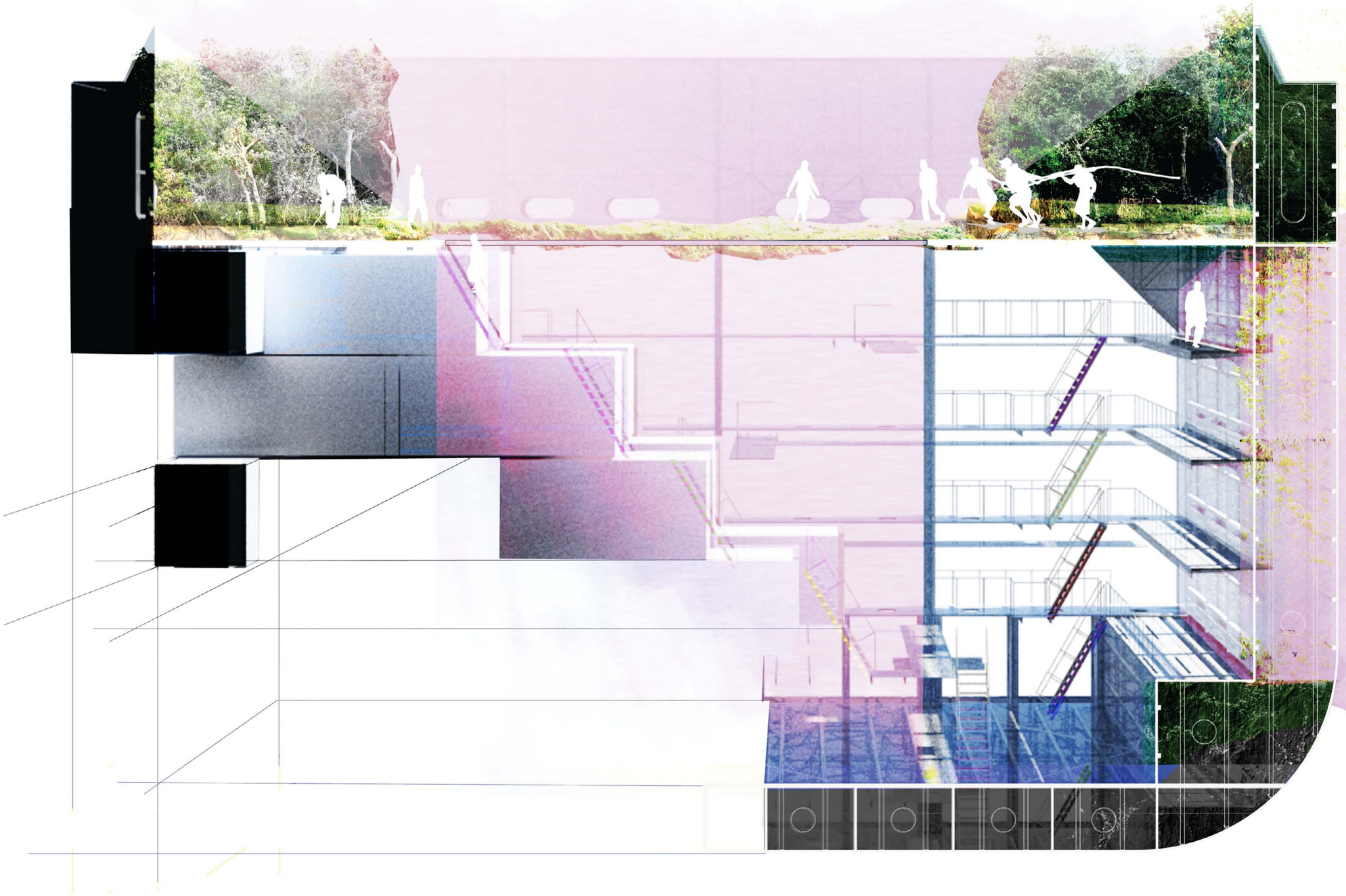
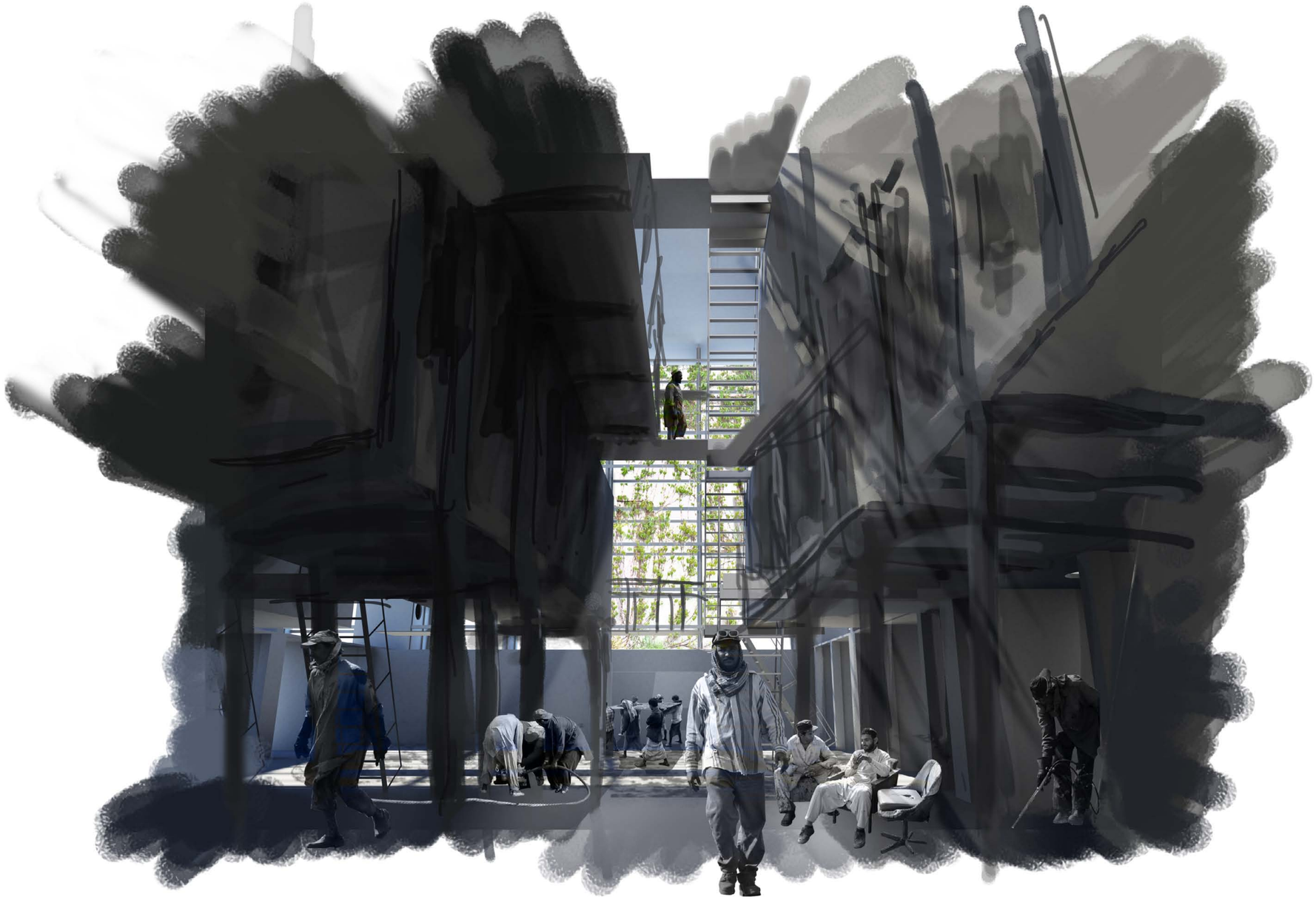
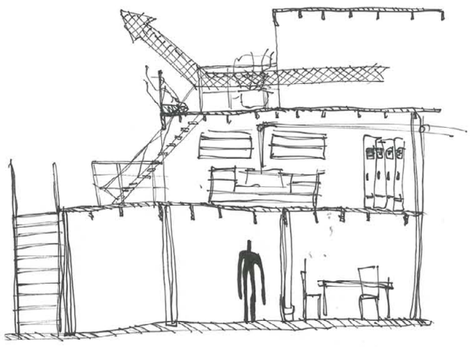


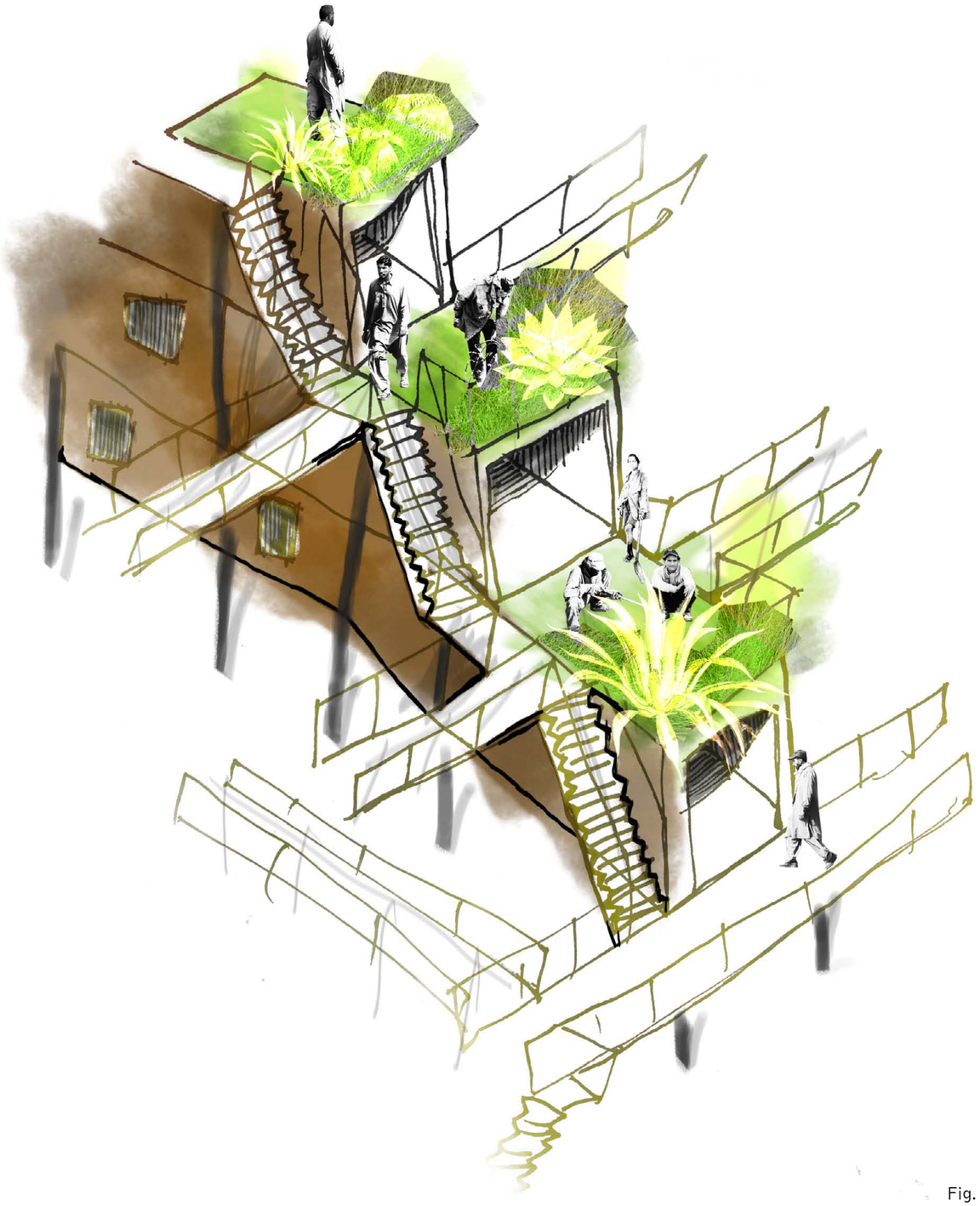
Fig. 5.03 Communal spaces and natural lighting - transverse section view.



TRANSVERSE SECTION

Fig. 5.04 Digital painting of common space.





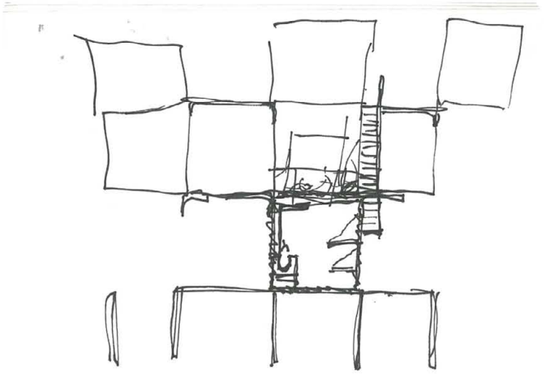


Fig. 5.05 AxonometricdDrawing of tiered cabins.

