Ed Drongool

LIVING ON THE EDGE

DEFINING SHIPBREAKING AT THE EDGE OF GLOBALISATION
IN ALANG, INDIA

Fig 1.01. Child Labour in the Shipbreaking Yards

2016

MASTERS OF ARCHITECTURE THESIS

For My Family

Fig 1.02. Men Climb Aboard to Dismantled the Beached Vessel

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Thanks to my supervisor Kevin Sweet for your guidance and encouragement throughout the year.

To my parents and Ella thank you for your on going support throughout my five years of study.

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ABSTRACT

Forty thousand men on the coastline of Alang, India, dismantle a large portion of the world's discarded ships in a process referred to as shipbreaking. The discarded vessels are dismantled piece by piece, with no more than a gas torch and physical labour in a country with little to no regulations on the rules of labour or environmental protection. Workers of the shipbreaking yards live in slum dwellings, within a toxic landscape of petroleum hydrocarbons, heavy metals, lead paint and asbestos; all are toxic by-products of globalised industrialisation. As a result of the extreme work and poor housing conditions, the impoverished inhabitants are at high risk of life threatening diseases which commonly result in death. On the shipbreaking yard alone, an average of sixteen deaths per year occur as a result of the extremely hazardous working conditions. While the need to dismantle and recycle ships will not disappear any time soon, it is imperative that current practices become safe to both workers and the environment.

This thesis outlines a design project that introduces the creation of an ecosystem within the shipbreaking community of Alang by introducing many interconnected systems that allow for self-sufficiency. Inspired by concepts of bio-mimicry, the project provides the means to capture toxins safely using naturally produced materials; creates community, family based housing that replaces the current housing slums; and modernises the shipbreaking process by implementing a cyclical ecosystem that capitalises on the regions natural resources. By making the process of shipbreaking environmentally safe and creating a hazard free, more productive work environment, this project suggests that a business practice that is unwanted and hidden can be productive and economically viable.

Fig 1.03. *Shipbreaking Workers* VII

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PERSONAL STATEMENT

In February 2014, a year before commencing my architecture thesis, I was granted an opportunity to travel to Chennai, India as a member of a Victoria University of Wellington research team, to investigate resilient housing for coastal slum communities.

This experience allowed me to become immersed into the culture of India and gave me the opportunity to experience first hand, the slum conditions which exist throughout most of the country. A lasting memory I have from this experience is not the appalling living conditions but how welcoming and positive all the people were, in particular the children of the slums. It was rewarding to be in situation where I was conducting research that had such a profound impact on my perception of the social responsibility of architecture. This trip personally highlighted how architecture could become a vehicle for social and environmental improvements for many slum dwelling communities around the world.

Due to my time spent in India on the research trip, I was drawn to the shipbreaking yards of Alang. The hardship documented in the photographs (fig 3.01, 3.04, 4.08, 4.09) reveal the dreadful conditions both the young and old are working and living in. This real life problem - a direct result of globalisation - opens a door for architecture to act as a device that might improve the lives of the thousands of disadvantaged workers living in shipbreaking yards of Alang.

Fig 2.01. Fisherman's vessels and slum dwellings where our research took place. Chennai, South India.

3

INTRODUCTION

- 3.1 PROBLEM STATEMENT
- 3.2 RESEARCH QUESTION
- 3.3 RESEARCH AIMS
- 3.4 OBJECTIVES
- 3.5 DESIGN METHOD
- 3.6 SCOPE
- 3.7 STRUCTURE

Fig 3.01. *Impoverished Shipbreaking Workers*

3.1 PROBLEM STATEMENT

“At Alang, in India, on a six-mile stretch of oily, smoky beach, 40,000 men tear apart half of the world’s discarded ships, each on a sump of toxic waste.” (Langewiesche, 31)

The process of shipbreaking occurs when a vessel becomes damaged or uneconomically viable to operate, thus the vessel becomes more valuable if it is dismantled and sold piece by piece for recycling.

Workers of the shipbreaking yards live and work in unimaginable conditions, within a toxic landscape of petroleum hydrocarbons, heavy metals, lead paint and asbestos; all are toxic by-products of the labour intensive shipbreaking process, described as “one of the world’s most dangerous jobs”. (Gwin) As a result of the extreme work and poor housing conditions, the impoverished inhabitants are at high risk of life threatening risks and diseases which commonly result in death. On this shipbreaking yard alone, an average of sixteen deaths per year occur as a result of the extremely hazardous working conditions. (Sahu, 53)

ON THE SHIPBREAKING YARD ALONE, AN AVERAGE OF SIXTEEN DEATHS PER YEAR OCCUR AS A RESULT OF THE EXTREMELY HAZARDOUS WORKING CONDITIONS.

Workers live in narrow shanties known as Kholis; three by three meter shacks with up to fifteen inhabitants per unit. Stripped of their basic human rights, they do not have access to clean drinking water, sanitary facilities and are often left without electricity. Authorities, in an attempt to alleviate unliveable conditions, have set up an astonishingly low number of sanitary utilities for the workers consisting of twelve showers and six toilets to be shared among the thousands of workers. (Sahu, 53)

The benefits of the shipbreaking industry in Alang provide the region with an economic opportunity that allows the recycled steel and other materials to be used by many other industries. Roughly 315 ships will be left to be dismantled on the shores of Alang per year (Langewiesche, The Shipbreakers 33) ensuring that there is continual work that provides an economic benefit to the area. However, in the current working conditions, this economic benefit comes at the cost of toxic pollution that effects the people and the environment. The housing and

Fig 3.02. *Metals pollute the Shipbreaking Yards*

living conditions will only continue to get worse as the shipbreaking industry grows. An increase in the number of ships to dismantle creates greater pollution to the environment and to the neighbourhood, further increasing the health risk to the inhabitants. While pressure has been placed on the shipbreaking yards of Alang to be more ethical and environmentally friendly from many organisations, there is little that can be achieved as each plot is privately owned and operated. However this project will propose a design solution that will provide a mediation between the economic benefits of the shipbreaking industry and improve the working and living environment. This solution will attract more skilled workers and their families plus have an enormous environmental impact, allowing future growth and prosperity for the shipbreaking yards of Alang.

3.2 RESEARCH QUESTION

Fig 3.03. *Child Labour in the Shipbreaking Yards*

How can an architectural rethinking of the shipbreaking process in Alang improve the environmental, economic, social and working conditions for all parties involved?

Fig 3.04. Inhabitant Works in the Sludge of Toxic Waste

3.3 RESEARCH AIMS

The aims of this research project is to create an architectural design solution that is a self-sufficient ecosystem that achieves the following:

- Improve working conditions for local shipbreakers
- Improve living conditions for local shipbreakers and their families
- Provide economic benefit and growth potential for shipbreaker facility owners and invested parties
- Clean up existing environmental conditions and provide methods to contain and recycle toxins from the shipbreaking process

3.4 OBJECTIVES

- Construct a safe shipbreaking system that prevents using the traditional life threatening methods of dismantling a ship.
- Develop familial housing conditions that provide a sense of community and allow families to live and work together.
- Ensure inhabitants have access to clean drinking water and sanitary facilities.
- Develop an improved shipbreaking process that has the capability of dismantling two extra ships per year.
- Investigate natural materials that mitigate the pollution of toxic oil. Provide a means to collect and store water to ensure water access all year round.

