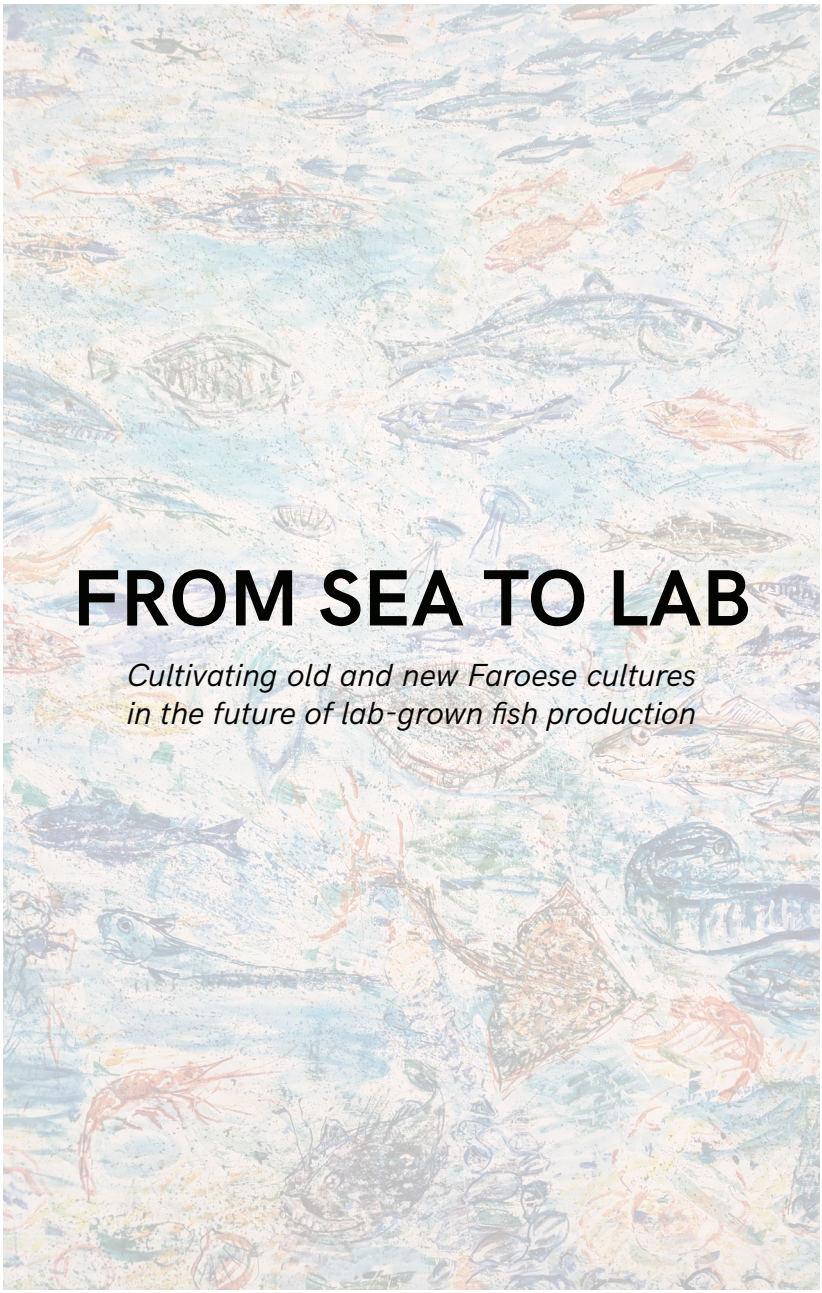

# FROM SEA TO LAB

*Cultivating old and new Faroese cultures in the future of lab-grown fish production*

**THESIS PROGRAM** *by Jonathan Kim*

FROM SEA TO LAB

Architecture Thesis Program

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MA in Architecture – Architecture and Extreme Environments

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# INTRODUCTION

# PREFACE

# FROM SEA TO LAB

**WHAT**

This thesis program is a speculative architectural proposal of a *cell-cultured* (refer to page 11) fish production facility replacing a traditional fish processing facility, alongside culinary and social spaces in Tórshavn, Faroe Islands.

**WHERE**

This proposal is situated in the western harbour of Tórshavn, particularly replacing two underused industrial buildings that were once fish processing facilities but no longer adequate for modern production.[1] The site's existing clash of industrial and social programs provides the opportunity for further hybridization with a new industry and cultural spaces.