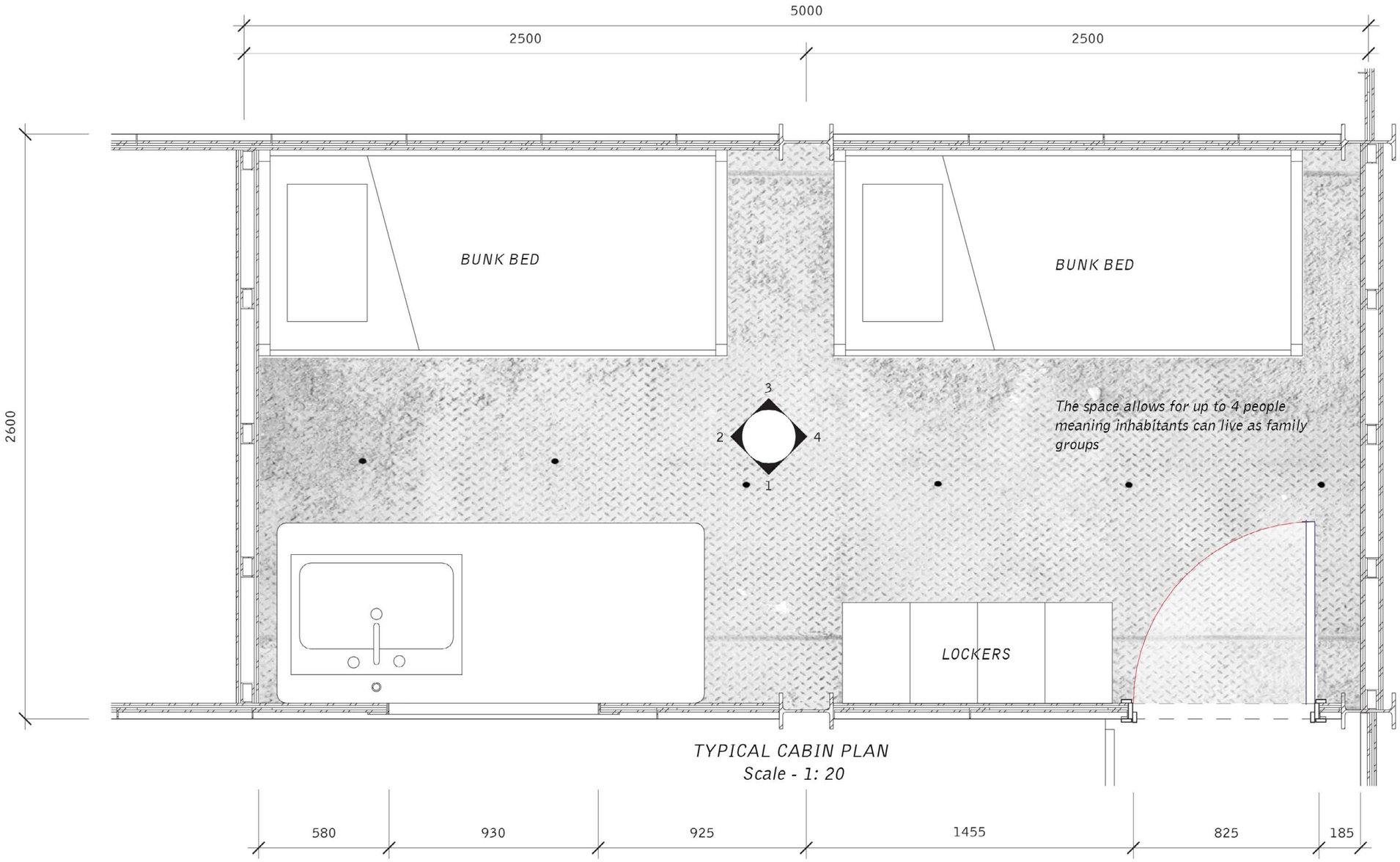
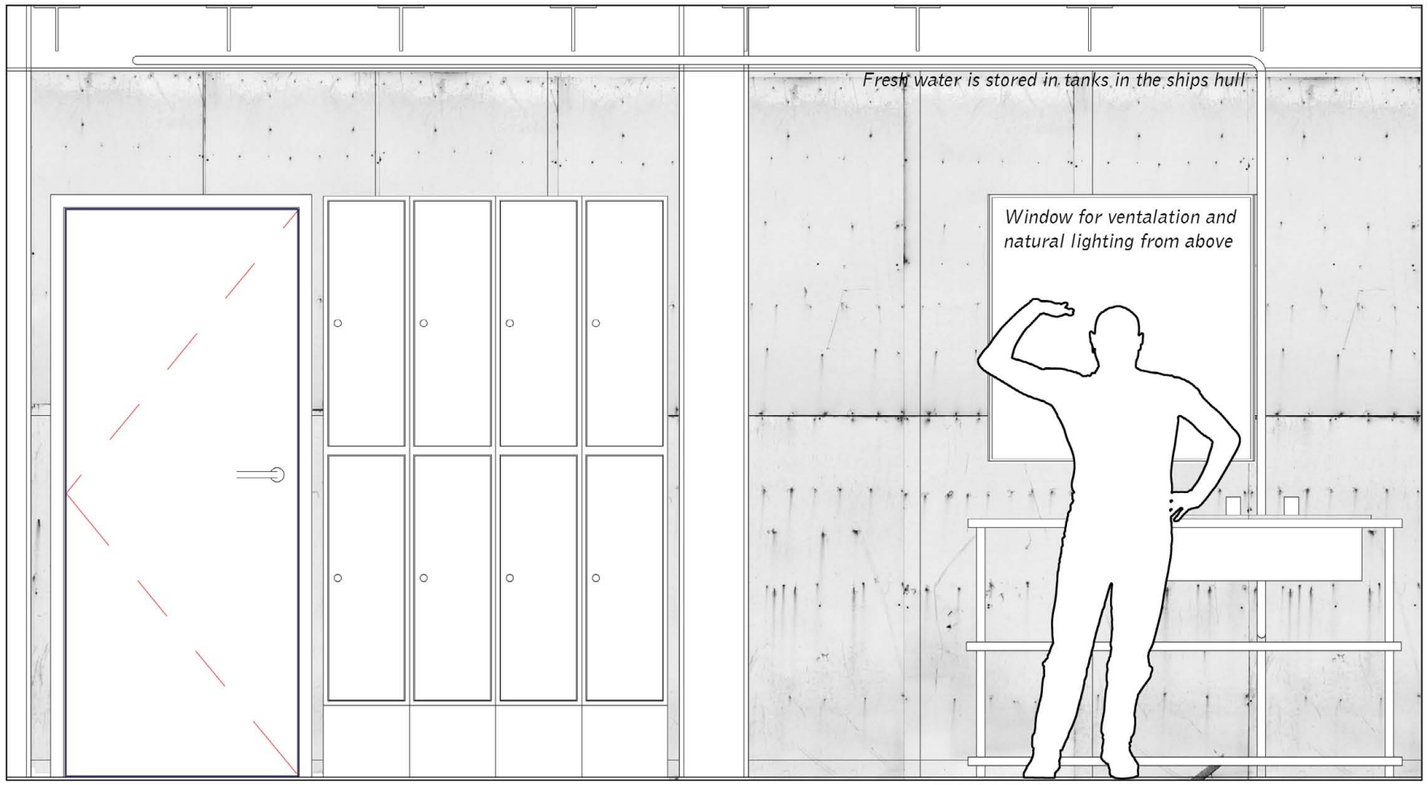
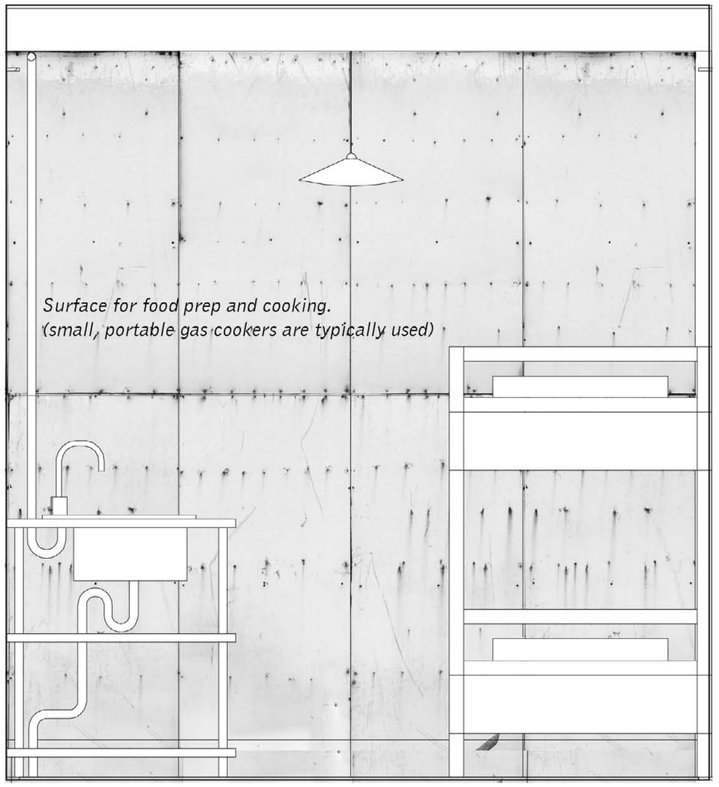


Fig. 5.06 Floor plan of a possible cabin layout.



ELEVATION 1



ELEVATION 2

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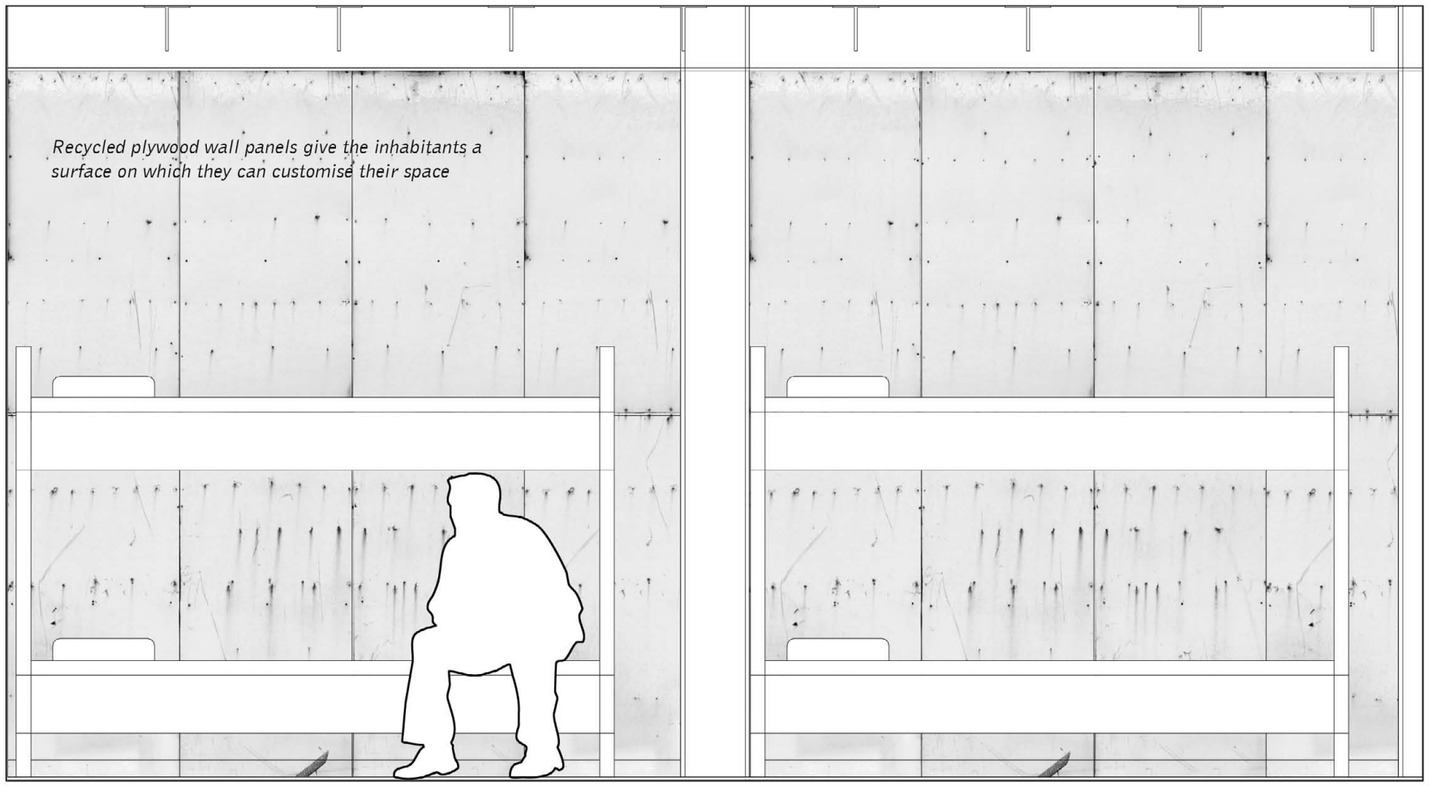
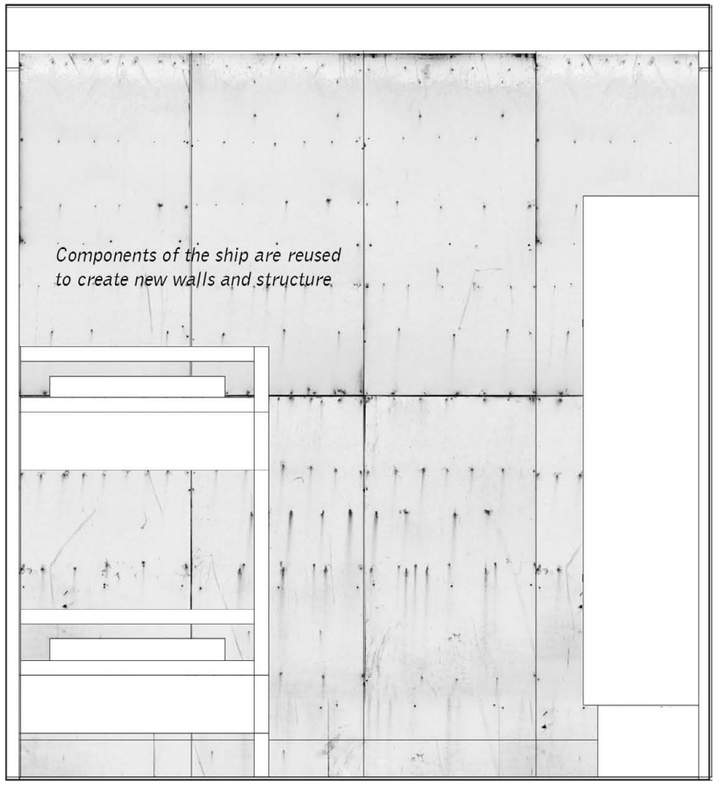


ELEVATION 3



ELEVATION 4

Fig. 5.07 interior elevations of a possible cabin.

