THE KUIP CENTRE FOR BIO-BASED RESEARCH AND RECREATION.

The Migration of Energy

1. INTRODUCTION

1.1 Thesis Topic

The Migration of Energy looks at the Dutch transition towards a bio-based economy.

This proposal contextualises the Dutch energy transition through three key themes. Firstly, the move away from conventional biofuels towards biomass waste and algae as an advanced biofuel. Secondly, the importance of an emblem intrinsic to Rotterdam, that sets a precedent for the transition and thirdly the necessary engagement with the public in order for the transition to be viable. All of which will showcase Rotterdam's values and commitment to a renewable energy transition.

By integrating public, recreational sports and leisure activities with conventionally private primary industry, this research and design proposal aims to identify the programmatic capacity for an emblem to act as an educational and interactive tool for the public. The ambition to create a hybrid centre for bio-economy research and production, underpinned by social and ecological practice.

1.2 Research Summary

The bio-economy is a sustainable approach to primary industry that generates energy, food ,feed and water in an environmentally sensitive way, that sustainably manages the world's finite natural resources. The bio-economy harnesses renewable biological resources and converts these resources and associated waste streams into 'value added products, such as food, feed, bio-based products and bio-energy'. (European Commission, 2012)

Although biofuel were once seen as the solution to replace fossil fuels in the transportation industry, new research has revealed that external factors such as indirect land use change make co2 emissions from biofuel production comparable or even greater than diesel (T&E, 2016). Therefore, cleaner alternatives are required. Whilst there is no single perfect solution to climate positive energy

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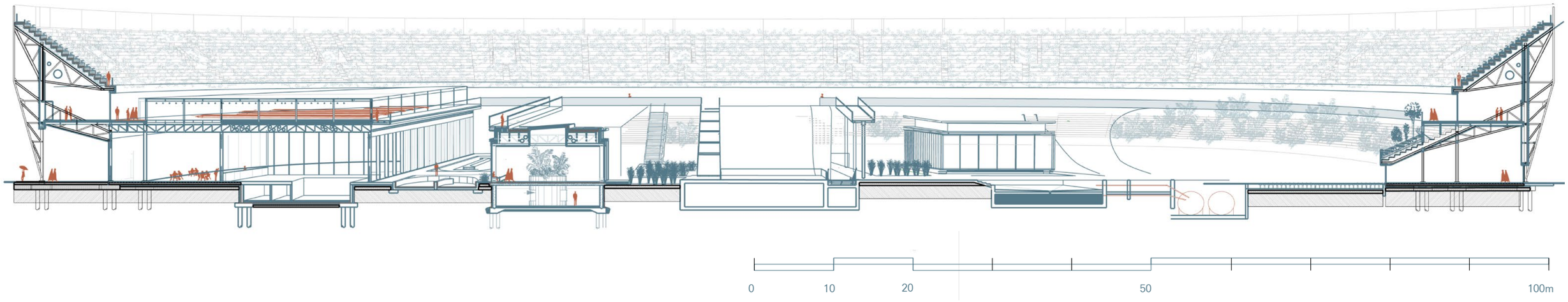


generation, The Migration of Energy considers how public buildings within a city like Rotterdam can harness existing metabolic and ecological flow in order to generate new, cleaner and more environmentally conscious energy, food, feed and water.

The devaluation of nature is increasingly present through biodiversity loss, climate change, air and chemical pollution and contamination, (Kellert et al 2008, 5). A bio-based design strategy offers the opportunity to use nature to mitigate current environmental challenges as well as introduce design principles with low environmental impact and principles that benefit the natural environment through 'restorative environmental design'. (Kellert et al 2008, 5) further having positive impact on inhabitant's health and productivity.

Based on the principles of hedonistic sustainability, leisure and swimming facilities are introduced because of their role in encouraging public adoption of new technologies. Hedonistic sustainability approaches functional challenges of providing and managing water, energy and climate within the built environment, whilst also creating spatial pleasures and recreational amenities for local inhabitants (Ingles 2011). Through this principle, ecosystems are created that merge economy and ecology to improve quality of life rather than burden it (Ingles 2012).