3.5 DESIGN METHOD

The shipbreaking yards of Alang, India were chosen for this design lead research in response to worldwide attention of toxic working and living conditions for the thousands of impoverished inhabitants. 185 shipbreaking yards pollute the coastline with heavy metal, asbestos and oil. With no enforced regulation to mitigate the environmental damage or reduce health risks to workers, inhabitants are forced to live and work within the toxic sludge with no safety equipment. The shipbreaking process relies on the physical labour of the men and boys cutting apart each ship and transporting the large metal plates up the beach by hand. This process exposes workers to a high risk of injury and death daily.

This thesis begins by examining literature relating to contemporary systems of biomimicry, pollution mitigation, water harvesting and urban agriculture as sources of inspiration for generating an innovative architectural proposal for improving the lives of those working and living in these yards. Case studies from various projects, inside and outside of the architectural realm, have further informed each stage of the design. Each design stage has been explored through design iterations using mixed media which ensure the overall design outcome meets the thesis objectives. This includes sketched ideas for simple diagrams, physical model making, in order to understand scale and 3D Cad design in order to refine and test integrated systems.

Fig 3.05. Methods of Making the Design

3.6 SCOPE

This thesis sets out to achieve a design solution that is made up of interconnected functional and architectural systems. These systems are water harvesting; pollution mitigation; cotton farming and an automated retrieval system. Together they allow the project to be self-sufficient and improve the environment social conditions inherent in the site and the culture. It investigates how technology – related to the same technology that created these conditions – can be used in positive and imaginative ways through the architecture to provide an environment that is clean, safe and unifying as well as supports the economic growth of the shipbreaking yards.

Fig 3.06. Housing Community Snapshot

3.7 STRUCTURE

Site Analysis: This section analyses the specific site conditions of Alang and highlights the site conditions that will be addressed within the design.

Research: This section investigates various design options that will respond to identified site conditions. It investigates self-sufficient systems such as automotive retrieval system and cotton absorption can be applied to the design in order to improve the shipbreaking process and the living and environmental conditions.

Preliminary Design: This section explores preliminary design experiments based on the research within the previous chapters. Exploration of the design is achieved through sketches and digital design process that result in a scaled physical model.

Concept Design: This section reviews and improves the initial design outcome through digital form. It also incorporates a more established sense of identity and a improves on the self-sufficient ecosystem through biomimicry principles that are further investigated and refined.

Developed Design: This section presents the final outcome of the design, demonstrating how the chosen systems and architecture combine to produce project that meets the research objectives.

Conclusion: This section reflects upon the final design outcome and provides points to improve on in the future.

4

RESEARCH

- 4.1 HISTORY
- 4.2 TOPOGRAPHY
- 4.3 SHIPBREAKING PROCESS
- 4.4 LIVING CONDITIONS
- 4.5 COTTON ABSORPTION
- 4.6 AGRICULTURAL FARMING
- 4.7 SHIPPING CONTAINER SYSTEM
- 4.8 WATER

Fig 4.01. A Young Boy Works In The Yards 23

Fig 4.02. *Beached Vessels*

4.1 HISTORY

The ten kilometre stretch of coastline was once pristine with no vehicle access and only known by local fishermen. However, in the early 1980s shipbreaking began after a storm beached a large cargo ship, resulting in the community dismantling the vessel for materials. (Langewiesche, 33).

The Alang shipbreaking yards, have become the largest in the world, recycling half of the world's discarded ocean vessels. In 2007, India accounted for forty-one percent of the world's total ship recycling capacity and ninety percent of them are broken down on the shores of Alang. (Dermaria 3) The shoreline is now home to 185 individual

shipbreaking yards that vary in size and scale based on the beached ship. The number of workers at each site is determined by the ship that is being broken and can range from sixty to three hundred per site. The yards are dependent on the improvised workers who work for as little as a dollar a day in order to provide for their families. In a country with an extremely high unemployment rate, even these low wages are better than nothing, resulting in little to no government intervention.

Fig 4.03. Working Conditions

4.2 TOPOGRAPHY

The geographical location and topography of Alang, provides the shipbreaking industry with perfect physical characteristics for beaching and breaking down vessels on the shoreline. The length of the shoreline stretching ten kilometres, combined with its location on the edge of the Gulf of Khambat, provides protection from any major storms. The large tidal range of up to thirteen meters, provides an easy and inexpensive platform for cargo ships to be run aground during a king tide, leaving them upright on the shoreline. When the tide moves out, the ship is ready to be dismantled by thousands of workers. (McElroy-Brown, 3)

Fig 4.04. Context Map

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The shipbreaking yard employs **40,000** directly & **200,000** indirectly making it one of largest industry's in India.

470 deaths since 1983. On average **16 deaths a year**.

Largest shipbreaking yard in the world. **50%** of the world's discarded ships are broken at Alang, India.

183 shipbreaking plots.

Roughly **315** ships will be left to be dismantled on the shores of Alang per year.

13 meter tidal range.

10km of coastline.

Key Statistics (McElroy-Brown) (Langewiesche) (Sahu)

Fig 4.05. Site Map of Alang 29

Fig 4.06. Cutters

4.3 SHIPBREAKING PROCESS

The issue of environmental pollution begins as soon as the any ship arrives to the Gulf of Khambat. Although each vessel that arrives on Alang beach brings economic prosperity for the owners and financial certainty for the thousands of impoverished workers, it also brings devastating toxins to a once very fertile landscape. There are little to no regulations governing the protection of the environment or the workers from toxins that come with the aged ships.

In order for a ship to be dismantled, the first step is for the ship to be beached in the designated plot along the shoreline. To do so, the ship is driven at full speed towards the shore during a king tide. There is a 13-meter difference in water level between a low and a king tide, making it is essential that the ship is beached during this time to ensure the ship is as far up the shore as possible. Once the ship has been beached, it remains stable as the tide moves in and out. Workers shackle the ship more firmly by placing anchors down in the shallows and by drawing the hull as high up onto the beach possible.

This process is the most inexpensive way to run a ship aground. (Langewiesche, 41)

From here, the dismantling of the ship begins during low tide. Men armed with only a simple LPG gas and oxygen torch begin taking apart the vessel's structure, with little to no safety gear. (Dermaria 3) (fig 4.06) Workers climb aboard with nothing more than ladders and ropes, where they begin to dismantle and off load all non-structural items. Any good oil is pumped into barrels for resale and the residual oil sludge, with no commercial value, is poured onto the beach. (Langewiesche, 41) Although fuel and oil tanks are emptied, they continue to produce volatile vapours and a high risk of explosion until they have fully been aerated. This is an extremely hazardous process that often results in fatal injuries.