5.03
NEW COMMON SPACES

In addition to the common spaces that share the same holds as the cabins, the first hold as the ship is entered is dedicated entirely too communal space. This hold is occupied by a cleansing/ storage area and a space for communal prayer. In a similar way to the previous experiment, this communal space is privileged over the others. It has its own self-contained ablution area and has a double height ceiling that denotes its importance. The cleansing area is where occupants can clean off the majority of filth they accumulate over the day and store their gear. It also has a symbolic function in signalling the beginning of the sanctum. Through the act of washing the worker removes the influence of the yard before they move into a place of safety.

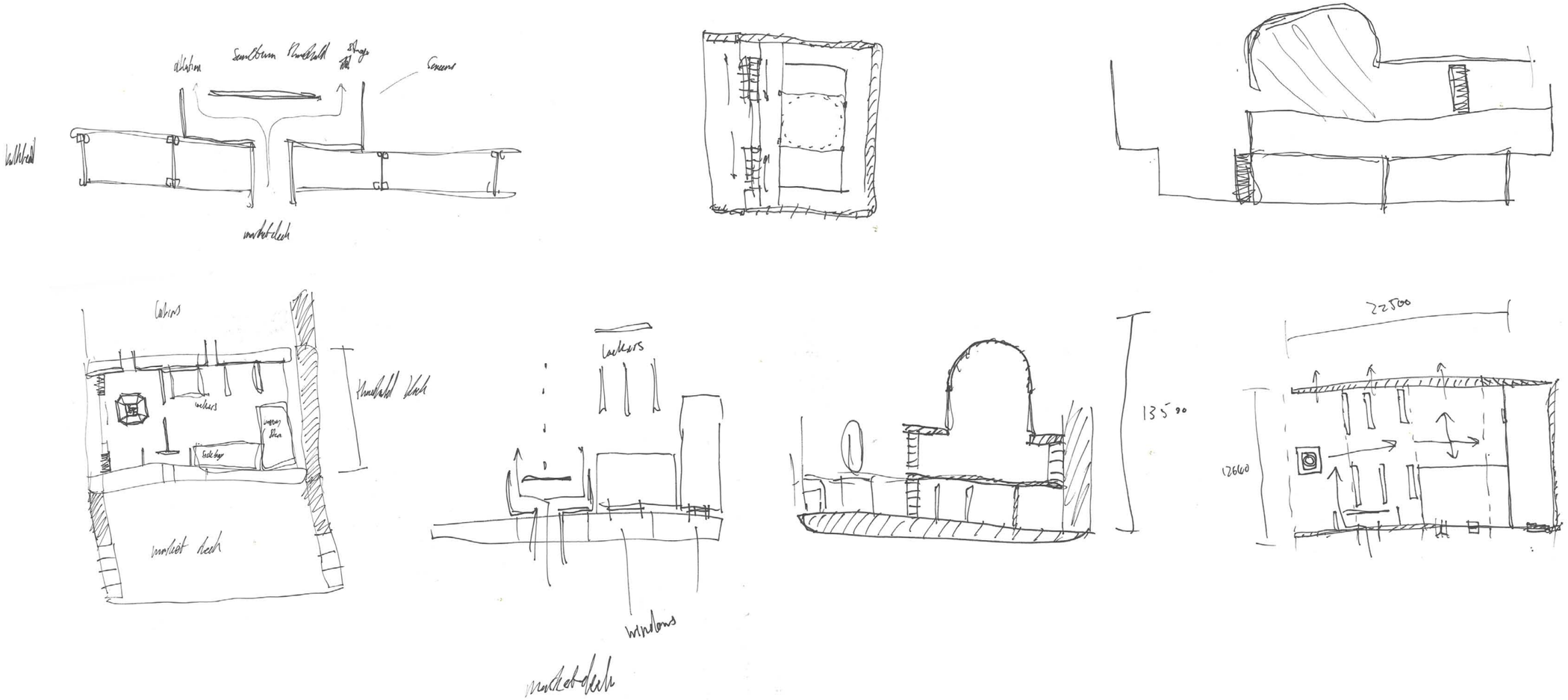


Fig. 5.08 Common space exploratory sketches.

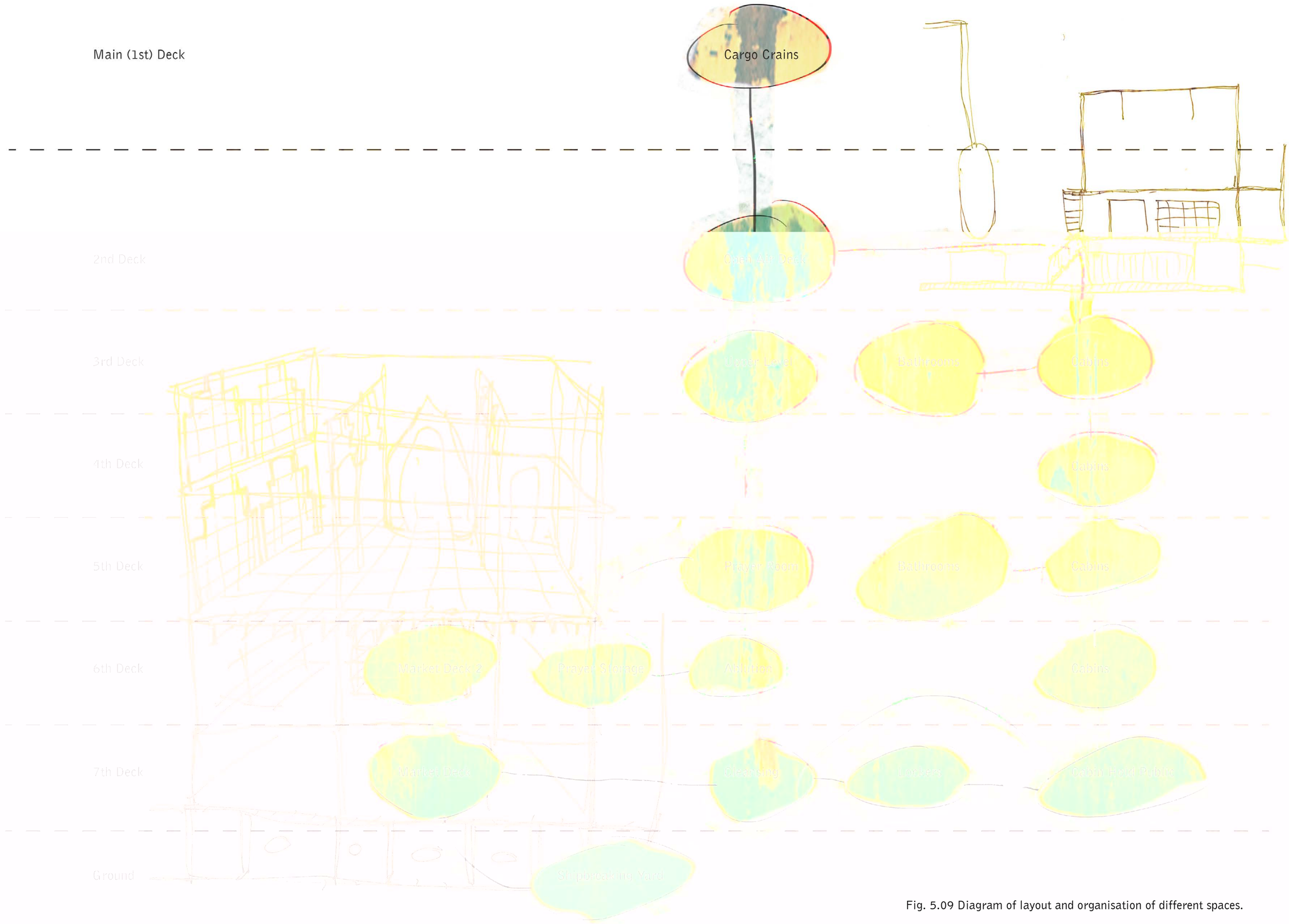


Fig. 5.09 Diagram of layout and organisation of different spaces.

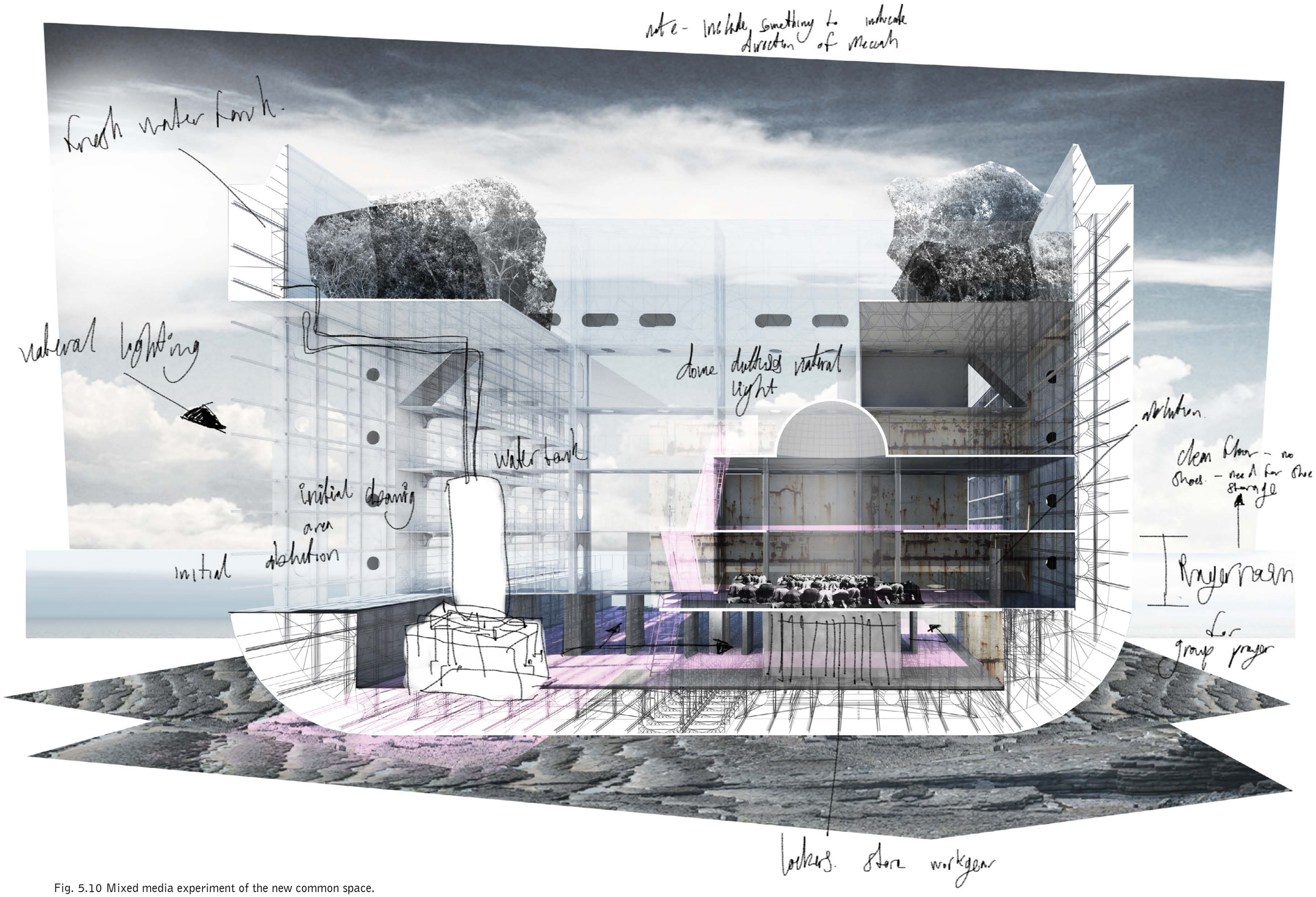


Fig. 5.10 Mixed media experiment of the new common space.