**WHY**

With the existing and looming effects of climate change and industrial activity on the ocean, the traditional fishing industry needs to adapt. The Faroe Islands is at particular risk due to their high financial dependency on commercial fishing, i.e. over 90% of their exports.[2] This thesis program is a speculation in transitioning the conventional fishing industry into the future of *cellular agriculture* (refer to page 11).

**HOW**

This program envisions a transformative timeline from year 2021 to year 2100, with the construction of a new fish processing plant later repurposed into a cell-cultured fish production facility. The proposal of a new cellular agriculture industry in Tórshavn is supported by cultural, public, and research spaces to promote a culinary transformation and acceptance of cell-cultured fish products in the Faroese diet.

# ACADEMIC FRAMEWORK

This architectural thesis program is developed within the MA in Architecture – Architecture and Extreme Environments course at the Royal Danish Academy. The Master program intersects design and technology through the study of present and future issues in site-specific contexts.[3]

In the fall semester, there is a design-build of a 1:1 architectural prototype to be used during a month-long study trip. The prototype serves as both a scientific tool, allowing the studying and recording of data regarding a contextual problem of choice, as well as an aesthetic design, allowing for local engagement.

The fieldwork studies and interactions lead into an architectural thesis program in the spring semester – a building proposal that is geared specifically towards the contextual needs and demands through the consideration of artistic, cultural, and sustainable design potentials.

# TERMINOLOGY

**2100**

Current climate change modelling focuses on the risks and impacts of the 21st century, and thus most project only until the year 2100, despite the certainty of continuous changes beyond 2100.[4] (IPCC)

**AQUACULTURE**

"the cultivation of freshwater and marine resources, both plant and animal, for human consumption or use"[5] (Collins English Dictionary)

**CELL-CULTURED MEAT**

"harvesting animal cells and quite literally growing them into fat and muscle tissue inside industrial bioreactors"[6] (Chase Purdy, *Billion Dollar Burger*)

**CELLULAR AGRICULTURE**

Cellular agriculture is the production of tissue cells (e.g. fat, muscle) in a lab environment to create meat that traditionally would originate from the rearing and slaughtering of livestock.[7] (New Harvest)

**FISH PROCESSING FACILITY**

A processing plant where fresh fish is sorted, sealed, frozen, and packed for shipment.[8] (Pelagos)

**PELAGIC**

1. "(of marine life) living or occurring in the upper waters of open sea"[5] (Collins English Dictionary)
2. "the pelagic zone, includes all marine waters throughout the globe beyond the continental shelf"[9] (Britannica)
3. (of fish) travelling schooling species[8] (Pelagos)

**TIMELINE**

1. "a graphic representation showing the passage of time as a line"[5] (Collins English Dictionary)
2. "a time frame during which something is scheduled to happen"[5] (Collins English Dictionary)

# CONTEXT

# GEOGRAPHIC

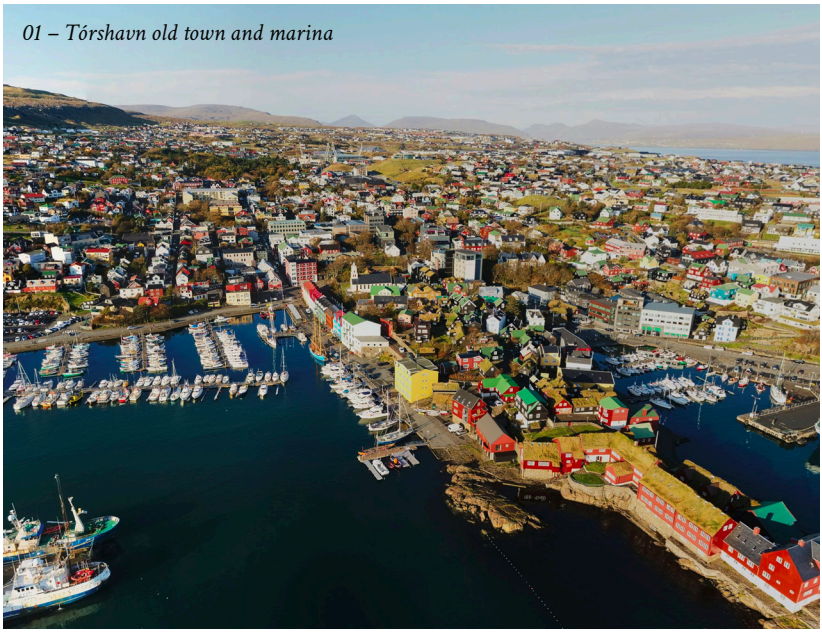
The Faroe Islands is located in the North Atlantic, between Iceland, Norway, and Scotland.