Contemporary research indicates that the public should be more active stakeholders within the transition because of their capacity for surveillance, adoption of new technologies and government led programs. (WUR, n.d). Feyenoord City's Football stadium; The Kuip, is due to be succeeded by a new stadium. Enabling a significant opportunity to create an 'emblem' for Rotterdam's bio-economy transition.

1.3 Research Question

One therefore proposes the research question :

How can Rotterdam create an emblem for the Dutch bio-economy transition that fosters transparent communication between industry, policy and the public?

1.4 Design Brief

The Kuip Centre For Bio-Based Research and Recreation uses leisure and play to bring plant-based industry to the forefront of public minds on an urban and national scale.

The Kuip is in a historically deprived district, surrounded by socially and economically deprived neighbourhoods with low environmental quality and low access to higher level education, particularly within the sciences. This diverse program addresses the challenges of the Feijenoord neighbourhood in an accessible way. It's position at the beginning of a newly re-established green belt activates a public, natural landscape that can inspire curiosity and education in an engaging and playful way. Stadium's and large sports facilities, because of their scale have historically been zoned on the peripheries away from residential buildings and offices. (Hofmeister, 2019 4). Reinforcing the harsh boundary between residential zone and quiet, lifeless, business park within Feijenpoort. By occupying and densifying the stadium with a mix of sports, leisure, commercial business, the building along with the rest of the Feijenpoort site strategy can transform the surrounding neighbourhoods of De Veranda, Vreewijk, Hillesluis and Feyenoord into more diverse and less mono-functional neighbourhoods.

1.5 Research Plan Analysis

Group and individual research into Rotterdam South and the Feijenpoort area was conducted through first hand site visits, interviews with local residents as well as second hand data. This culminated in an understanding of key opportunities for social, economic, environmental and physical improvement. These were further framed through the lens of achieving all SDG goals as a group. These further helped to shape our intentions and select an appropriate site. Once a program was defined, functional organisation and design strategies were developed in order to fulfil the program's ambition. These were shaped by benchmarking buildings of similar architectural quality, ambition, scale and program. This exercise was instrumental in ensuring appropriate program relations particularly when proposing a hybrid program such as this.

The strengths of the research plan are the clear ambition to transition towards cleaner biofuel and potential to 're-brand' the Kuip and neighbourhood.

2. DESIGN CONCEPTS

2.1 Site Concept

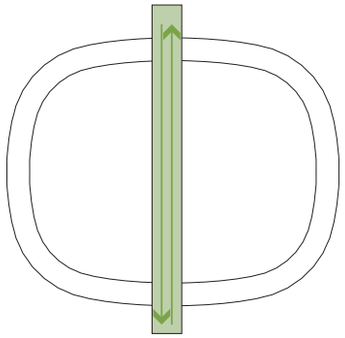
As a municipal monument, the site is a landmark of heritage and cultural value. It is therefore an important cultural node within Rotterdam and within the Feijenpoort site strategy. Therefore, clear approaches to the site are made through pedestrian boulevards. Both from the harbour and across the train tracks to connect to the Academy for the Arts. At the smaller scale of the immediate site boundary, the building further considers these access points from Puck van Heelstraat street and the former Feyenoord City Sprinter Station.

2.2 From Spectator to Participant

The Kuip is a municipal monument (OMA et LOLA 2019) located in Rotterdam South, yet close to the heart of Rotterdam. It is already an emblem of collective pride for football lovers. Retaining this sensory experience of awe and reverence is particularly important. By creating public spaces in the centre of the 'pitch', visitors also switch from spectator to participant.

AMBITIONS

2.3 Green Corridor

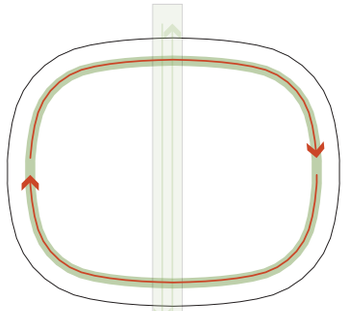


2 DESIGN CONCEPTS

Why: Using nature to enhance the public realm and connect public programs will encourage pedestrian physical and social life as well as improve the quality of the built environment.