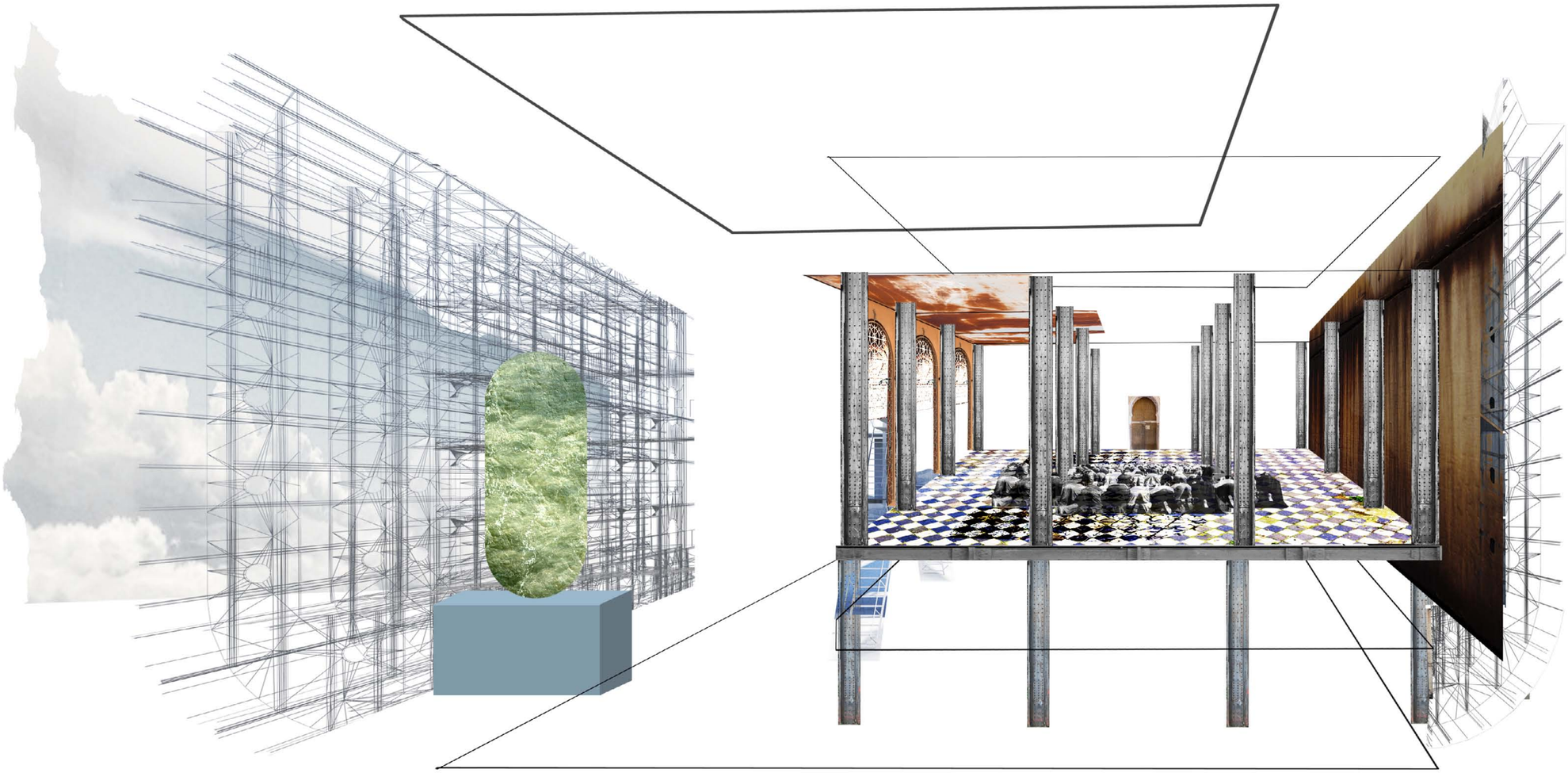


Fig. 5.11 Collage developing common space.

SCALE
1:100

Fig. 5.12 Transverse section of common areas in the initial hold space.

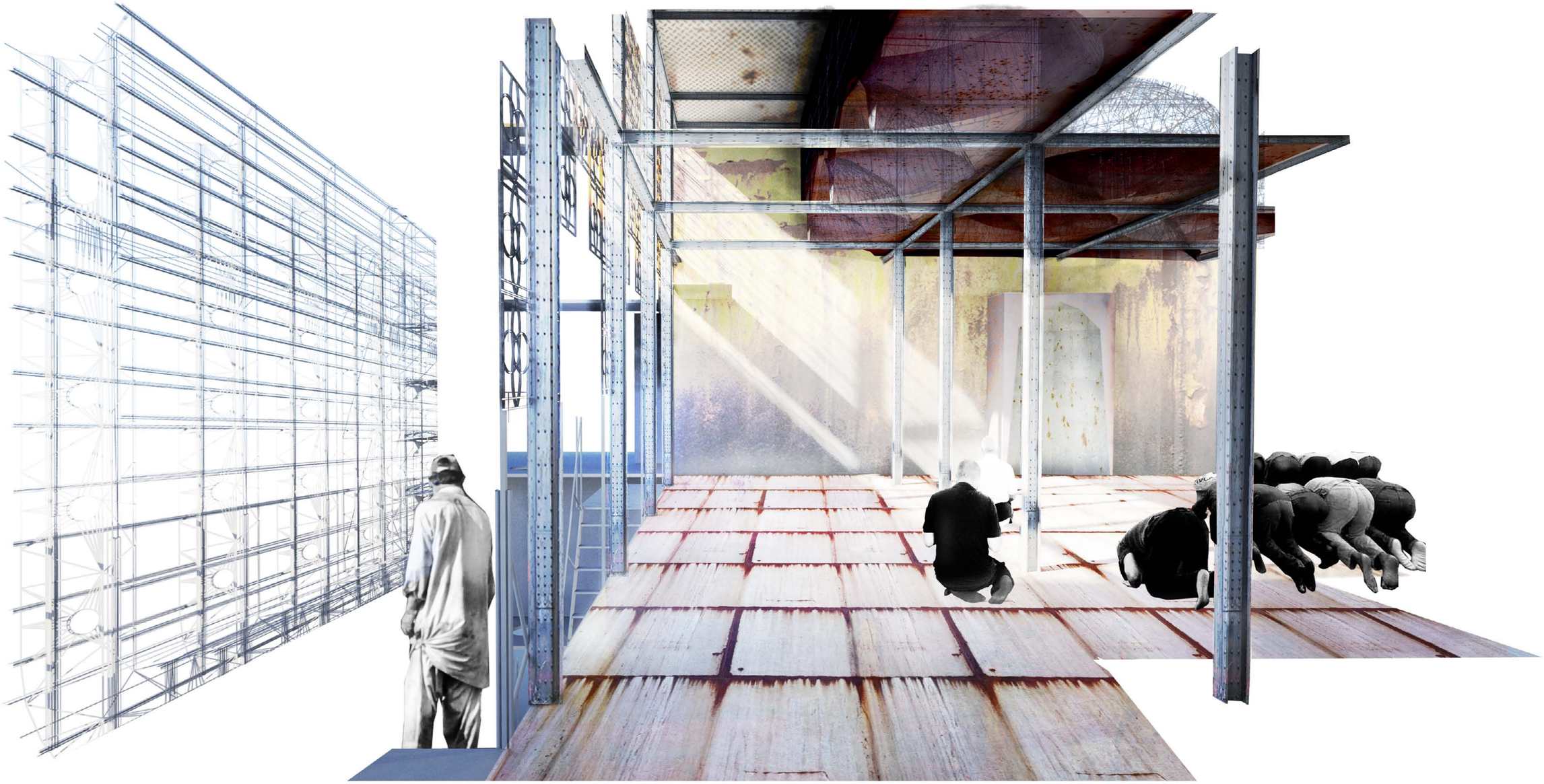


Fig. 5.13 Perspective of prayer room.

5.03

A RESOLVED EXPERIMENT

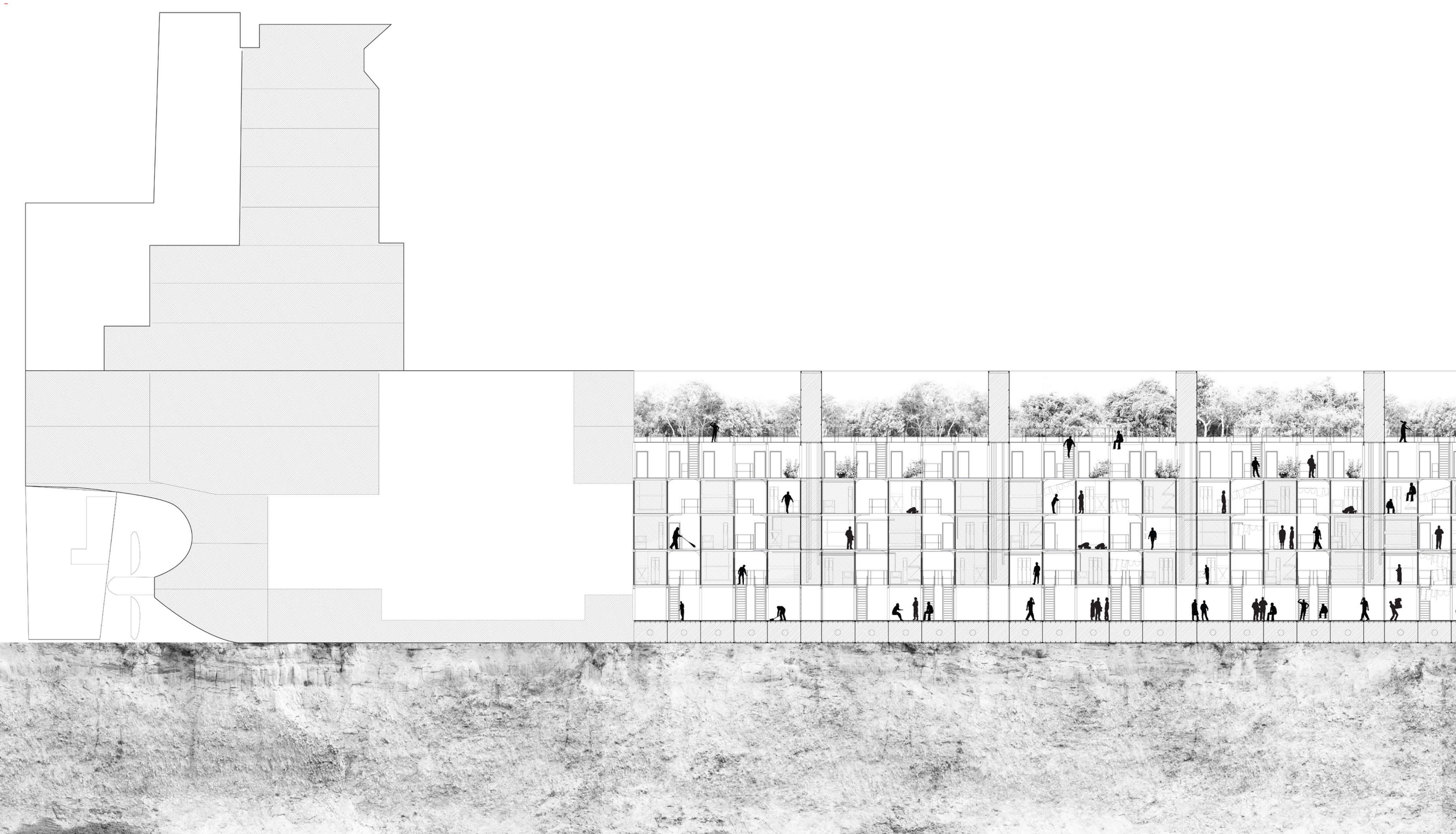
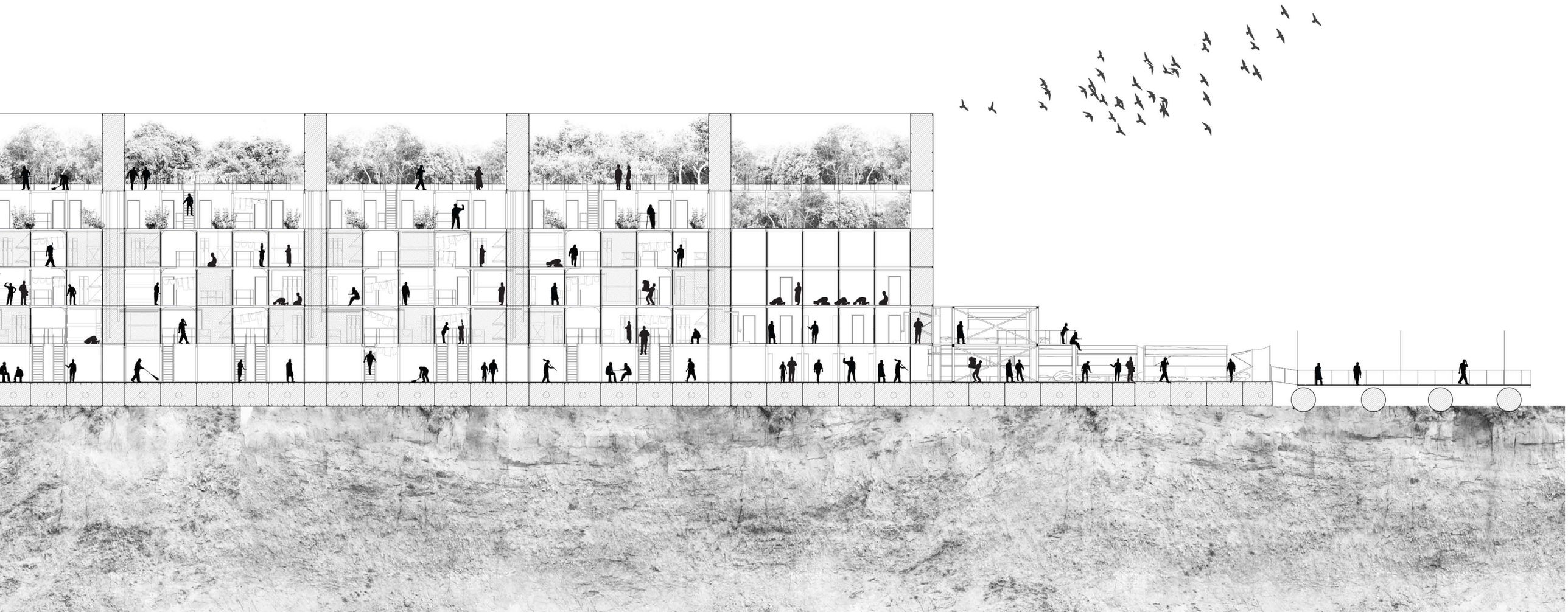
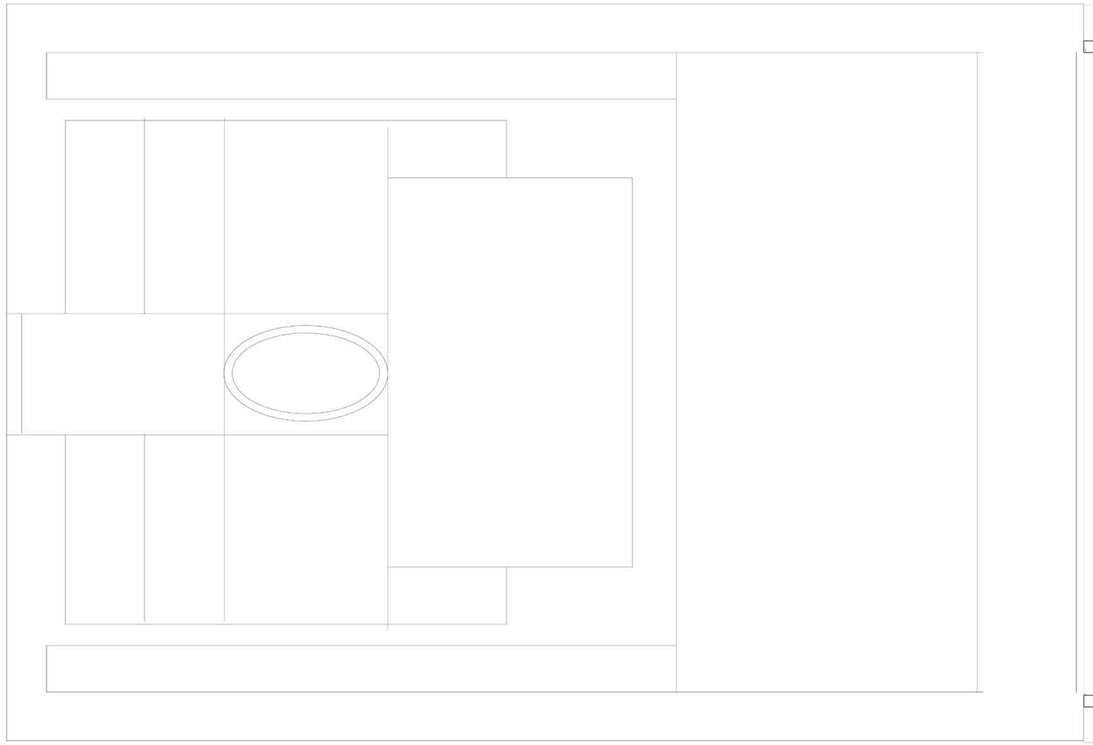