TÓRSHAVN
COPENHAGEN

The archipelago is a self-governing group of eighteen islands within the Kingdom of Denmark.[10]




*Jonathan Kim*



*01 – Tórshavn old town and marina*

*02 – Western harbour (front) and eastern harbour (back)*


01
02

# HISTORIC

*Commercial fishing in Faroese waters*

# FISHING INDUSTRY

Fishing is a significant part of the history of the Faroe Islands, from the initial act of self-survival, to the later economic flourishing of the archipelago. The industry grew from the late 18th century onward through initial trading with Norway, labour migration with Shetland, and knowledge sharing with multiple coastal regions. The archipelago's royal monopoly trade (den kongelige monopolhandel) ended in the latter 19th century and the introduction of free trading transformed the industry to a largely self-employed one and later to a commercialized scale.[11]

*Expansion of Tórshavn's eastern harbour*

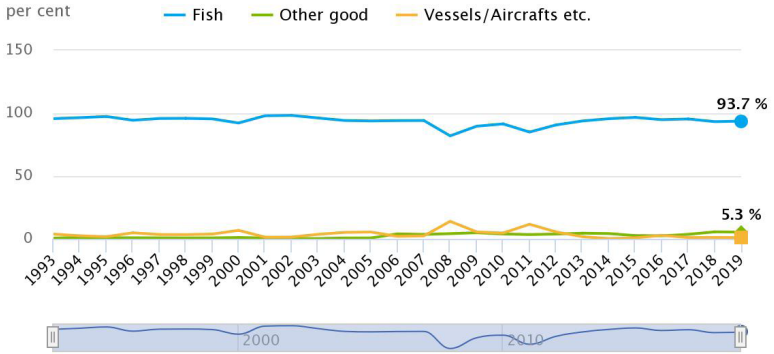
*Drawing of Tórshavn in 1778*

# HARBOUR

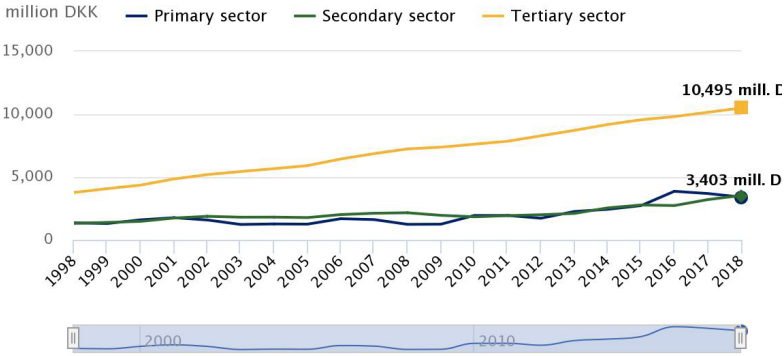
The historic trading of fish goods relied on the royal monopoly trade – a trading and social organization that existed until the latter 19th century. The institution was located in Tórshavn – the city's name literally meaning Norse god Thor's harbour – and served as the only trading place of the islands until the 1830s.[11] The development of the harbour naturally grew with the economic development of the fishing industry. Today the harbour in Tórshavn has undergone further construction for the past several years with the economic expansion of cargo shipping for companies such as Smyril Line and Eimskip.[1]