The process of breaking down the ship proceeds from bow to stern. (fig 4.07) The many workers are divided into three groups to break apart the ship in the most efficient way possible. These groups are a shipboard of

Fig 4.07. Large Section is Cut From the Ship

elite cutters and their assistants who slice the hull and super structure in into multi-ton pieces; a ground crew of less experienced workers who winch the pieces of these vessel up the beach so that they can be cut down further into sections of ten-foot steel plates; and a final group of workers who do not have the skill set required for the first two groups and partake in the final dismantling. This last process is the most laborious, and involves carrying the ten-foot steel plates piece by piece up the beach and loading them into the trucks to be taken away for recycling. (Langewiesche, 48) (fig 4.09)

Ninety-five percent of each ship is recycled. The demolished vessel structure is melted down and made into steel reinforcing rebar, used within India's construction industry. Two percent of India's steel is produced through this ship breaking process. (Deshpande , Kalbar and Tilwankar, 251)The non-structural elements of the ship, such as generators, motors, kitchen appliances, furniture, wires, ropes and cables removed from the ship, are taken down to the Alang street markets where they

are sold and re-used. (Langewiesche, 48)The remaining five percent of each vessel is non-recyclable waste. This waste gathers up as toxic sludge; a combination of oil, lead paint and asbestos, and remains left on the beach. For every vessel that is dismantled, another layer of toxic waste is distributed onto the landscape.

The global shipping industry is the most significant system for transporting trade around the world with eighty percent of the world's goods transported by sea. To give some perspective of how significant the shipping industry is, between 2009 and 2010 there were approximately 100,000 ships out at sea in operation. After a life span averaging about thirty years, most vessels are no longer fit for operation. These vessels are sold and dismantled for recycling on the beaches of third world countries where they provide an economic life line to an impoverished community. The dismantling of the ship provides work for hundreds of thousands of people, bringing great wealth to the shipbreaking plot owners. (Frey 9)

Fig 4.08. *Toxic Sludge*

Globally, the ship breaking yards thrive during economic down turn and declines in periods of international economic growth. This was evident during the global recession between 2008 and 2009, where the ship breaking industry rapidly increased due to an excess in the number of vessels required for trade. It was more cost effective to recycle entire ships than leave them in operation. When single hull tanker ships built from 2010 to 2015 were phased out after regulations were put in place by the International Maritime Organisation, this increased the demand for shipbreaking further. (Frey, 6)

Profit made on each ship is determined by the weight of the vessel and the time it takes to dismantle it. Internationally ships cost approximately 300 US dollars per tonne. To recover the financial investment, the ship needs to be dismantled quickly, which can take a team of workers up to five months. (Frey 8) For the workers dismantling the ships, although the average income is an appalling one dollar a day, and has many risks involved, the process provides work for the thousands of migrant workers trying to provide for their families. Without this process of shipbreaking, these people would not be able to survive.

Fig 4.09. *Men Lift Smaller Cut Sections*

In order for these workers of Alang to continue to have work, infrastructure needs to be designed that allows for the process of shipbreaking to continue, whilst combating the major issues of safety and pollution.

Fig 4.10. Shipbreaking Beach

Fig 4.11. Size of the Shipbreaking Plots

KEY ALANG SHIPBREAKING NUMBERS

Plots	180
Workers	40,000
Workers per Plot	244

Variable width size of each Plot.

30m 200m

Fig 4.12. Plot Size

ECONOMICS

Minimum amount of tonnage(t) per plot needs to produce in order to be profitable.

30m	120m	10,000t per ship
120m	200m	25,000t per ship

OVERALL

Average tonnage of 12,444t per ship

Average US price per tonnage \$300

$12,444 \times \$300 = \$3,724,200$ Revenue

Fig 4.13. Stages of dismantling a vessel

Fig 4.15. *Workers Bathing*

4.4 LIVING CONDITIONS

The workers of the ship breaking yards live in slum dwellings located in close proximity to the yards. This housing is the only option for migrant workers, due to it being inexpensive and in close proximity to the yards. The condition of the housing is extremely poor, constructed from left over scrap materials from the ships, and surrounded by the toxins from the yards nearby.(fig 4.16) Research suggests that between 35,000 and 40,000 migrants who work at the Alang shipbreaking yard live in these shanty dwellings without adequate facilities for drinking water, sanitation and electricity.

Workers are forced to defecate in the open due to the low number of toilet facilities available for the thousands of people. Clean drinking water for workers is only obtained by purchasing bottled water from the village. (Sahu, 53) As a result of the poor housing conditions as well as the hazardous nature of the shipbreaking work, inhabitants are at high risk of life threatening to diseases.

Fig 4.16. Slum Dwelling

The over populated housing rules out any possibility of family living as there is not enough space and the dangers and health risks involved. This disconnects workers from their families and leaves no room for a social community. Families typically live in the home villages of where the workers originate from and money is sent back to support them.

4.5 COTTON ABSORPTION

One of the major issues with the shipbreaking process is the toxic pollution that leaks into the sea, damaging the environment and creating unsafe working conditions. Prior to the Alang shipbreaking yard, the area was a well established farming and fishing community, where people lived off the land. Today the coastline is very far from its once fertile state.

Once a ship is broken, oil leaks onto the sand and into the water with every change in tide. The oil combined with heavy metals and lead paint forms toxic sludge that workers trample through every day working in the yards. This sludge not only causes health issues to the thousands of workers but has huge environmental effect on the surrounding land and sea.

In order to mitigate the toxic sludge, the project have investigates methods for clearing oil spills and the materials used in the process. There are typically three methods used to clear an oil spill; physical, chemical and biological.

Physical methods such as booms, which consolidate the oil and skimmers, which lift the oil from the ocean, while effective, do not prevent or mitigate the flow of oil from the ship.

Chemical methods introduce more chemicals into already toxic environment and would not be beneficial to the site. Biological methods use natural occurring elements to counter the effect of the oil. This method was deemed appropriate for this project as it helps to contribute to the concept of a design that is part of a self sufficient ecosystem.

For this design to successfully reduce the oil pollution from the ship breaking process, an appropriate sorbent – an insoluble material or mixture used to recover liquids

through absorption - needed to be identified; one which soaks up the oil, without causing further damage to the environment. Oil sorbents transform liquid oil into a solid state which can then be removed and disposed of. Once oil is a solid, managing and disposal of it is more achievable. No training or expertise is needed to apply a sorbent, therefore many of the untrained workers in the shipbreaking yard could safely adopt and apply a similar method. (Praba Karan, Rengasamy and Das, 193)

There are several different materials that acts as sorbents for oil. One is polypropylene, a synthetic material used in the event of an oil spill in the ocean. However, polypropylene has poor biodegradable properties and can only be used a single time making it inappropriate for the goal of a self-sustained ecosystem. (Praba Karan, Rengasamy and Das, 193) An environmentally friendly and naturally occurring sorbent is cotton. Cotton has similar absorption properties to propylene, yet being a natural source, it can also be used up to five times before being it is required to be burnt down, reducing the environmental impact to a minimum.