Fig. 5.14 Longitudinal section of the ship while inhabited.

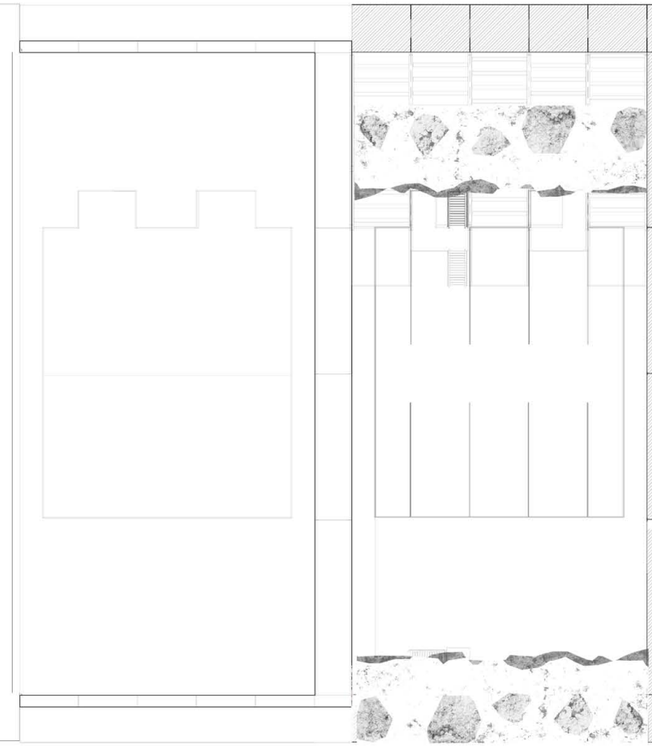
SCALE
1:250



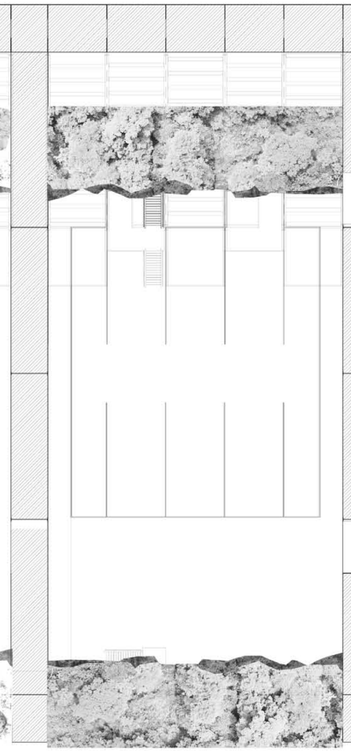
1st DECK (MAIN DECK) PLAN



2nd DECK PLAN



2nd DECK PLAN



3rd DECK PLAN

SCALE
1:250

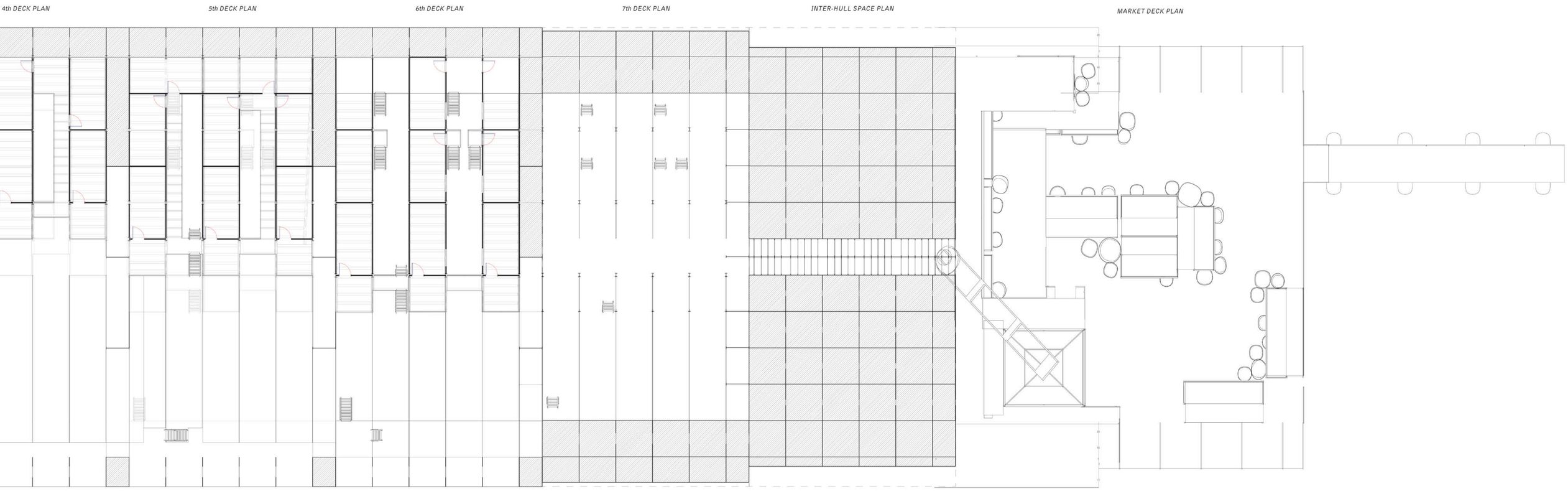


Fig. 5.15 Composite floor plan of the length of the ship.

Cabins are enveloped by the tanks that occupy the space between the double skins of the hull forming a shield from the danger of the yard. Light filters down to the deck through translucent wall of vines creating dappled spotlights around which the workers relax and eat after a day of work.

Fig. 5.16 Transverse section perspective of tiered cabins.

Reconstituted columns and beams are cut from bracing and stiffening members of other ships. These form a latticework that is covered with recycled timber and steel sheets to create new walls and floors. Diffused light reaches here during the day, at night this space is lit artificially, powered by diesel generators retained in the ships engine room. As people pass through here on their way to work, or their cabins, they have the opportunity to socialise with their peers.

Fig. 5.17 Perspective view of the 7th deck common space looking south.

The workers that live together are able to support one another by lessening the difficulties of life at the shipbreaking yard through cohabitation. An example of this would be rostered cooking rather than having to cook individually each day. Integration of produce to promote self-sufficiency also doubles as a means to introduce an organic element into the hard, geometric steel of the recycled components by having plant life cascade down the front of the cabins. These cabins are partly self-built so that each one is slightly different and personalised to the occupants needs.

Fig. 5.18 Perspective view of the inside of one of the many tiered cabins.

CHAPTER 6.00

CONCLUSION

6.01
INTRODUCTION

This chapter analyses and critically reflects on the results of this research project and addresses how the research question has been answered. In addition to this, this chapter also tries to rectify some of the complications and problems that arose over the course of the design experimentation as a way of analysing what went wrong and exploring how this project could further progress.

It should be stated now that while a design solution was reached, I do not believe it is particularly successful in addressing the local context adequately. This however opens up room for discussion around ships as the subject of adaptive reuse and also the role of the designer in the informal city.

6.02
THE DESIGN

One of the key concepts that was explored through this project was that of sustainability. Sustainability in this project meant the reuse of materials, eliminating waste or adapting something to a new use. Already the purpose of the shipbreaking yard is to recycle the steel the ships are made of for domestic construction purposes and resell the other miscellaneous items to private or commercial buyers. This experiment proposes that these materials could be used in a more direct and raw form to create new structures and dwellings. Due to this it was important to consider how spaces could be constructed through predominantly the use of gas cutting and welding since these are the main tools that are available and can be facilitated by the workers themselves.

The idea of self-construction has its flaws, particularly when it comes to designing the details of the space. The informal setting that has been proposed positions the role of design as an investigation in organisation. The inhabitable spaces in between the structure become less designed and planned as more control is given to the occupant in their construction. The formal gives way to the informal. All that is effectively provided is a base structure made up of recycled columns and beams, cut from the larger bracing members of the ship's hull. Within this structure the occupants are free to build and expand. The intent of this is to foster a sense of ownership over the space. Additionally, it opens up the design for eloquent crafting by the on site tradesmen as a form of expression.

There are two main issues with this design solution. The first of which is that after the initial structure is put in place the rest of the interior becomes speculation, without further research it becomes too difficult to accurately predict how the occupants would go about building their own spaces. Like many other speculative projects there is no real way to know how it would be used or inhabited until it is built. Despite there being an attempt to solve this complex issue, over the course of the design process western biases have been projected onto this foreign site.

This has brought into question the amount of control the designer can have over such informal spaces and has resulted in a very speculative view of the way these people would live and utilise the provided space. This is a form of 'colonialism' and gentrification of a context that is not fully understood. This is a glorified and idealised view of the informal city where the design tries to emulate its natural and organic beauty rather than suitably address the existing social context.

The second issue is in the contradictions between designing a space fully and allowing the occupant to customise it themselves. There is very little incentive for this to occur. Traditionally, in places similar to Bangladesh the home is viewed as an ongoing symbolic and economic investment. As it is adaptively expanded, it carries the history and experiences of the family and can be passed on to their children or relatives (Lizarralde, 2015). In the case of the adapted ship and the context of the shipbreaking yard the degree of transience of the typical worker is probably too great for them to consider self-building a worthwhile temporal or economic investment for a space that they neither own legally nor will be realistically living in for an extended period of time.

When reflecting back on the first part of the research question it is certainly plausible that this design outcome is a way in which a ship beached at the shipbreaking could be reused to generate an inhabitable interior environment. However, given the context of the site, it is unclear if the space would be utilised effectively or efficiently. There are many assumptions made about this project and as a result it has addressed the issue of social housing in a utopian way. What is the role of designer when it comes to the informal city in general? This is a question that needs to be looked at in more depth. This project has shown many of the difficulties of designing for the extreme poverty of informal spaces without it becoming an experiment in urban planning. For example, in terms of quality of life improvements, a clean water supply and proper waste management have a dramatic effect on the health of the people (Sinha, 2012). Perhaps if these systems had been explored in greater detail, rather than the organisation of space, a more detailed interior space could have been designed around them.

While alternative housing solutions for the impoverished is a cause worth investigating, and is a potent issue in regards to Bangladesh's shipbreaking yards, it has overshadowed and limited this research in its attempt to explore the cargo ship as a structure for adaptive reuse.

6.03
INHABITING OTHER SHIPS

Throughout the process of designing a space in the context of the Chittagong shipbreaking yard it has become clear that there are a number of other ways that ships could be re-inhabited. One of the key aspects of the design outcome that limited its application to other ships is the context of the local area and that of Bangladesh as a developing country. It is clear however, that given a different context for a more affluent and formalised society it would be easier to explore the interior of the ship more architecturally rather than organisationally. This would allow for more complex systems that would resolve many of the issues that arose out of consideration of the levels of poverty in and around the shipbreaking yard.

Mass housing for the reuse of ships could be further explored in the context of rising sea levels. Temporary housing solutions and transportation for communities displaced by the rising sea levels could help with the process of seeking refuge; provided that the ships were to remain sea worthy. Similarly, ships reused for more permanent housing could be used to offset the effects of rising sea levels for coastal cities due to their ability to float. Ships could also be used to house migrant work forces that would have the ability to be relocated to new coastal sites as required. Although a form of the latter example already exists it has not been implemented through adaptive reuse.