## Exports of goods, commodity groups

% of total value



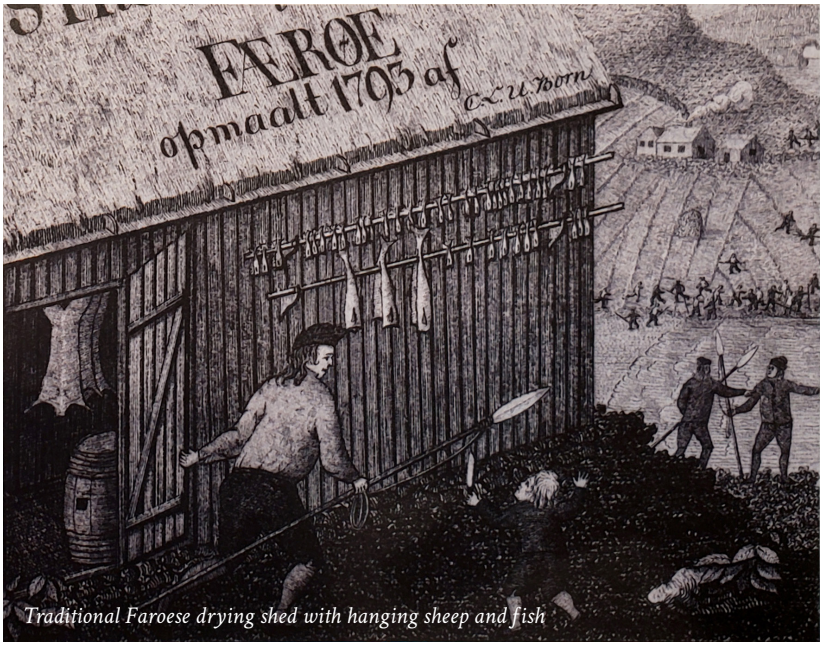

## Gross value added, industrial sectors



*Faroe Islands' export (arrow) and import (circle) routes*

# ECONOMIC DEPENDENCY

The Faroese society experienced a change in the late 18th and 19th century, from a self-sufficient peasant society to an industrialized fishing community. Stockfish (tørrfisk) trading with Bergen was listed as early as the 16th century, and clipfish (klipfisk) production was possible in the 18th/19th centuries with the introduction of salt, opening up a market to southern European countries like Spain and Italy.[11] Electrification of the islands in the latter 20th century paved way for factory production and freezing of fish fillets for the world market.[12] Today the fishing industry accounts for over 90% of the country's exports and 20% of its GDP,[2] and employs about 4,000 people.[13]




*Traditional Faroese drying shed with hanging sheep and fish*


*Ræstur fiskur*

# FOOD SECURITY

Fish has been an important food resource since the inception of the Faroe Islands. Pilot whale hunting began since the islands were first settled and provided a food source that was able to be eaten during Lent.[12] The air-drying and fermenting of fish (e.g. ræstur fiskur) was also an act of self-survival, allowing food to be preserved and stored for later consumption.[12] Despite culinary modernization and trade of the Faroe Islands in the 19th/20th centuries onward, fish remains a vital food security for the islands, as well as other parts of the world. Population growth is expected to be concentrated in coastal urban areas, increasing the demand for fish as a food resource.[14]

# ENVIRONMENTAL ISSUES

## CLIMATE CHANGE

Climate change is negatively affecting the ocean, from increased acidification due to carbon dioxide intake, to storing most of the Earth's warming (an astonishing 90% between 1971 and 2010).[4] These effects are forcing migrating fish species to move to colder and northern waters, threatening reefs and the loss of biodiversity and fish stock, and creating dead zones (oxygen-deprived zones) with a total size of about Europe.[15] The Faroe Marine Research Institute gives national fishing recommendations through close monitoring of fish to promote thriving stocks.[13]