Cotton is readily available from locally grown plants in India. With further research into the cotton fields of India, it was discovered that in fact, India is one of the largest cotton producers in the world. In addition to this, Gujarat the state which Alang is located in, happens to be India's biggest producer of cotton. (Esha 6)

From this research, another opportunity was discovered to incorporate another system – an agricultural one – into the design of the project. This system would provide the required sorbent to mitigate the toxic oil spills and an opportunity to enhance the social structure of the community by providing income for the workers' families.

4.6 AGRICULTURAL FARMING

Villages surrounding Alang in a 12km radius have all experienced economic and social changes since shipbreaking started on the shores. Village locals heavily relied on agricultural farming as a source of income prior to the establishment of shipbreaking process in Alang. The arrival of the shipbreaking yards, caused damage to the farm lands, creating an environment unsuitable for growing crops. Many farmers were left with no work, forcing them to work on the yards. (Dermaria 7)

Cotton picking in India is predominantly a female industry while the shipbreaking process is male. This gender discrepancy was seen as an opportunity to reunite families by providing work for both men and women. The need for a natural sorbent such as cotton and a desire to create a stronger social environment was used to add another system to the design – an agricultural system. By combining the cotton industry with the shipbreaking industry, it will allow for both female and male workers to coexist in same area, creating a sense of community. Social wellbeing will improve and provide opportunities for families to live within the safe, toxic free environment of the proposed shipbreaking yards. The addition of cotton to the design, can be used as a device to not only mitigate pollution and protect the environment from the dismantling of ships, but to bring people together creating community whilst investing in the local economy and restoring a once prosperous industry.

The following case study was used as a “proof of concept” to support the idea of integrating an urban farming strategy as a viable system into the project.

CASE STUDY : DYV-NET, DYNAMIC VERTICAL NETWORKS PROPOSAL / JAPA ARCHITECTS

JAPA Architects have designed a concept for an efficient, farming structure, located in the heart of Hong Kong. China's cities have increased by 10 percent annually since the the year of 2000. This has meant a large decrease in the availability of agricultural land. Yet China still supports 20% of the worlds food consumption through farming. The lack of farmland has caused chronic food shortages and with more cities and industries expanding into what's left of the farmland, an innovative shift in rethinking farming is needed. (Furuto)

The result is a vertical farming structure, inspired by the traditional rice farming terraces. The design allows for crops to be grown on a vertical platform, significantly reducing the land area needed to produce more crops. The structure allows light and ventilation through the design and by housing all the crops within the design, it can control the growing process to ensure there is no waste and that there are efficient growing times through incorporated automated systems. (Furuto)

In order to grow cotton in the shipbreaking yards, a functional design solution was needed to ensure the crops have enough natural light, ventilation and water within the restricted land area of each plot. The Dyy-net project provides a precedent for the agricultural system that has been introduced to the design project. These elements can be seen in the images. (fig 4.18)

Fig 4.18. Vertical Networks

4.7 SHIPPING CONTAINER SYSTEM

Throughout the world, there are thousands of abandoned containers left at docks because of their operational lifespan of twelve years. Their size and characteristics are universal in order to facilitate the handling and transport of them. (Minguet 6) As part of a sustainable strategy for the project, it was determined that these containers could be recycled and integrated into the design in several different ways.

One was that they could be utilise as small modular houses for the thousands of workers, replacing their current living conditions in the slum dwellings. The number of workers required on site varies based on the size of the ship being broken and this modular system can respond to that demand by increasing or decreasing the number of housing units as the work requires. There are many examples around the world of containers being used for housing, particularly in wake of a disaster or as a transitional form of housing. (Meinhold, 62)

CASE STUDY : SHIPPING CONTAINER RELIEF HOUSING – SEED

SEED is a disaster- relief housing system that transforms shipping containers into homes. Designed by students at Clesmon University, a prototype was built in 2009. The design was in response to a natural disaster in the Caribbean. Students were tasked to provide housing for the many who lost homes. When investigating local materials, it was discovered that there were millions of unused shipping containers. These became the modular basis to the design.

SEED used 40 x 8 foot containers, fitting them out into comfortable living spaces. The design also included emergency gardens, allowing families to have a self sufficient food supply. Water pods were incorporated to provide clean, safe drinking water and showers and energy pods provided electricity. (Meinhold, 75)

This case study provided a precedent for how containers can be converted into housing. While the case study used containers that were 40 x8 foot, (12 x 2.4 meters) this project uses the a container standard of 20x8 foot (6 x 2.4 meters), (fig 4.19) throughout the project. This allows for the same structural system to be used for both dismantling the ship and providing housing.

The 20 x 8 foot (6 x 2.4 meters) containers will determine the size of the structure I will use for the combined design system. This will enable efficient transportation of containers through each shipbreaking yard. The housing containers can be designed in modules. Having a fixed kitchen/ living container and bathroom/showers containers attached to sleeping containers housing single bunk beds, will maximise the amount of people that can inhabit each yard in more improved living conditions. This idea will be explored in my design chapters.

Fig 4.20. Seed Housing Project Using Recycled Shipping Containers 49

AUTOMATED BAGGAGE HANDLING SYSTEM

Fig 4.21. Automated Baggage Handling System

Soundly. They could be used as a transportable collection system for the reclaimed materials. As a ship is dismantled, workers can stack the recycled materials into the shipping containers. Once filled the containers could be moved to a loading dock and carried away. (fig 4.22) This would dramatically reduce the hazardous materials that get dumped onto the beach and would improve the productivity of breaking down each ship.

Because the shipping containers are modular and easily transportable, a system to move them around the project was needed that was efficient and safe. Research was conducted into automated retrieval systems similar to airport baggage handling. Airport baggage handling systems (fig 4.21) are capable of moving millions of pieces of luggage around the world quickly and reliably with little human interaction. These efficient systems were the inspiration for an integrated container handling system with the project.

Fig 4.22. Container Rotation Diagram 51

Fig 4.23. Genusregal Grid Structure

CASE STUDY : GENUSSREGAL SHIPPING CONTAINER SHOWROOM BY BWM ARCHITEKTEN UN PARTNER

The Stacked Shipping Container Showroom, was designed by Vienna-based, BWM Architekten un Partner. (fig 4.23) This impressive 60-meter-long steel beam structure, housing the shipping containers, not only supports each shipping container but allows the shipping containers to be repositioned and rearranged over time. (Meinhold)

Vibrant colours painted over the shipping container cladding would work harmoniously with the landscape and the vibrant, colorful Indian culture. Through conceptual diagrams I can start to understand how spaces could be zoned into housing, transport, shipbreaking, storage and office area.