The reuse of ships does not need to be limited to just addressing housing issues, it could also be applied to recreational or infrastructure facilities with further exploration to properly investigate the implications. Ships as museums have already been explored in some cases but the modern cargo ship has been overlooked in terms of heritage value. This is not so much an argument for their value but more of a consideration of how a cargo ship could be implemented as a museum ship. This particular investigation of the shipbreaking yard has made it clear that human interactions, and construction / destruction practices provide potential for new interventions.

6.04
METHODOLOGY AND REPRESENTATION

The wicked problem, as stated by Ritchey (2011), is subjective and strongly stakeholder dependent; there is often little consensus about what the problem actually is, let alone how to resolve it. This project is a wicked problem in the sense that a successful design can only be determined, post-implementation, by those inhabiting it. Sinha (2012) discusses this as one of the issues with designing for informal environments, its success can only be determined speculatively by designers through research, experience or tacit knowledge.

The heuristic process as a method for approaching this wicked problem was suitable as its inherent, iterative experimentation is appropriate for discovery and refinement of the design. Despite this, the scale of the project and amount of time available has left it in a state that lacks resolution. There are a number of factors related to the methodology that has brought the project to this point. The heuristic process of discovery, analysis and incorporation of new ideas is, at times, tedious and often lacks direction. This made it easy to follow unproductive leads and get lost investigating, ultimately, irrelevant information. Additionally, working iteratively through design experiments from an interior architecture perspective has made it difficult to engage with problems at a larger and more organisational scale. Due to this, and the retrospective and reciprocal nature of the methodology, design decisions were made that obscured the fundamental problem of designing for informal spaces.

If this problem were to be re-examined, a number of things would be done differently. Reuse of cargo ships could be explored in a formal environment rather than the informal. This way more focus would be placed on the interior itself and its expression through detailing. With a different context, different programs could be justified and adaptive reuse could be explored in different ways. The methodology itself could be adjusted or changed so that factors such as narrative, for example, could be promoted. This way certain aspects of the design could be focused on in more detail rather than being hindered in an attempt to reach a comprehensive understanding of the entire space and context.

Representation and methods, that convey and work through the design problems of this research project, have had a large impact on the results. The majority of this project has revolved around drawing and 3D modelling as a way to locate and situate individual aspects of the design within the larger shell of the ships' hull as a way to better comprehend its enormous scale. However, as the research project developed digital modelling took on a primary role that had previously been occupied by drawing. As a result the representations of the interior lost the looseness and chaos inherent in the context of the shipbreaking yard and local environment that could been better represented through analogue means. This in turn has ultimately made it more difficult to convey the intent and tone of the research project.

6.05
EPILOGUE

To conclude, the design outcome will be readdressed in the context of establishing the inhabitation of the ships' hull as an organisational exercise that takes an approach to seek and better understand the nature of the site and its inhabitants. The intention of this is to further explore the organisational direction that this project has taken without the influence of factors that were reductive to the last iteration of the design. Through this process it will be clearer to convey how the ship's hull begins to be inhabited while addressing some of the criticisms of the previous iteration.

The process of combining old experiments with new drawings creates a new visualisation and representation of the organisation of the ships' interior (Fig. 6.01). The patina of the subsequent experiments builds up in one new image that begins to capture the chaos of shipbreaking. It reflects the nature of self-construction and begins to present the interior space as a result of craftsmen coming together to cohabit a space rather than individuals moving into pre-built rooms. A sense of ambiguity of the specific construction of the self-built cabins is established while the overall organisation remains clear. In informal environments and spaces where self-construction becomes central to the design it is necessary that the inhabitants are able to express themselves through their homes.

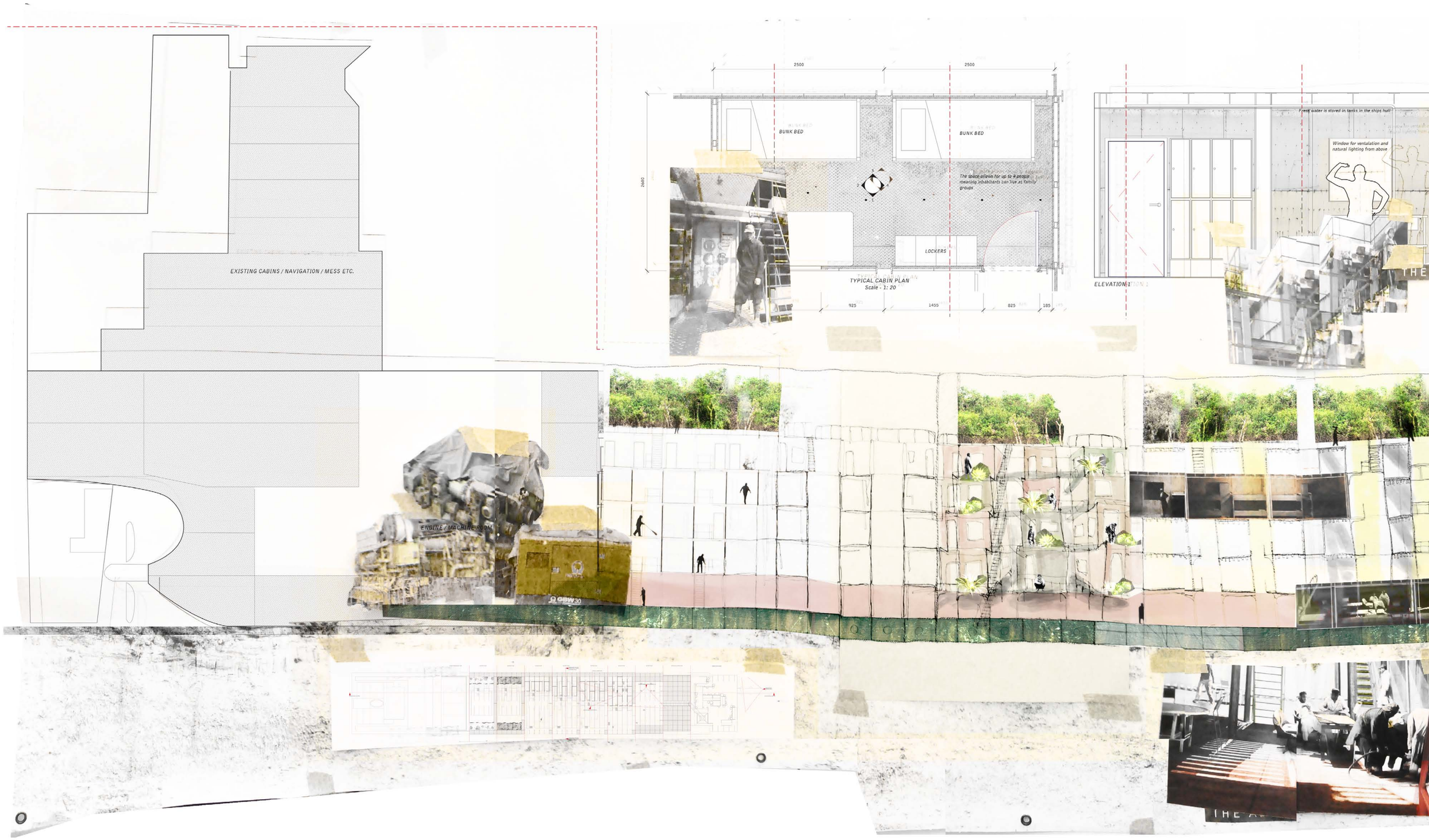

EXISTING CABINS / NAVIGATION / MESS ETC.
ENGINE / MACHINE ROOM
2500
2500
2600
BUNK BED
BUNK BED
The space allows for up to 4 people meaning inhabitants can live as family groups
LOCKERS
TYPICAL CABIN PLAN
Scale - 1: 20
925
1455
825
185
Fresh water is stored in tanks in the ships hull
Window for ventalation and natural lighting from above
ELEVATION 1

Fig. 6.01 Longitudinal section - An organisational experiment of the ship through collage, drawing and painting.

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"Quinta Monroy unit after expansion" Quinta Monroy / ELEMENTAL. (2008, December 31). Retrieved 5 December 2016, from http://www.archdaily.com/10775/quinta-monroy-elemental/

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"A worker without safety gear at risk of falling" Halda, T. (2010). Shipbreaking Yards of Gadani, Pakistan 2010. Retrieved from http://www.shipbreakingplatform.org/photo-gallery-gadani-2010-tomas-halda/

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APPENDIX

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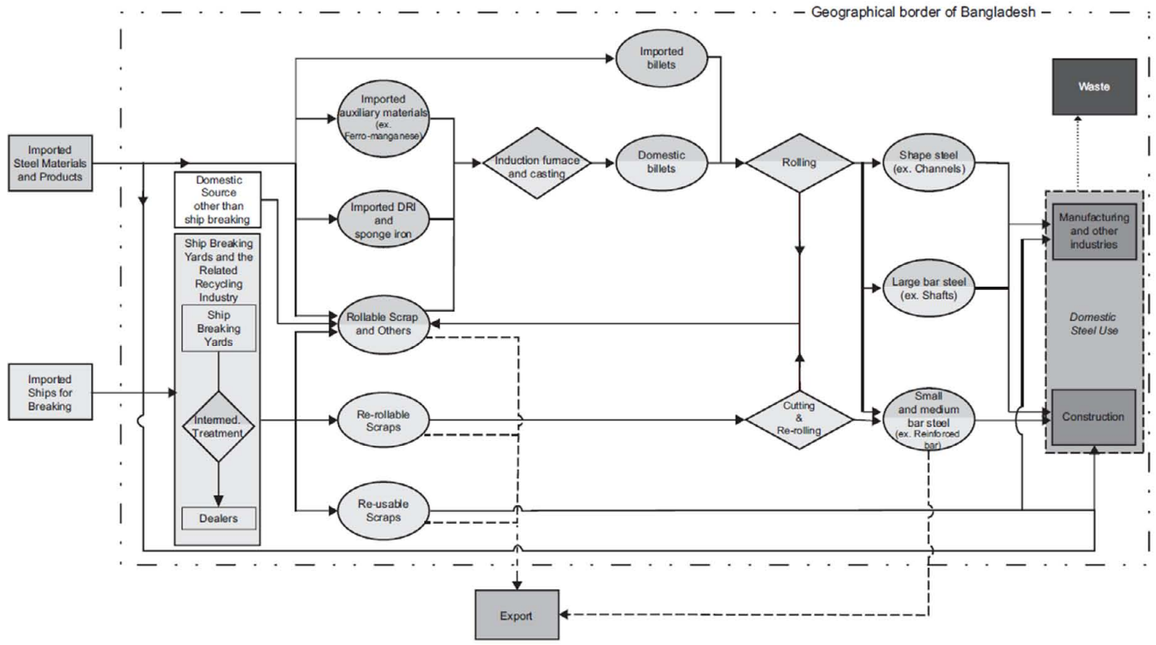
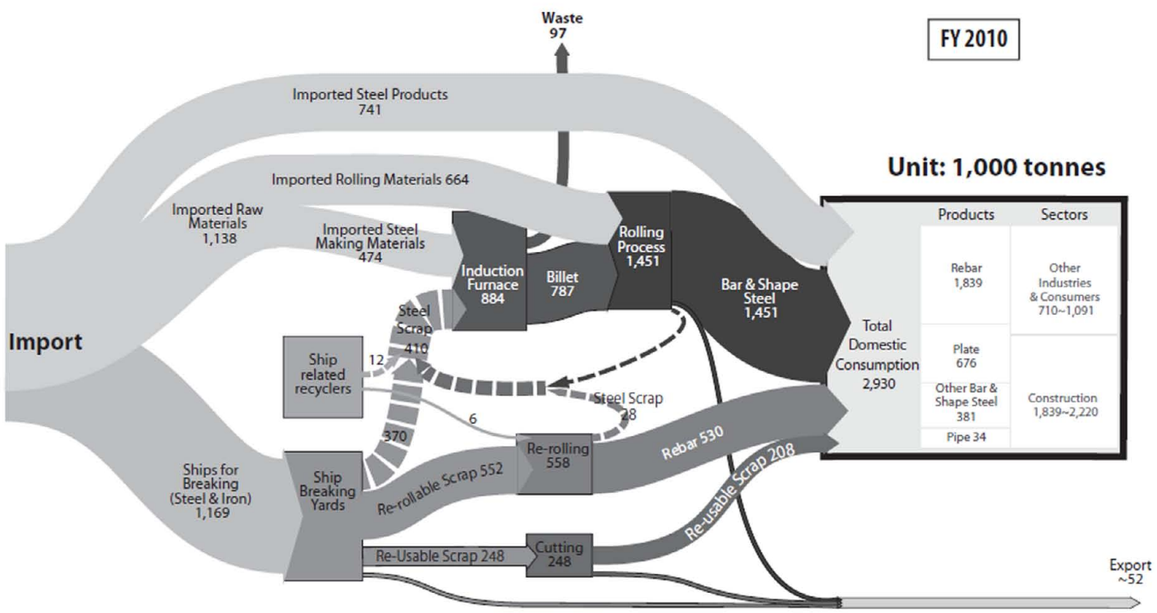
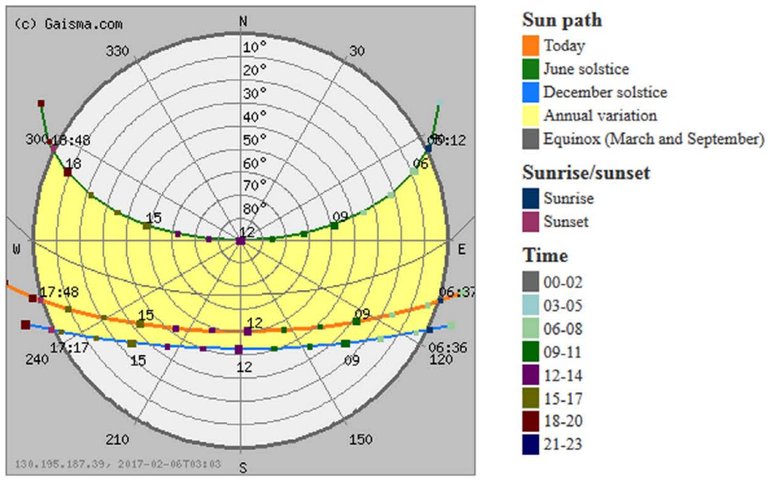




Appendix 1.01 Material flow analysis of steel in Bangladesh

Dhāka, Bangladesh - Sun path diagram



Notes: * = Daylight saving time, * = Next day. How to read this graph? Change preferences.