How: An activated walkway connecting the Kuip to Feyenoord City harbour along the Feijenpoort cultural axis and associated public transport routes. (Water taxi, sprinter station, metro and tram route)

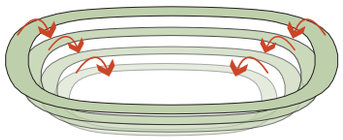
2.4 Parallel Journey for participant and process



Why: The circular shape of the Kuip can be seen as an infinite loop. This can enable a journey around the building, towards the roof where visitors can experience the newest innovations in harnessing plant technology through the cultivation of algae.

How: The Closed Loop Walkway will create a symbolic and physical circular relationship between programs.

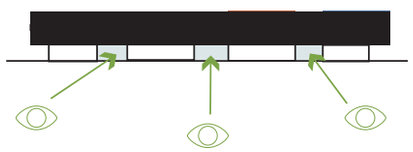
2.5 Cascading Landscape



Why: An extensive green roof structure creates a pleasant natural landscape for recreation whilst encouraging biodiversity, as well as educating the public.

How: The existing grandstands creates a strong foundation for a new natural landscape to be constructed on.

2.6 Solid vs Void

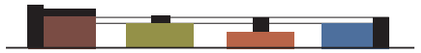


Why: A transparent ground floor will enable visual connections with the programs inside the Kuip and the surrounding context. It will indicate public program and retain the expression of the stadium as a 'bathtub' shape that is denser towards the top.

How: Transparent glass ground floor with recessed elements will counter the existing corrugated metal upper.

AMBITIONS

3.1 Buildings Connected by a Walkway

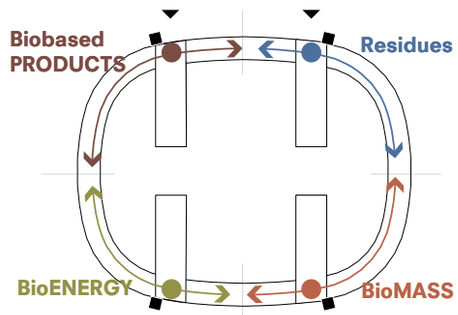


3 FUNCTION CONCEPTS

Why: As identified in my research, a bio-based economy requires close cooperation between policy makers, NGOs, researchers and the public in order to realise market potential and create acceptance and adoption of future innovations. Therefore, physically ensuring cross pollination between different groups is important.

How: Physical walkways connect each program. At this level, informal communication and collaboration take place through workshops and meeting areas.

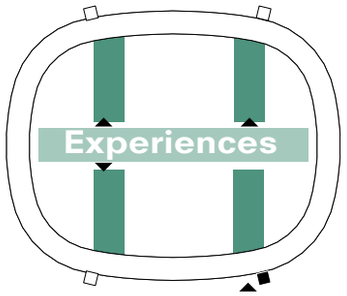
3.2 Parallel Journey for participant and process



Why: The bio-economy is made up of four quadrants. Each process supporting the next within a closed loop. Functionally and programmatically, retaining these quadrants is important because of the scale of the building.

How: The building is divided into four quadrants representative of the four quadrants of the bio-economy. Visitors are then able to experience them individually or together.

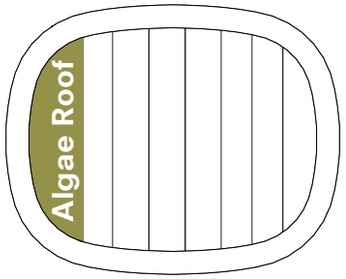
3.3 Integrated Public Experiences



Why: Each industry program is connected to a relevant public facing program to improve public awareness.

How: A central public axis cuts through all the industrial nodes. From here, all industry programs can be viewed and recreational activities accessed. Each of the main buildings as a supporting internal core.

3.4 Algae Cultivation Roof.



Why: Algae photo-bioreactors need a large surface area and maximum sun exposure.

How: Algae is cultivated on a large south facing roof in order to maximise light for cultivation. This is the highest point in the new program and a feature along the public walkway.