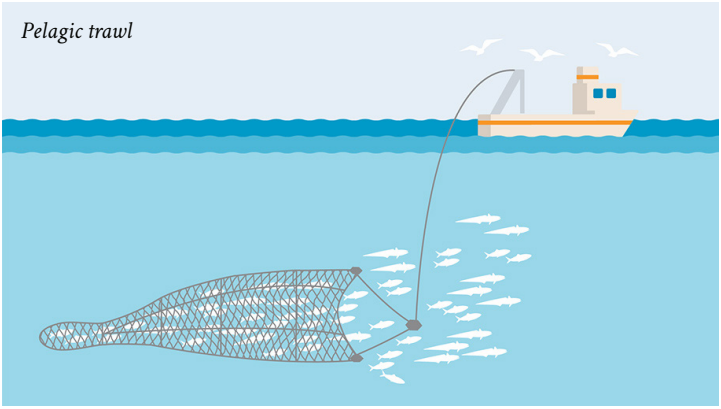


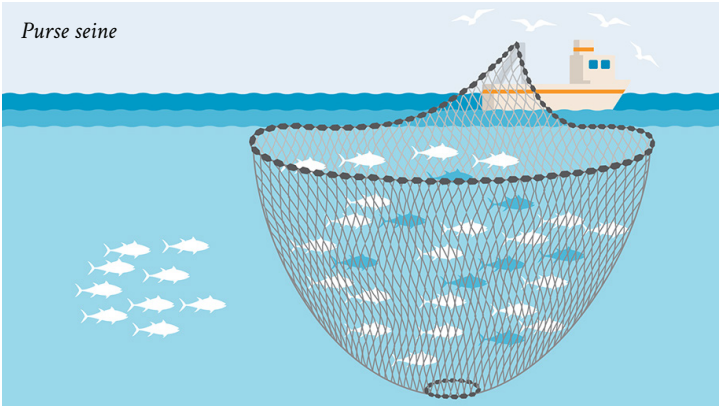
*Jonathan Kim*

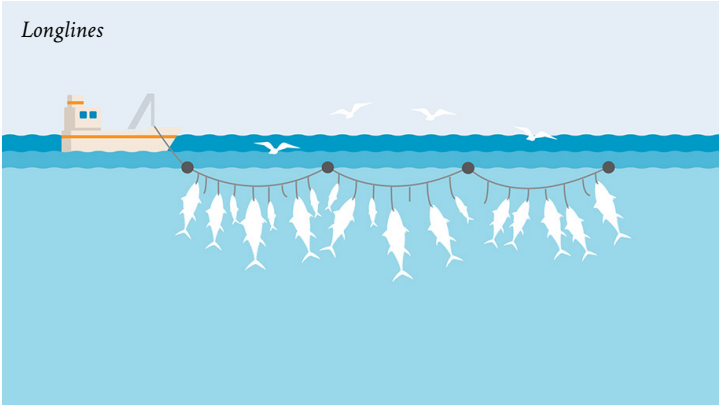
*Stingray bycatch*

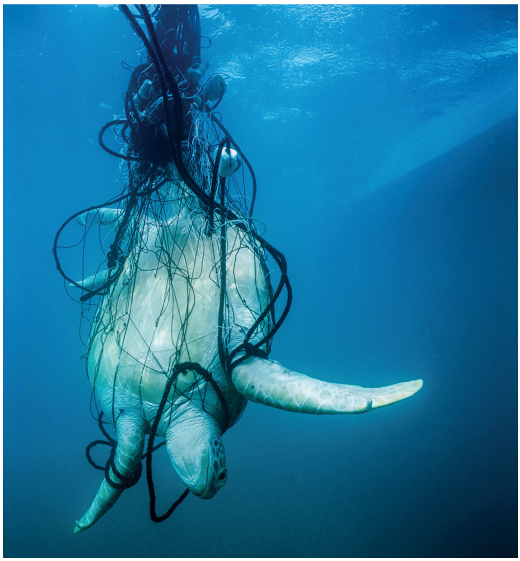
# OVERFISHING

A worldwide estimate of one to two trillion fish are caught yearly[16] with seafood representing a fifth of all animal protein for human consumption.[15] Increased fishing activity has created a global fishing fleet two or three times greater than what the ocean can sustainably provide,[14] with 90% of fish stocks fully or overfished, depleted, or recovering.[17] One management strategy by the Faroe Islands is the use of fishing quotas, i.e. a partnership with other North-East Atlantic coastal states set yearly total allowable catches on pelagic species.[18] However, not all countries in the world implement fishing quotas.[19] Furthermore, quotas lack sufficient conclusive data and do not prevent illegal fishing nor killing of bycatch.[16]