Fig 4.24. Movement Diagram of Container Through Structure 53

4.8 WATER

Alang and the surrounding area is classified as 'drought prone'. With an average annual rainfall of 558mm and temperature average 28.5 degrees Celsius. (Elias, 23)

The majority of the rainfall is collected in the monsoon season during July with an average of 227mm. In other months there is little to no rain. (Climate) Collection of rainfall in the monsoon period is therefore critical, in order to supply the community with fresh drinking water and water for the agricultural crops.

Water is currently supplied from rivers and ponds, which often dry up in the summer months. Further more, most of this water is polluted with human waste from washing clothes and bathing, as well as from passing cattle and vehicles. Many of the streams in Alang are also used to discharge waste water from the villages. (Elias,23) For the workers in the shipbreaking yard, fresh water is only obtained when water tankers are transported to the site by authorities.

In order to achieve a self-sufficient eco system design as outlined in the overall research objectives, I have investigated biomimicry principles that can be applied to the design solution of the shipbreaking yards. Specifically, understanding natural water collection techniques. Providing a source of fresh water to the inhabitants and community is essential in order to improve their lively hood. This investigation of biomimicry is outline in the concept design phase.

Fig 4.25. Alang Site Map

5

PRELIMINARY DESIGN

5.1 OBJECTIVES 5.3 PROGRAMME 5.2 INCORPORATED SYSTEMS

5.4 SHIPBREAKING PROCESS 5.5 SCALED MODEL 5.6 SUMMARY

5.1 OBJECTIVES

- Establish design programme.
- Establish how non-architectural systems and local materials and methods can be used within the design structure, to mitigate pollution, improve safety and create a self-sufficient eco system.
- Investigate how the shipbreaking process can become more efficient and improve economical growth to the industry.
- Explore design outcomes through physical modelling in order to understand scale.

5.2 PROGRAMME

The programme has been determined by the systems needed to ensure the design meets the objectives for this thesis. Specifically, pollution mitigation, an improved shipbreaking process and providing a safer environment for inhabitants occupying the site. This program has been established through diagrams in order to understand the relationship between the identified systems. (fig 5.02)

1. Establish program
2. Establish size in relation to other programs.
3. Relationships between programs. Recycling metal on site no longer included.
4. Program iteration 1.
5. Program iteration 2.
6. Program iteration 3.

KEY

- Housing
- Shipbreaking System
- Cotton System
- Circulation
- Container storage
- Metal Recycling

Fig 5.02. Program Study

Fig 5.03. Final Preliminary program diagram.

Fig 5.04. Cotton Absorption Sketch

Fig 5.05. CAD Model of the Preliminary design outcome 61

5.3 INCORPORATED SYSTEMS

The systems established in the early research have been incorporated into the design in order to ensure the objectives of this thesis are met. These systems are as follows:

- Automated retrieval system is used in the Shipbreaking Platform. (fig 5.08)
- Cotton growing system used in Dock structure.(fig 5.06)
- Cotton absorption system used in Cotton Tower. (fig 5.10)
- Water collection system used in Dock structure and Shipbreaking Platform.(fig 5.07, fig 5.09)

Fig 5.06. Dock Structure System

DOCK STATION

This grid structure has been functionally designed to accommodate the transportation of containers and includes the space needed for them to rotate where necessary.

The grid layout, based on the Genussregal case study (fig 4.23) provides flexibility to accommodate the shipbreaking process, water collection and housing. The length of the structure also provides a purposeful growing area for cotton plants.

KEY

1. Cotton Field
2. Cotton Producing + Water Collection
3. Container Transport System
4. Offices
5. Platform Housing and Services
6. Transport exchange
7. Structure

Fig 5.07. Dock Structure Exploded.

Fig 5.08. Shipbreaking Platform

SHIPBREAKING PLATFORM

The automated retrieval system used in the shipbreaking platform allows empty shipping containers to be transported to the breaking platform. Once filled with recycled metal, it is transported and held in storage until taken of site.

Housing containers located to the east, with views and all day sun, provide separation from the shipbreaking process, which is necessary to improve inhabitants wellbeing. However, this has isolated the housing from where potential community activities can occur and will need to be addressed moving forward.

Fresh rain water collection is achieved through water tanks, producing enough water for the housing units to maintain fresh water all year round.

KEY

1. Cotton Field
2. 88 Shipping Containers
3. Moving System
4. Shipbreaking Area
5. Transporting Line
6. Breaking Platform
7. Cotton Recycling
8. Housing
9. Housing Platform
10. Wheels

Fig 5.09. Exploded Program of Shipbreaking Platform

Fig 5.10. Cotton Tower

COTTON TOWERS

Cotton towers ensure the cotton is run under each vessel and around any area where oil may spill through the shipbreaking process. This system will ensure the objective of pollution mitigation is achieved

KEY

- 1. Cotton Extractor Component
- 2. Cotton Extractor
- 3. Cotton Recycling
- 4. System Area

Fig 5.11. Exploded Program of Cotton Tower

5.4 SHIPBREAKING PROCESS

The design proposes a more refined solution to beaching the ships working from the original process. Still relying on the natural topography of the site and a king tide, a raised boat ramp has been designed allowing a safe platform for a vessel to be driven onto. The cotton wraps under the ramp, in case of any oil spills, where the oil will be absorbed. As a result, there should be no contact between the oil and the beach. This can be seen throughout the model images. (fig 5.14)

This design improves the dismantling process of each vessel, reducing the time taken to 56 days, seen in (fig5.13, fig 5.14). By reducing the process to 56 days, compared to the current 80 days, each plot will dismantle two additional ships yearly, therefore ensuring economic growth in the future.

Fig 5.13. The Improved Shipbreaking Process Over 56 days

Fig 5.14. Shipbreaking process break down over physical model

PHYSICAL MODEL DIAGRAM

The physical model showcases how the shipbreaking process is improved to 56 days. (See Above). Lines drawn over the model indicate the path the shipbreaking platform will take. (See Below)

Fig 5.15. Physical model photos

5.5 SCALED MODEL

The 1 : 500 scaled model has allowed me to explore the design in a physical form which has highlighted strengths and weakness. A weakness being the disconnection between each system. While each system functionally benefits the shipbreaking yards, an integrated design is more desirable. This will also reduce the large foot print this current design has established, highlighted by the physical model.

A strength of the design has been the incorporation of cotton as a locally sourced material to mitigate pollution.

SCALED MODEL

Fig 5.16. Physical model photos

Fig 5.17. *Photographed in site*

5.6 SUMMARY

Strengths

- The time it takes to dismantle a vessel has been reduced through the use of an automated shipping container system inspired by the case studies.
- Integrating the agriculture into the design has many environmental, economical and social benefits. The use of locally grown cotton to absorb oil in order to mitigate pollution, uniting separated families into a community, and re-establishing agriculture as a local industry.
- Water collection tanks incorporated into the design enable fresh rainwater to be collected during the monsoon season and distributed when fresh water is needed.