AMBITIONS

4.1 Restore the structure

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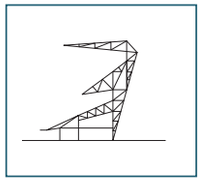

1937

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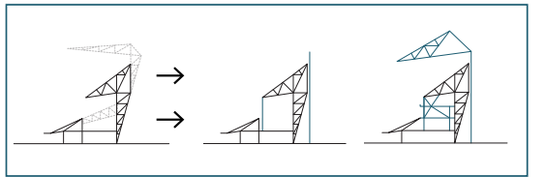

1994

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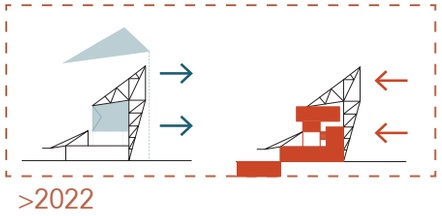


>2022

Modified from Source: Crimson, 2012)

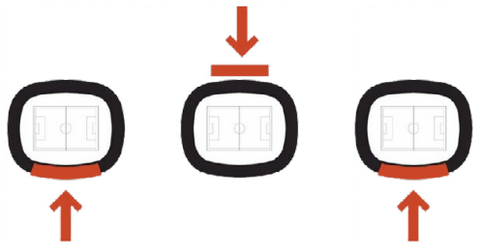
4.2 Facade set backs

Crimson, 2012)

4. STRUCTURE CONCEPTS

Why: The Kuip was initially constructed in 1937 by architects Leendert van der Vlugt and Johannes Brinkman. Since then, it has undergone a number of renovations and extensions. The largest of which was in 1994 when a new conference centre was constructed and connected to the east facade. This repositioned the main entrance of the Kuip from the West side to the East. Corrugated metal and glass were introduced as a safety measure as well as to create offices; increasing the enclosed area. Finally, and most notably, a steel cantilevering gallery roof (Krijgsman et al, 1994) structure was introduced. All of which increased the stadium capacity and introduced flexibility to diversify away from football and enabled various concerts and events to be held throughout the year. These transformations over the years cluttered the building and distracted it from the original essence and design principles of the expressive steel structure. The ambition is to restore these features.

How: The gallery roof was built as a structure independent to the stadium body, I propose removing it to reveal the existing structure. Secondly, the main entrance will be reverted back to the West facade and conference extension demolished.



1936 1994 2021

Modified from Source: Crimson, 2012)

Why: The aim is to create a permeable and transparent interface all long the ground floor where visitors are drawn in by the experiences that they can see inside. This also gives opportunities to expose the tribune structure in a rhythmic way.

How: Facade setbacks create niches to draw visitors in and redefine the articulation of the stadium by exposing and enclosing selective areas.

5. CONCEPTS ON SUSTAINABILITY

As the world moves into a territory of energy ambiguity, the ways we harness energy will become inextricably linked to developing clean water and air. The potential of plants for energy, water and air purification is largely untapped; particularly at a viable urban scale.

Energy security isn't just about production. Its not about producing more or even just about producing cleaner, its also about reducing and balancing. To counter the energy intensive nature of sports centres, and swimming pools, the park treats its own water so that swimming pool water can be treated, reused then returned to aquifers or the river instead of just discharging into urban sewer systems.

The Kuip as a Research and leisure centre adopts the principles of biophilic design, providing sustainable alternatives to key sub -areas of '1. energy and resource efficiency, 2. Sustainable materials, 3. safe waste generation and management, 4. Pollution, 5. Biodiversity protection, 5. Indoor environmental quality. (Kellert et al 2008, 5)

5.1 Climate

Leisure centres and swimming pools are inherently energy-intensive because of heat loss and evaporation, therefore a new kind of leisure centre that cleans water an generates its own clean energy can pave the way for future civic amenities. In terms of climate control, each block contains its own active, mechanical air handling systems. The blocks house various labs, sports courts and auditorium which all need a level of climate control different to each other. Daily and seasonal climates are controlled through ATES Aquifer Thermal Energy Storage) which uses ground source heat exchangers within an open system. This will be coupled with algae to electricity which will be used to power the necessary electricity for labs and sports facilities.

Intermediate zones under the algae roof however, can be naturally ventilated and are not climate controlled. This is because the Vierendeel roof structure containing algae photobioreactors will act as a buffer zone and insulation layer for the program below.