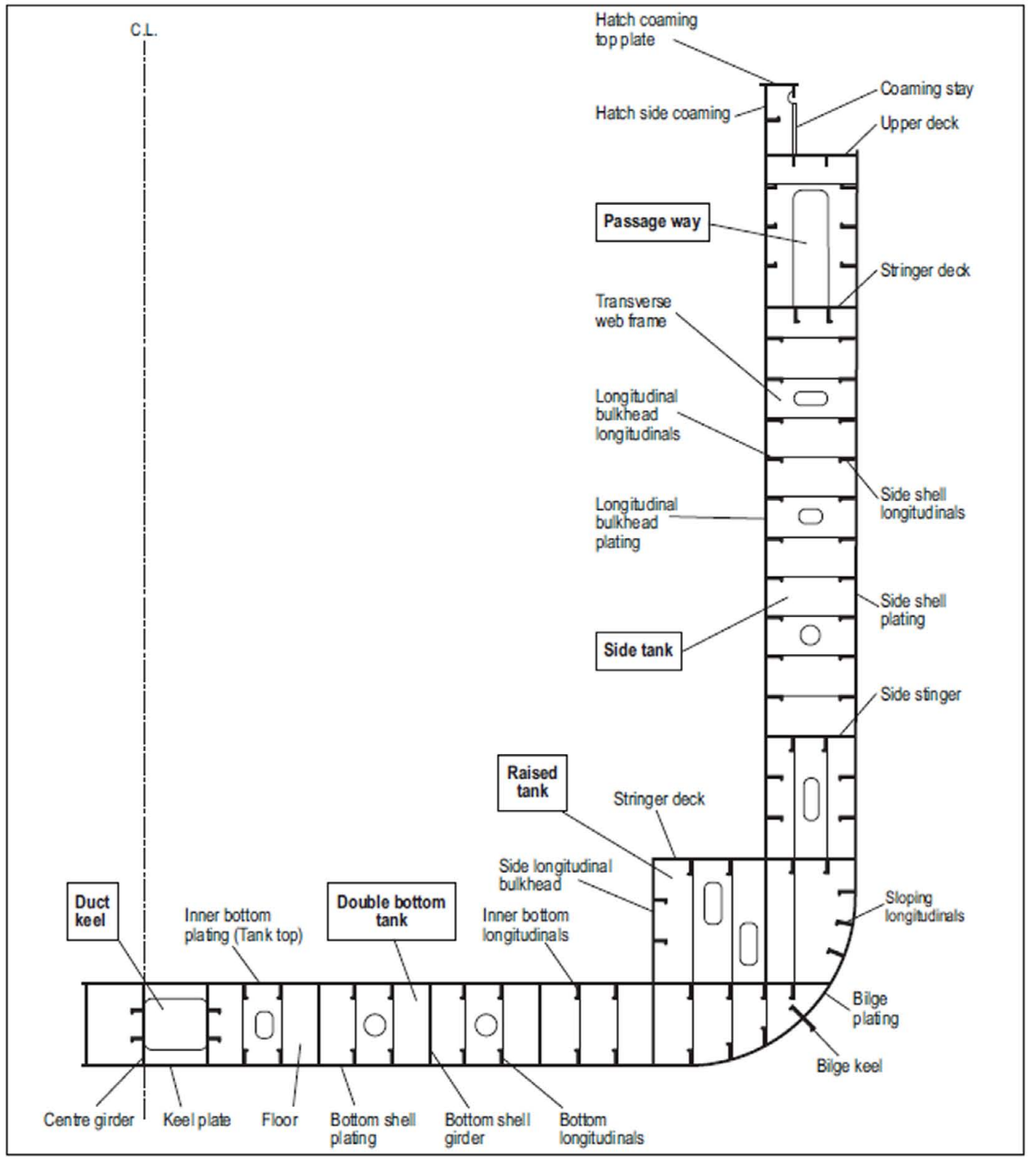
Appendix 1.02 Dhaka, Bangladesh - Sun path diagram

Average Normal Rainfall in mm

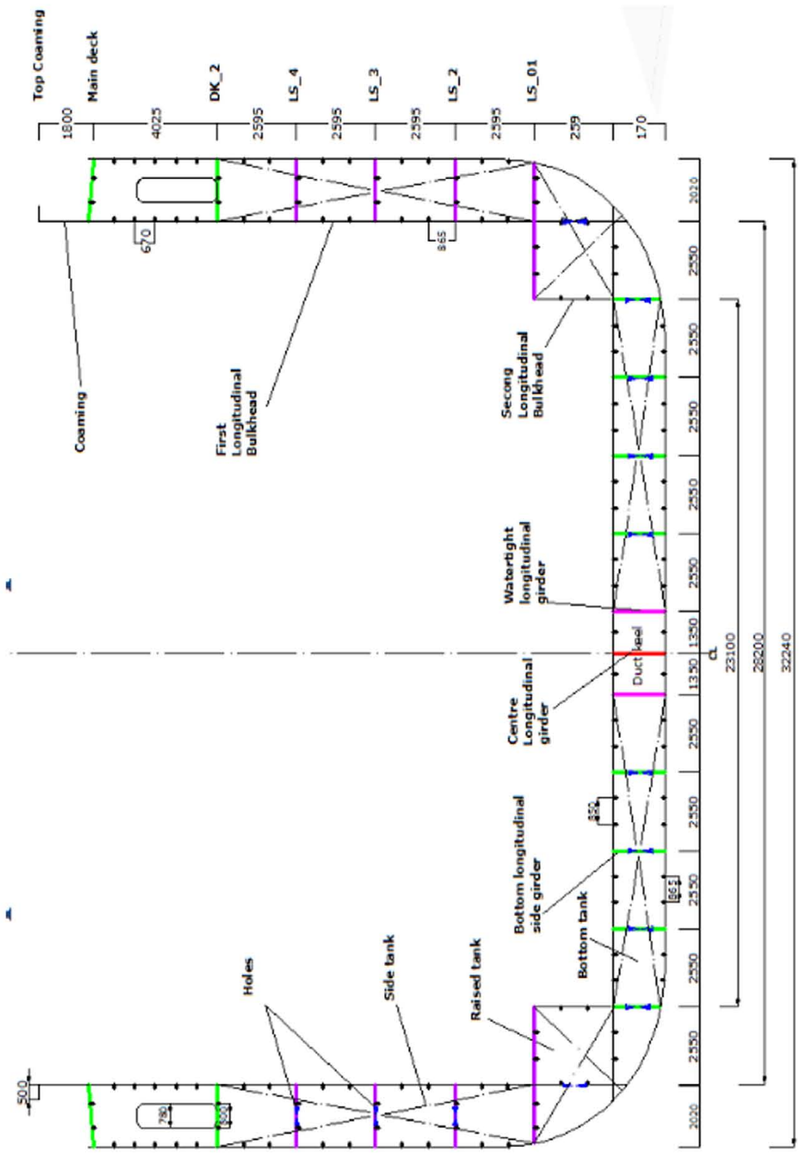
St_name	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Dhaka	7.7	28.9	65.8	156.3	339.4	340.4	373.1	316.5	300.4	172.3	34.4	12.8
Mymensingh	10.0	20.5	35.8	128.6	356.9	394.3	436.3	318.1	335.3	190.9	17.5	8.7
Tangail	9.0	33.5	33.1	151.1	258.6	311.2	345.1	253.1	298.1	139.7	29.6	12.1
Faridpur	7.0	27.7	51.1	142.4	267.7	345.1	339.8	308.5	264.2	156.1	31.8	11.3
Madaripur	9.7	34.2	60.9	154.3	264.3	384.3	401.5	351.5	246.5	149.6	32.3	5.4
Chittagong	5.6	24.4	54.7	147.4	298.6	607.3	727.0	530.6	259.3	184.8	67.5	11.9
Sandwip	10.3	27.0	62.8	165.9	340.4	652.8	835.1	695.0	395.0	219.7	64.3	9.4
Sitakunda	5.6	19.6	91.9	184.5	351.0	548.4	726.8	545.6	316.4	240.3	54.2	7.9
Rangamati	5.1	24.3	62.1	147.9	319.7	504.8	572.6	435.2	259.6	152.2	55.7	9.5
Comilla	7.5	28.8	66.2	153.9	329.6	329.8	415.5	316.0	226.6	141.6	41.6	8.6
Chandpur	6.7	21.1	74.5	162.1	296.4	383.4	424.3	360.6	247.0	124.8	39.8	6.7
Maijdi Court	12.1	30.0	81.2	135.1	340.5	532.7	790.2	637.1	359.1	169.8	58.5	8.8
Feni	8.0	35.0	76.8	192.9	383.6	529.9	731.5	536.1	324.8	200.2	52.9	9.9
Hatiya	6.2	22.1	62.9	140.3	300.1	572.0	698.7	566.2	385.0	211.0	63.0	12.3
Cox's Bazar	4.1	17.0	34.7	121.8	286.8	801.9	924.6	667.1	330.1	213.6	109.4	13.0
Kutubdia	6.5	24.0	51.4	85.5	215.6	638.3	763.7	488.9	299.8	169.3	71.9	9.3
Teknaf	1.9	16.5	15.3	73.0	259.9	968.1	1029.7	898.9	402.1	207.4	75.7	5.9
Sylhet	9.4	36.2	155.3	375.6	569.6	818.4	819.2	612.6	535.9	223.9	30.4	9.4
Srimangal	5.0	31.3	84.1	216.1	449.9	449.7	339.4	299.3	278.5	150.0	40.3	11.2
Rajshahi	11.3	17.5	24.8	63.7	136.4	264.6	320.7	273.9	295.9	106.4	16.3	10.6
Ishurdi	8.1	21.5	30.8	95.0	206.3	288.6	335.6	261.2	282.8	98.1	17.4	10.8
Bogra	8.7	15.2	20.1	80.5	222.0	343.8	406.1	285.3	310.1	126.9	13.1	11.3
Rangpur	9.3	11.8	24.5	104.0	294.4	417.4	464.8	376.1	383.0	132.1	10.5	7.9
Dinajpur	12.3	10.5	11.3	67.1	232.5	335.3	433.6	387.7	383.8	115.1	7.0	10.2
Sayedpur	12.6	6.5	22.7	94.1	221.7	435.2	350.0	350.0	456.3	139.7	11.8	6.7
Khulna	13.3	44.4	52.1	87.5	200.0	335.6	329.8	323.5	254.7	129.8	32.1	6.6
Mongla	16.9	35.9	58.1	72.4	180.9	323.8	342.7	344.4	313.0	149.9	48.0	1.6
Satkhira	13.7	40.1	37.6	86.5	152.4	296.6	375.4	297.3	280.1	120.6	31.2	11.4
Jessore	14.8	26.1	44.6	75.4	169.9	298.7	304.1	291.8	236.9	107.9	29.0	15.8
Chuadanga	14.8	26.6	20.2	39.8	142.8	235.4	351.7	232.8	297.1	101.3	21.0	13.0
Barisal	8.9	27.0	57.1	132.3	232.9	408.4	407.3	371.3	259.4	158.6	52.4	12.6
Patuakhali	9.0	24.9	41.3	132.9	276.4	547.1	572.8	484.8	380.8	163.7	71.7	7.3
Khepupara	6.1	24.9	50.9	132.4	258.5	510.0	650.1	479.9	357.7	228.1	58.3	7.2
Bhola	10.3	32.7	63.4	129.7	274.0	465.2	444.5	395.5	264.2	155.3	52.0	10.6
Country	9.0	25.5	52.4	130.2	277.3	459.4	523.0	420.4	318.2	160.3	42.4	9.6