Weaknesses

- The disconnection of the programmes as a result of the incorporated systems needed to meet the design objectives. More programme analysis will be undertaken and investigation into a suitable roof structure will start, to ensure a more cohesive design.
- The current water collection method would work well during wet months, however a method of collecting water all year round would make the design more self sufficient. This research can run in parallel with designing a roof structure.

6

CONCEPT DESIGN

6.1 OBJECTIVES

6.2 PROGRAMME

6.3 BIOMIMICRY PRINCIPLES

6.4 DESIGN OUTCOME

6.5 SUMMARY

Fig 6.01. *Plan Collage*

6.1 OBJECTIVES

- Continue to explore ways to integrate the systems into the programme to establish a more cohesive design.
- Maintain the current cotton absorption method, however improve and refine the system.
- Investigate methods of enclosing the design with a roof structure that will enable more efficient water collection all year round. This can be achieved by investigation into biomimicry architecture principles.
- Investigate how the housing and living spaces can be better incorporated into the design.

Fig 6.02. Revised Program Iteration One

KEY

1. Housing
2. Container Storage
3. Shipbreaking Platform
4. Cotton Growing
5. Cotton Burning tower
6. Boat Ramp

Fig 6.03. Revised Program Iteration Two

6.2 PROGRAMME

To improve the functionality and connection of the program, I have carried out sketch experiments over the existing physical model. Through this process I have established a more cohesive and functional design, where the integrated systems work more harmoniously together. The sketches were then tested in CAD software, creating a 3D model, allowing me to further explore 'Revised programme iteration two'. (fig 6.03)

The cotton growing system has determined by the amount of area needed to produce enough cotton for pollution absorption throughout the year. Therefore, determining the overall length.

Fig 6.04. Section A - A Sketch 85

Fig 6.05. Naibian Fog-Basking Beetle

6.3 BIOMIMICRY PRINCIPLES

*“You never change things by fighting the existing reality. to change something, build a new model that makes the existing model obsolete” Richard Buckminster Fuller.
(pawlyn 1)*

Fuller’s quote gives insight into a different way to think about design, one which provides investigation into systems and materials outside the typical architecture realm.

In order to achieve a self-sufficient eco system that naturally collects fresh water for the inhabitants and community, I have investigated biomimicry principles that can be applied to the design.

“For virtually every problem that we currently face – whether it is producing energy, finding fresh water or manufacturing benign materials- there will be numerous examples in nature that we could benefit from studying.” (Pawlyn 1)

The Namibian fog-basking beetle harvests its own fresh water supply in a desert. At night the beetle will climb to the top of a sand dune, its matt black shell will radiate heat becoming slightly cooler than its environment. As the moist breeze blows in off the sea, water starts to pool in droplets on the beetles back. Then, before morning light, it tips its shell up and the water runs down to its mouth, for a drink, before returning to hide from the searing heat. (Pawlyn 67) (fig 6.06)

This method of harvesting fresh drinking water can be applied to the roof structure design, With Alang’s climate conditions and proximity to the sea it should result in a similar outcome, if the roof is designed correctly. This roof design will enable access to fresh drinking water during the dryer months and can still be produced daily, rather than being reliant on catching water during the monsoon season. Water produced will be used for housing and cotton growing. Any excess water would be used to supply the community with clean drinking water.

Fig 6.06. Namibian Fog Catching Beetle Water Harvesting Diagrams.

- KEY**
- 1. Hydrophilic
 - 2. Hydrophobic
 - 3. Droplet
 - 4. Rolls
 - 5. Mouth
 - 6. Angles its back.

Fig 6.07. Roof Sketch Iterations Mimicking the Namibian Fog-catching Beetle

Fig 6.08. *La Palmas Water Theater Perspective*

Fig 6.10. *Section*

Fig 6.09. *Louvers*

CASE STUDY : LAS PALMAS WATER THEATRE

This project addresses water management issues in Las Palmas, an island which is suffering from declining rainfall. With tourist numbers increasing every year, fresh water is scarce and needs to be transported in from mainland Spain. (Pawlyn 70)

The design doubles as a desalination plant and sculptural outdoor theatre. Inspired by The Namibian fog-basking beetle, Pawlyn collaborated with Seawater Greenhouse to design “an array of condensers and evaporators that are stacked on top of each other” which produces fresh drinking water. (Rankouhi 33).

With seashore breezes consistent year round, the design harnesses them and directs the breeze through the louvers, mimicking the arching of the beetles back. The louvers guide the breeze into the condensation panels which draws seawater from 100m below the surface. The warm air is blown through and reacts with the cool seawater, resulting in fresh condensation that is collected for drinking water. The louvers optimize productivity as wind from any direction can be directed through the design. (Pawlyn 70) (Rankouhi 33)

The Las Palmas Water Theatre successfully demonstrates a well-designed architecture , that besides being efficient and functional; responds to the issues of water shortages,. Architecture here acts as a catalyst between aesthetic and programme allowing the architecture to become more than just form – it also provides a necessary function.

The design for this thesis will draw from the functional aspects of this case study in order to obtain fresh drinking water on site. The idea is to provide a dual function; providing an aesthetically pleasing form as well as providing necessary water for a community.

CASE STUDY : INVESTIGATION

It is essential the roof is capable of providing fresh drinking water all year round. Using the current sketched roof in fig 6.11 as an initial design, I created a 3D printing a façade system, based upon the researched principles of the Namibian fog desert beetle. This enabled me to investigate a façade system that could be attached to the roof to harvest fresh water daily for the entire community.

The hydrophilic areas on the roof mimic the beetle's back, however I have designed a catcher with an increased hydrophilic surface area, that allows for more water to be produced. This can be seen in (fig 6.11)

The catchers (fig 6.11) provide enclosed surfaces that heat up from the sun, then when night falls, cool air pass-through the catcher. This reaction creates condensation which becomes fresh water. This water is collected at the base of the catcher and is directed to water tanks within the design.

The catchers are designed to pivot and can be positioned in any direction the wind is blowing to ensure water harvest is daily. This concept is derived from the louver system in the Las Palmas Water Theatre.

Strengths

This roof design would naturally harvest enough fresh water daily for the inhabitants and the surrounding community.

Weaknesses

On reflection, a more simplified version may be just as efficient and more appropriate to integrating into the design.

KEY

- 1. Hydrophilic
- 2. Hydrophobic
- 3. Vapor Catcher
- 4. Wind Caught, cooling down inside the catcher, creating condensation resulting in droplets.
- 5. Water Droplets
- 6. How Catchers can be applied to the roof as a facade system to collect water for the community.

Fig 6.11. 3D Printed Experimentation of Self Water Harvesting

Fig 6.12. Program Collage Resolved From Sketch Iteration

ROOF DESIGN

The following iterations (fig 6.13) show the design evolution of the roof's form. The final resolved roof shape ensures water collection is improved whilst being aesthetically pleasing among the landscape of Alang.