5.2 Water management

'The living machine' will be a key feature within the building. This is a decentralised means of biological water treatment that takes places in greenhouse conditions enabling tropical plants such as helophytes to thrive an contribute to water treatment. The scale of this feature enables the water treatment process to become a visible, transparent and accessible experience for visitors.

The building aims to treat half of its water supply on site through 2 different mechanisms. In an open-loop system, the large roof surfaces collect rainwater which is stored to support grey water uses and plant irrigation. Grey and black water circulate tropical plants and algae photobioreactors before being used for irrigation or safely discharged back into the Maas. The second mechanism is a closed-loop system where wetlands reeds purify water for natural pools.

5.3 Materials

The Three step Vierendeel is a steel structure in keeping with the Kuip's materiality and enabling the necessary large spans across the site; be inhabited for algae. It's lighter than concrete yet also allows for an easier dismantling and less interference with the existing structure. However, smaller modules are constructed with structural GluLam columns enabling easy assembly even in a curved structure with individual components. This celebrated the value of natural materials and also gives clear material differentiation between old and new.

6. REFLECTION

6.1 Aspect 1

Relationship between research and design

My approach towards unifying research with design was through identifying appropriate case studies to benchmark. The benchmarking exercise was very helpful and successful in developing a new programmatic hybrid that I haven't come across before however I was unsure how to tackle the scale of the stadium, which straddles between public building and urban infrastructure.

Even after developing my programmatic and overall design / massing and spatial concepts with clearly associated design principles, I struggled to unify them in a coherent way and create a sense of hierarchy of ideas that could be read through the vast stadium. Contrary to the approach I would typically take to design which is from the inside out, I didn't realise until much later on that in order to tackle such a large, specific space and create a coherent, whole, I needed one strong design principles that would define the organisation of the interior spaces. I felt a sense of ideas aligning once the key concept of various landscape strips fell into place.

Within my research plan and subsequent ambitions, I had not been clear on my intentions on how to deal with the 'old' and 'new' structure early enough. It took some time to realise that in taking an existing building, this project really had to be about understanding and responding to the building. Listening to it and letting its history, form and materiality tell me what it wanted its future to be.

I had initially proposed a completely new structure in the site of the existing Kuip. An organic form that was bold, expressive, and fluid. However, the more time I spent analysing the building and identifying robust, well-maintained materials and appreciating the important cultural and physical identity of the building it became apartment that from both a sustainable and cultural point of view, these key elements ought to be retained.

Subsequently, one significant challenge throughout the design process was therefore trying to make sense of how the existing, clearly articulate structure with clear geometry and angles could be adopted and adapted into a fluid and expressive form whilst also being sensitive to the circular geometry of the site.

I think that this successfully came through integrating a natural landscape that could absorb and be supported by the stadium's tribunes rather than developing a new competing architectural vocabulary.

The project became a much more sensitive adaptive reuse strategy which in fact was much more appropriate for its program of ecology, waste management and circularity.

6.2 Aspect 2

Relationship between graduation topic and studio topic

In trying to resolutely pinpoint my fascinations over the course of the year, my research took long broad strokes. I knew that I was fundamentally interested in the notion of value. The value of things we inherently discard as waste and the possibility that everything around us holds value depending on the lens we are observing from. I struggled to ground the theoretical importance of true-cost economics within an architectural context until I came across the notion of urban metabolism and urban designs' failure to create synergistic relationships between various flows of energy, food, materials, in the way that would occur seamlessly and intuitively within nature. This led me to recognise the importance of what nature must teach us and became the basis for enquiry into the bio-based economy and the migration of energy.

6.3 Aspect 3

Research method and approach chosen by student in relation to graduation studio.

Complex Projects is a studio exploring the relationship between architecture and the complex systems that surround the practice. The inherent complexity within the practice of architecture and having to negotiate between different stakeholders, scales and contexts as well as the ability for the architect to observe, understand, interrogate and respond to these challenges. I wanted to speculate the role of architecture as a facilitator for wider interdisciplinary challenges faced by the planet and felt that the migration of energy as a physical commodity as well as a societal value was a relevant and interesting relationship. I felt ambitious in taking on a wide range of topics (research, sports, heritage) and may not have resolutely achieved complete synthesis between them but do feel that the themes I explored and program I developed were unprecedented. I therefore feel that I offer a valuable angle of enquiry that I would like to develop in the future.