Bangladesh
Meteorological
Department

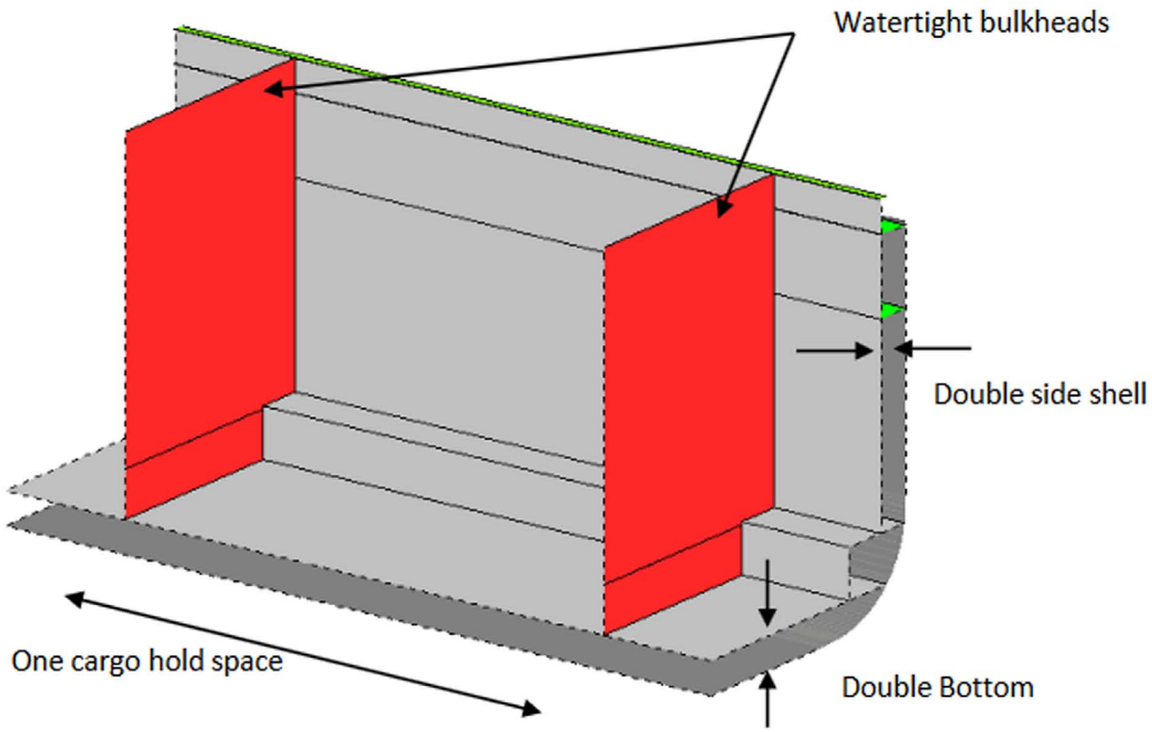
Appendix 1.03 Average normal rainfall in mm

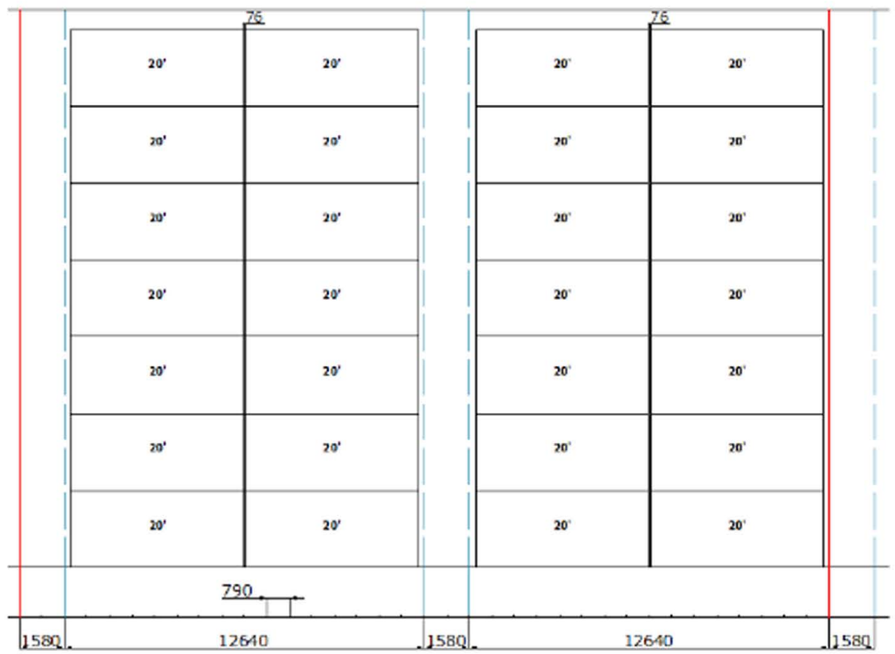


Appendix 1.04 Nomenclature of a typical transverse section in way of cargo hold



Appendix 1.05 Midship section



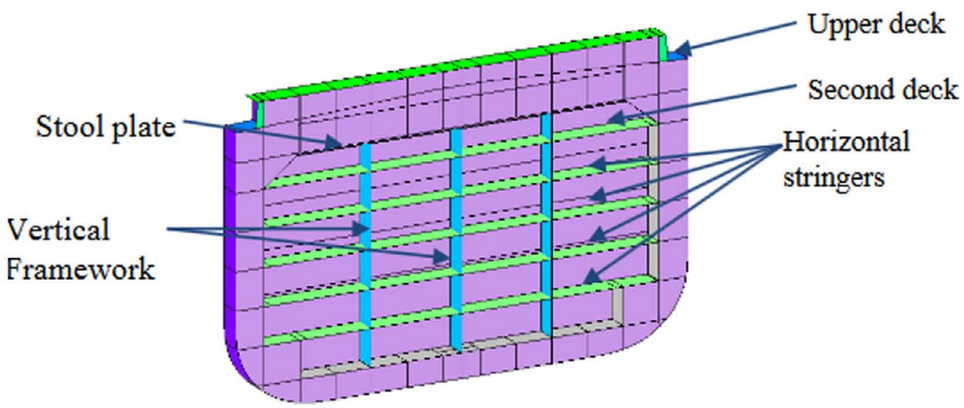


Appendix 1.06 Structural topology of one cargo hold

Transverse bulkhead structure

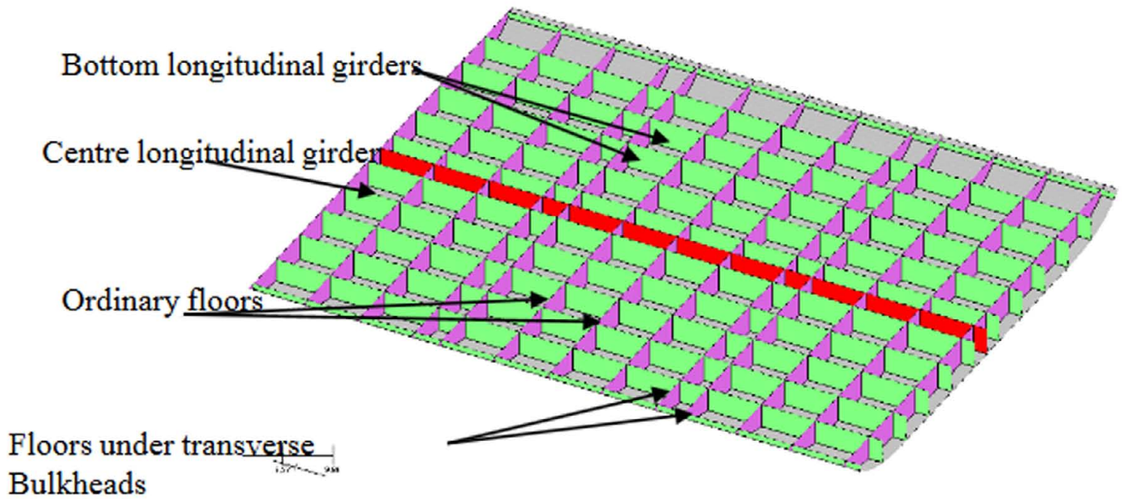
The structure of each bulkhead is extended over two frames.

The spacing between the transverse bulkheads is equivalent to the length of 40 ft container.



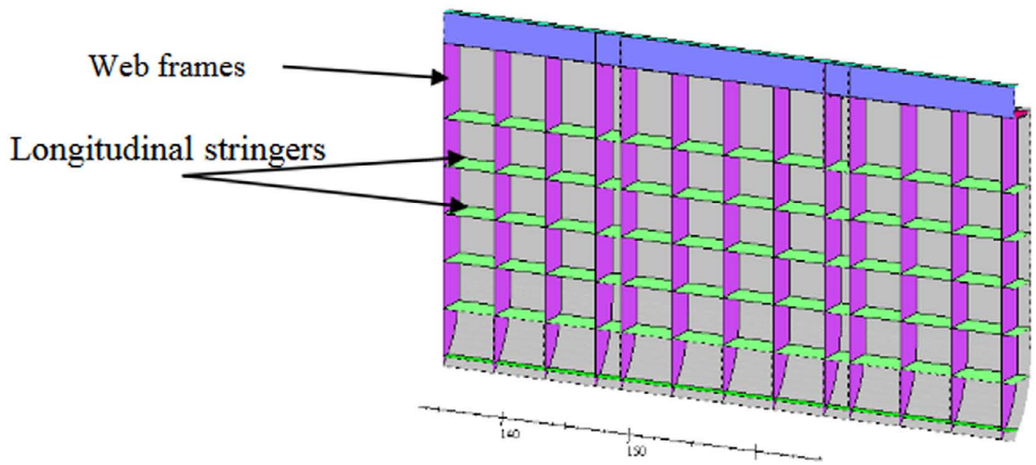
Double bottom structure:

side longitudinal girder and floors form rigid support for the containers' seat.



Double side structure

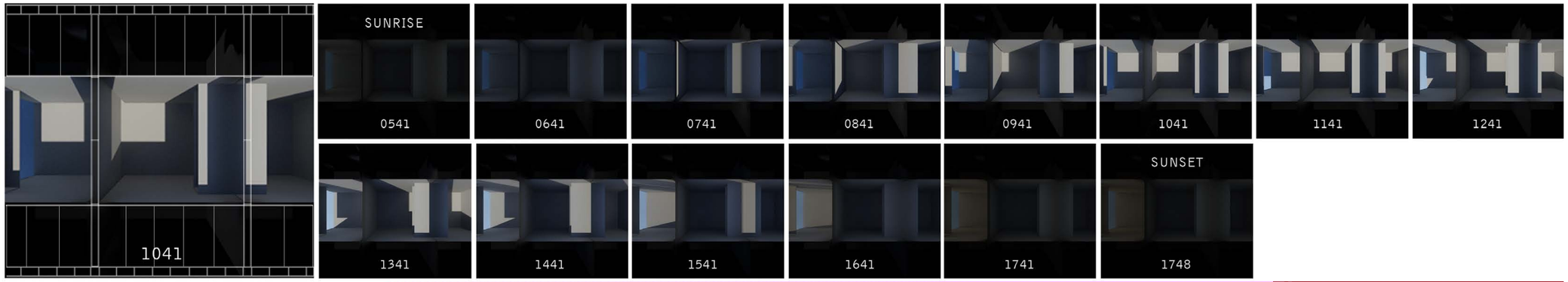
longitudinal stringers and web frames form a rigid support for ship's sides structure between transversal bulkheads.



Appendix 1.07 Double hull structure

21 DEC WINTER SOLSTICE

22 SEP AUTUMNAL EQUINOX



Appendix 1.08 Sun path analysis for light wells.

REVIEW 1 NOTES.

- DETERMINE SCOPE MORE STRICTLY
  - FOCUS ON 1 SPECIFIC CONTEXT
  - LIMITS ON WHAT IM LOOKING AT
- REASSEMBLY FROM THE PERSPECTIVE OF THOSE LIVING ON THE SITE
  - THE SLOW BUILDING OF BY INHABITANTS OVER TIME
  - TOOL BOX FOR THEM TO BUILD FROM
- STORY BOARD OF AVERAGE WORKER
  - BEFORE INTERVENTION
  - AFTER INTERVENTION
- BE EXPLICIT ABOUT WHAT THINGS ARE
  - CLARITY
  - SCOPE
  - CRITICAL REFLECTION
- RELATIONSHIP BETWEEN SHIP AS
  - INTERIOR
  - LANDSCAPE
  - URBAN PLANNING
- MORE CASE STUDIES.

Appendix 1.09 Formal review 1: notes and feedback

REVIEW 2. 1608 19. - FEED BACK NOTES.

- MORE STORIES OF WORKERS.
  - HOW THEY USE THE DIFFERENT SPACES.
- ECONOMICS OF THE DESIGN AND HOW IT APPLIES TO OTHER SPACES.
- UTOPIAN VS. SOCIAL
- LOOK INTO HISTORY OF SHIP BREAKING.
  - GOLD RUSH, BURNING OF ABANDONED SHIPS.
- WHERE THE WATER COMES FROM
  - HOW POWER IS SUPPLIED
- FURTHER PUSH THE IDEA OF THE SANCTUM
  - HOW ARE THE INHABITANTS PROTECTED.
- THE ISSUE OF TOXINS AND DANGERS.
- THE GROUNDLINESS AND REALITIES OF THE SITE.
- MORE / CLEARER CLIMATE ANALYSIS
- CLARITY OF MATERIALS AND PARTS BEING USED.

Appendix 1.10 Formal review 2: notes and feedback

REVIEW 3. 16 11 03 REVIEW NOTES.

- COLONIALISM OF PROJECTING MY IMPRESSION OF HOW THESE PEOPLE SHOULD LIVE
- IS THE 'APARTMENT LIKE' SOLUTION THE WAY THESE PEOPLE WOULD LIVE. WHY WOULD THEY LIVE THERE?
- ORGANISATION OF SPACE BEING MORE IMPORTANT THAN DETAILS. SINCE THE DESIGNER CANT REALLY INFLUENCE HOW THESE SPACES WOULD BE PUT TOGETHER
- THIS OUTCOME IS MORE OF A PROJECTION OF HOW I THINK THEY WOULD LIVE.
  - AMOUNT OF CONTROL.
- THE INFORMAL CITY.
  - GLORIFICATION
- - SIMILAR TO GENTRIFICATION
- AWARENESS OF CONTADICTION BETWEEN DESIGNING AND SELF-BUILT
- SHOULD AN INFORMAL CITY BE WITHIN A SHIP
- INTERIOR ARCHITECTURE AND HOW IT DEALS WITH SCALE
  - RELATIONSHIP WITH THE DISCIPLINE
- DIFFERENCES BETWEEN CHITTAGONG AND OTHER LOCATIONS.
- WHAT THIS OUTCOME OPENS UP.
- APPROPRIATE REPRESENTATION TECHNIQUES.

Appendix 1.11 Formal review 3: notes and feedback