Based upon the case study of Les Palmas (fig 6.09) the form of the roof has been designed to maximise rain collection, while still harvesting its own water at night using the methods of the Namibia Fog Basking Beetle.

The roof heats up during the day and is shaped to catch the cool night breeze, creating condensation. The condensation pools on the roof and flows down channels designed to lead the water to various water collection tanks. Water is then distributed to the necessary areas.

The collection tanks are designed to hold larger volumes of water to ensure all the water is collected through the monsoon season. This ensures water can be stored, resulting in a fresh water supply for the inhabitants, community and cotton growing all year round. (fig 6.25)

Overall this roof doubles as a lifeline to the inhabitants and community with its water harvesting qualities as well as a functional response to providing aesthetically pleasing shaded community areas.

Fig 6.13. CAD Modeling Iterations of The Biomimicry Influenced Roof

West Elevation

South Elevation

6.4 DESIGN OUTCOME

The following exploded diagrams highlight how each system is incorporated into the improved design. The result of this design was found through the various sketch iterations explored in this chapter. (fig 6.03)

Fig 6.14. Water collection systems

Fig 6.15. Cotton Growing and Absorption Systems

Fig 6.16. Automotive Retrieval System

Fig 6.17. Housing System

Fig 6.18. Circulation and Community Area /Water Supply.

The grid structure has been maintained allowing for the automated retrieval system to transport containers through the design for shipbreaking and housing purposes. The location of the housing area is still slightly isolated from the shipbreaking process as cotton and vertical water tanks act as visual barriers from the shipbreaking platform. (fig 6.16) The new housing layout also allows for better community connection. The finer details of the community and housing layout will be further refined in the next stage of the design.

Community areas have been added with the roof structure providing shade over a large grassy area that can be used for markets and outdoor activities. This is positioned at the entrance of the design allowing a transition area to the entire Alang community. Bathing pools, for immediate residents and the community as a whole have also been incorporated based upon traditional Indian bathing steps. These are filled from the water harvesting roof. (fig 6.22)

Fig 6.19. Overall Diagram of Incorporated System

The following images demonstrate how the shipbreaking design is situated on site and how it is occupied by the inhabitants.

Fig 6.20. Site context plan of Alang, Inida.

Fig 6.21. Roof Plan

Fig 6.22. Plan Level Three

PLAN

KEY

1. Entrance	5. Housing	9. Automative Retrieval System
2. Bathing Pool	6. Shipbreaking Platform	10. Truck Ramp
3. Boat Ramp	7. Cotton Growing	11. Conatiner Storage
4. Circulation Walkways	8. Community Area	12. Community Water Supply

KEY

1. Entrance	5. Housing
2. Water Storage	6. Shipbreaking Platform
3. Boat Ramp	7. Cotton Growing
4. Walkways	

Fig 6.24. *Coexistence of The Living and Working Systems*
Section A-A

Fig 6.25. *Coexistence of The Living and Working Systems Section B - B*

KEY

1. Water Collection Tower
2. Housing
3. Shipbreaking Platform
4. Cotton Growing

Fig 6.26. *The Machine*

Cotton and water towers provide a visual barrier from the shipbreaking. (fig 6.27)

The shipbreaking platform provides a safe area for workes to use current tools to break down the metal in small piece and transported in shipping containers.

Fig 6.27. Shipbreaking Platfom 121

Fig 6.28. Combined Shipbreaking Machines

Fig 6.29. Crit Review

5.6 SUMMARY

Strengths

- The programme works more cohesively with all of the necessary systems. This ensures the design still maintains significant pollution reduction, an increase in shipbreaking productivity and safer living environment for inhabitants.
- The use of biomimicry principles to design a self-harvesting fresh water collection roof has ensured clean drinking water all year round for the inhabitants and community.

Weaknesses

- Housing and community areas have not been fully investigated to allow for a more experiential condition. These areas are still leftovers of the systems and not designed to the human scale.
- A connection to the waters edge from the housing should be established. The project sits as an object in the landscape and does not integrate well into its surroundings.

7

DEVELOPED DESIGN

- 7.1 OBJECTIVES
- 7.2 DESIGN OUTCOME
- 7.3 SUMMARY

Fig 7.01. Slice of Overall Plan

7.1 OBJECTIVES

- Define the various housing zones with improved public spaces between them.
- Continue to design aspects at more of a human scale, understanding how spaces of inhabitation respond to the surroundings.
- Provided access to the water each that can be used by inhabitants and the community.

7.2 DESIGN OUTCOME

The proposed project provides a solution to improve the shipbreaking process, mitigate toxic pollution and provides improved living conditions for the shipbreaking workers in Alang. The final design phase will concentrate on the details of the design such as how the spaces can be occupied at a human, experiential scale. These spaces will include details of housing area, a place of worship, community areas and connection with the site.

Fig 7.03. *Ship Arrives on a King Tide*

Fig 7.04. Exploded Isometric

EXPLODED ISOMETRIC OF SHIPBREAKING SYSTEMS

KEY

1. Water collection Roof
2. Truss
3. Shipbreaking lift
4. Container System
5. Housing
6. Circulation
7. Cotton System
8. Louver System
9. Oil burning
10. Structure

HOUSING

The inclusion of the cotton industry to the design, in order to mitigate pollution brings the opportunity to provide family housing units due to the fact that the cotton industry is predominately female workers. Housing will need to be provided for single workers and workers with families. In order to help differentiate the single housing from the family housing, the living areas have been separated vertically. (fig 7.05) The single housing units occupy the lower levels of the structure and the family units are located on the upper floors. Dividing the floors is a shared food market.

The top floor is an open area located towards the east and acts as a place of worship for the migrant workers. Due to the diverse culture in the shipbreaking yards, a specific worship design would not be suitable so a more universal worship space was provided. (fig 7.05)

Bathing steps have been added as a transition between the structure and the sea providing a grounded connection to the site. These steps invite inhabitants to bathe in the sea. While not an option in the current state of the site, the future state of the site will allow this. The bathing steps are easily accessed via the double height stair wells at the both ends of the overall structure.(fig 7.05) The traditional washing area at the entry of the shipbreaking intervention has increased in size in order to accommodate more room for community use and activities. Water taps at the end of the bathing steps also provide a collection point for fresh drink water harvested by the roof. (fig 7.10)

On the floors occupied with housing units, the layout is more spacious compared to the previous preliminary design concept. This has been rearranged to provide more space between each unit to allow interaction outside the houses. (fig 7.12, 7.13, 7.14, 7.15).All the shipping containers within the design have unique facades due to the nature of being recycled. This gives the inhabitants some identity and individuality to their dwelling. (fig 7.08)

Access to the shipbreaking platform and community spaces are provided through the stairs at the end of the structure. The addition of a new stair well at the end of the housing area facing the east, improves the circulation for inhabitant's. Double height spaces have been designed around the stair well to provide greater sun access in the housing area and also make the overall space feel more open. (fig 7.05)

ISO OF HOUSING SYSTEM

KEY

1. Water towers
2. Worship Area
3. Family Living levels
4. Single Living levels
5. Food Market level
6. Circulation
7. Bathing Steps
8. Bathing Area

Fig 7.06. Family Housing

FAMILY HOUSING CONTAINER

KEY

1. Kitchen/Dinning
2. Bathroom
3. Bunkroom
4. Master Bedroom

The family units are made up of two connected standard shipping containers that are self contained. The containers house a kitchen/living space, a bathroom, a bunk room and master bedroom. While the areas are all small they are vast improvement from the slum dwellings.