Furthermore, The Migration of Ideas as a theme is one that is inherently undefined in the sense that it is curious about the input and influences that culture, technology, economics, politics, science have all had in shaping our world. It therefore forces us to consider and reconsider migration and the built environment as hyper-objects in themselves without clear boundaries but visible implications. This processing of information to make sense of the data is the complexity of the project. We tackle intangible notions determined by research but curated by our own curiosities and judgements for better or for worse. The process of designing for me was a process of refraining from the urge to react to my research in a hyperbolic way. It has been a practice of carrying through a few key ideas that are impactful way

6.4 Aspect 4

Relationship between graduation project and wider spatial, professional and scientific relevance

Much like the way we conduct research, constantly revisiting research, interdisciplinary design is about narrowing the feedback loop between consumers, scientists, and designers. It's about creating transparency through simplification so information can be accessible. This was the ambition of the project, and this is a practice required of architects within a professional environment. Furthermore, for the architect of the 21st C, designing resilience means designing to enable flexibility, adaptability and capacities for change and evolution in a way that is suitable and responsive to current challenges whilst also recognizing that we can only speculate the future.

6.5 Aspect 5

Ethical issues and dilemmas encountered during graduation.

The Kuip is a municipal monument. With that comes the responsibility and expectation to propose a scheme that considers and responds to the heritage of the stadium itself as well as its cultural significance within the local community, Rotterdam South and for Feyenoord City supporters. This put significant pressure on me to consider and anticipate the reactions that Rotterdammers may have to the designs proposed. I had initially envisioned that I would conduct interviews to understand the existing identity and public perception of the Kuip. Unfortunately, this project took place during a global pandemic, access to such information was greatly limited. This aspect of the project become more speculative and relied on Google reviews, football forums and personal reflections on site visit in order to establish the heritage value of key components within the building. Although I received some friction in my decision to remove the roof of the stadium in place of a new structure, I ultimately believe that made the most appropriate design decision that could balance the needs of a new program with the collective memories of the Kuip's past uses.