SINGLE HOUSING CONTAINERS

The single housing units house the majority of the shipbreaking inhabitants. These units provide a communal living arrangement. Each container has been designed to house a different function. The units have been broken down into communal bunk rooms, a kitchen, a bathroom and a living/dining space. This living arrangement ensures that a large amount of workers are able to live on site in an improved housing environment. The design provides outdoor spaces for socialising and dining, as seen in design plan.

KEY

1. Toilets
2. Bunk Room
3. Dinning Room
4. Kitchen

Fig 7.08. Housing

Fig 7.09. Roof Plan

0m 10m 20m 40m

FOLD - OUT PAGES

FIG 7.10 PLAN LEVEL FOUR

FIG 7.11 SECTION A - A

LOW TIDE

HIGH TIDE KING TIDE SHORELINE

- KEY
1. Entrance	5. Living Area	9. Markets
2. Bathing Pool	6. Shipbreaking Platform	10. Oil Burning
3. Bathing Steps to the Sea	7. Cotton Growing	11. Container Storage
4. Walkway	8. Community Area	12. Community water supply

Fig 7.01. Plan Level Four

Fig 7.02. Section A - A

OR PLANS

SINGLE LIVING FLOOR

10

7

2

1

1

1

3

6

5

7

8

11

12

KEY

1. Bunk Rooms

2. Kitchen

3. Toilet

4. Bath

5. Changing Room

6. Locker

7. Stairs

8. Cotton Preparing

9. Washing

10. Drying

11. Open Area

12. Storage

0m 5m 10m 15m 20m

1. Bunk Rooms
2. Kitchen
3. Toilets
4. Living Area
5. Entrance
6. Walkways
7. Stairs
8. Cotton Preparing
9. Bathing Steps
10. Community Space
11. Container Storage

Fig 7.12. Level Four Floor Plan Repeats on Level Five

SHIPBREAKING PLATFORM

Fig 7.14. Section B - B Shipbreaking Platform 151

Cut Ship into a large section.

Further reduce section on the shipbreaking platform into manageable piece that can be carried to the empty shipping containers.

Automated container system removes the shipping containers full of scrap metal from the shipbreaking platform to storage.

A truck removes the full shipping container and transports it to the recycling plant.

Fig 7.15. Shipbreaking Process

The shipbreaking platform is controlled by a lift that moves down as each section of the vessel is cut.

Fig 7.17. Men Working on the Shipbreaking Platform 155

COTTON SYSTEM

Fig 7.18. Section C - C Cotton System 157

Fig 7.20. Cotton System Diagram

KEY

1. Water collection from the roof, supplies fresh water for the cotton plants.

2. Air ventilation is controlled by the louvers.

3. Cotton runs around the structure and under a vessel to absorb any spilled oil.

4. Cotton crops growing.

Fig 7.19. Cotton System Exploded

Fig 7.21. Woman Working in the Cotton System 159

Fig 7.22. Entrance Showcasing the Community Area 161

Fig 7.23. *Inhabitants and the Community Living in the Shipbreaking Yards*

7.2 SUMMARY

Strengths

- The housing areas of family living and single living have been refined and detailed. Access between floors throughout the housing area have been improved through the addition of an east facing stair well.
- Steps from the housing zones connect the inhabitants with the sea and allow for simple access.

Weaknesses

- The nature of the designing an integration of various systems has meant the structure is quite machine like and the experiential quality of the project may not be as strong as it should be. The need to provide improved living and working conditions for the workers and Alang in general have superseded this.

Fig 7.24. Housing Area

8.1 SUMMARY

The economical means behind the shipbreaking yards in Alang are in fact beneficial to thousands of workers in the yards and across India. Due to the lack of regulation in the shipbreaking industry in Alang, the process of shipbreaking results in a hugely detrimental environment with safety issues that cause disease and death.

The primary aim of this thesis has been to improve not only the economical benefits but more importantly, the lives of thousands of disadvantaged workers living in the contaminated shipbreaking yards. This thesis has tested approaches on how contemporary technologies can improve the current shipbreaking process by exploring ideas both inside and outside the realm of architecture. In order to provide an efficient, safe process without displacing impoverished workers and to provide opportunities for workers to live with their families in a safe environment, the design considers how a community could be created within the current shipbreaking structure.

The design itself provides inhabitants with a safe living and working environment with great economic benefits to the shipbreaking industry in the region. Resolving issues of pollution, safety and productivity, the final outcome combines local materials, industries, and communities with contemporary technologies to create a self sufficient design system.

The final design meets the aims and objectives outlined for this thesis. The design functions as a machine, incorporating systems to complete tasks to ensure the shipbreaking process is efficient and as safe as possible. Housing has been designed to be as segregated as possible from the shipbreaking process

in order to create the most comfortable housing solution within the entire “machine”. This was a difficult task as the grid structure has been primarily set up to move shipping containers efficiently

The housing section is relatively flexible with each floor having different possible layouts with the shipping containers. The recycled nature of the containers provides inhabitants with housing containers that have a sense of individuality. The brightly coloured containers reflect the colourful Indian culture, and sit harmoniously within the landscape.

The design intervention is made up of innovative systems which enable it to harvest clean drinking water, provide a safe working and living environment, improve the shipbreaking process, and reinvigorates agriculture within the region. Essentially the design has become its own self-sufficient ecosystem. The introduction of women through the cotton picking industry, gives an opportunity for reintegration of family life to Alang. The proposed design offers a solution for the shipbreaking yards to grow into a community along the coastline of Alang India instead of continuing in its problematic state

8.2 FUTURE

If the scope of this investigation were to be expanded in the future, there are opportunities to implement similar systems in other shipbreaking yards in India and Asia. These include places such as Mumbai, Bangladesh and Pakistan, where similar issues with ship breaking occur.

The architectural framework established for the shipbreaking yards of Alang provides a platform that the industry could build upon to provide improved infrastructure, specific to each area.

Regulation for minimal standards could be set, based upon this design, that mitigates environmental pollution and increases economic growth while providing safer working and living conditions through architectural design.

‘Living on the edge’ can be achieved through integrated systems that are responsive to the surrounding environment.

Fig 8.01. Shipbreakers Working In Bangladesh

Fig 8.02. Boys Working and Living in the Shipbreaking Yards of Bangladesh

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