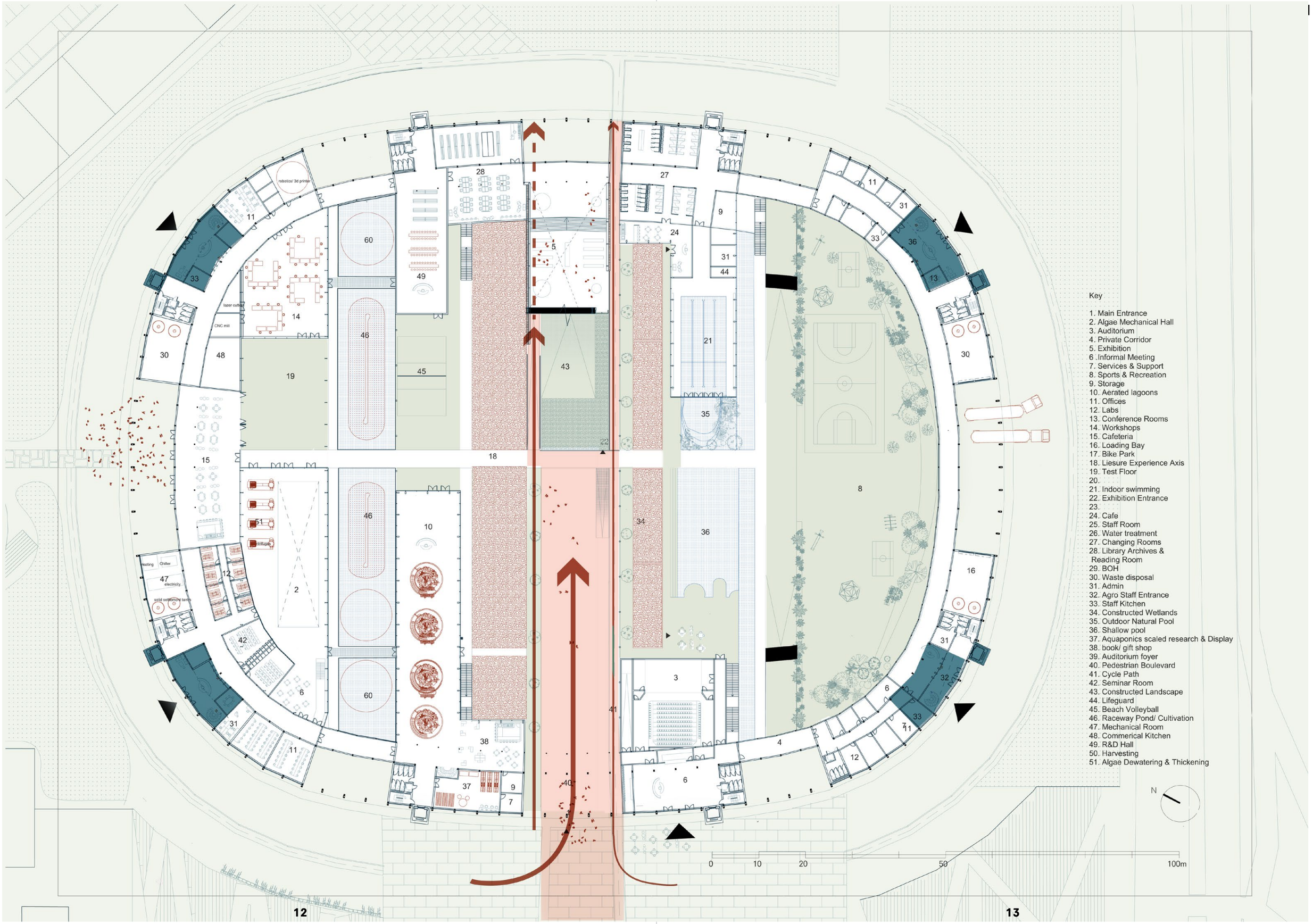
Another point of speculation was in the requirements for research labs. All the research I conducted on algae and biotechnology, labs were case specific and still at a theoretical, small scale. Therefore, the program specifications I have proposed, the scale of algae production and associated energy generation are as relative as I was able to make them. The research I conducted did express the importance of flexibility in laboratory design as such facilities are inherently always having to adapt approximately every 15 years. In this sense I do believe I retained an appropriate amount of specificity.

7. CONCLUSION

This project is therefore a about a holistic ambition to value ecosystem services through the bio-economy.

Whilst the project went through multiple evolutions, I think my intentions are coming to fruition. Producing renewable energy goes hand in hand with environmental re-mediation. Research into algae and cyanobacteria goes hand in hand with holistically valuing all eco-system services and I hope that public awareness goes hand in hand with fundamental accountability and systemic change.

As architects, we only have the power to create spaces that facilitate these important conversations. We are constrained and frustrated by the technological pace of architecture. We straddle the capacity to be high level revolutionaries and optimists whilst being diligently pragmatic.


robotics/ 3d printer
lazer cutter
CNC mill
electricity
Chiller
solid sedimentation tanks
Key
1. Main Entrance
2. Algae Mechanical Hall
3. Auditorium
4. Private Corridor
5. Exhibition
6 .Informal Meeting
7. Services & Support
8. Sports & Recreation
9. Storage
10. Aerated lagoons
11. Offices
12. Labs
13. Conference Rooms
14. Workshops
15. Cafeteria
16. Loading Bay
17. Bike Park
18. Liesure Experience Axis
19. Test Floor
20.
21. Indoor swimming
22. Exhibition Entrance
23.
24. Cafe
25. Staff Room
26. Water treatment
27. Changing Rooms
28. Library Archives &
Reading Room
29. BOH
30. Waste disposal
31. Admin
32. Agro Staff Entrance
33. Staff Kitchen
34. Constructed Wetlands
35. Outdoor Natural Pool
36. Shallow pool
37. Aquaponics scaled research & Display
38. book/ gift shop
39. Auditorium foyer
40. Pedestrian Boulevard
41. Cycle Path
42. Seminar Room
43. Constructed Landscape
44. Lifeguard
45. Beach Volleyball
46. Raceway Pond/ Cultivation
47. Mechanical Room
48. Commerical Kitchen
49. R&D Hall
50. Harvesting
51. Algae Dewatering & Thickening
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