Pelagic trawl


Purse seine


Longlines

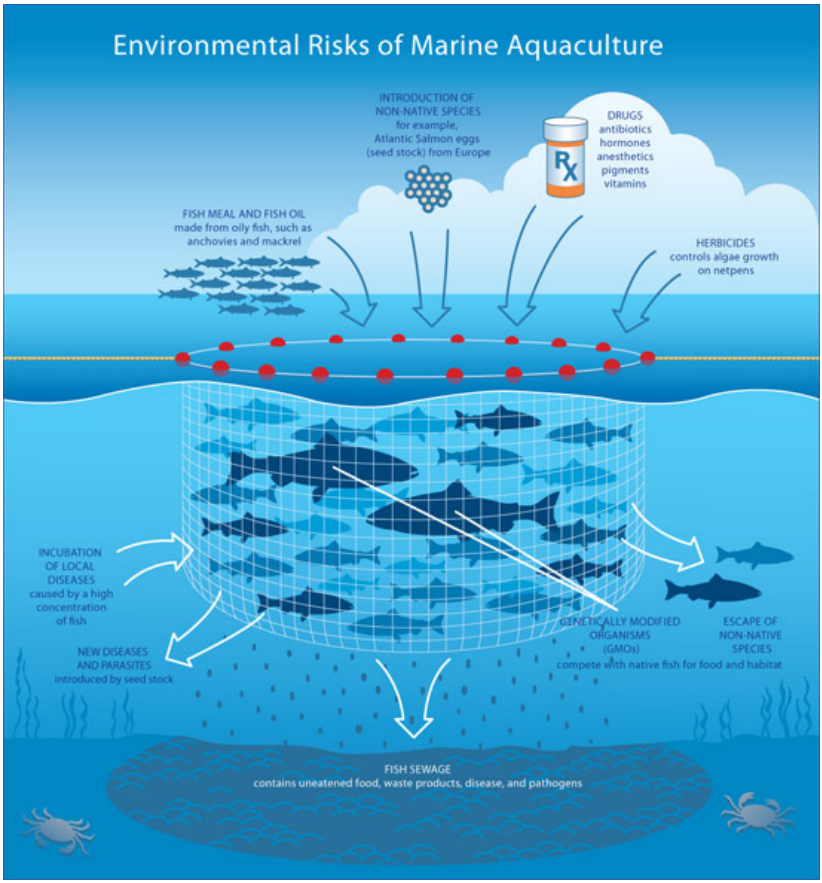


# OTHER FISHING ISSUES

In addition to overfishing, other fishing ramifications include negative animal welfare, high death rate of unintended bycatch, and ecological damage. Fish are sentient beings and the killing process of industrial fishing can take anywhere from one to twenty four hours.[16] One commercial fishing method is the use of trawl nets, which accounts for 55% of globally discarded bycatch and can damage or destroy the sea floor ecology, i.e. the natural habitat for fish.[16] Since 2015, a third of the world's seagrasses and half of corals have been lost.[14]



Jonathan Kim


Environmental Risks of Marine Aquaculture
INTRODUCTION OF NON-NATIVE SPECIES
for example, Atlantic Salmon eggs (seed stock) from Europe
DRUGS
antibiotics
hormones
anesthetics
pigments
vitamins
Rx
FISH MEAL AND FISH OIL
made from oily fish, such as anchovies and mackrel
HERBICIDES
controls algae growth on netpens
INCUBATION OF LOCAL DISEASES
caused by a high concentration of fish
NEW DISEASES AND PARASITES
introduced by seed stock
GENETICALLY MODIFIED ORGANISMS (GMOs)
compete with native fish for food and habitat
ESCAPE OF NON-NATIVE SPECIES
FISH SEWAGE
contains uneatened food, waste products, disease, and pathogens

*Aquaculture salmon farms in the Faroe Islands*

# AQUACULTURE ISSUES

A median estimate of 80 billion farmed fish were killed globally for food in 2010, a number higher than slaughtered mammals and birds in the same year.[20] The rearing of fish has its own environmental challenges compared to traditional fishing, including damage of ocean ecology,[21] relying on increased fishing catches for fish feed,[16] and the complex demand for multispecies domestication.[22] Salmon aquaculture is exemplary, requiring domestication of wrasse species and anthropods and copepods to simulate a suitable ecosystem for harvesting salmon without parasitic sea lice.[22] Recent aquaculture development in Norway includes combining sea kelp farming with salmon aquaculture to mitigate seabed damage, and partial implementation of closed habitats to reduce sea lice.[23]

# PROPOSAL

# PRELIMINARY FIELDWORK

*Drying of ræstur fiskur in an architectural pavilion*

A month-long study trip in Tórshavn took place during the third semester (winter 2020). Preliminary fieldwork investigations included quantifying ræstur fiskur drying, recording local climatic conditions, and surveying thermal comfort of local participants. An original fish-drying pavilion was built near the Tórshavn marina and housed the studies over a two-week period. The experiment successfully produced three samples of ræstur fiskur in a slightly colder and more humid microclimate. Thermal metric calculations (UTCI and PET) found the pavilion environment to be more thermally uncomfortable than the exterior, the opposite response from majority of participants; the potential to improve Tórshavn's outdoor spaces may lie with rain and wind covering.

*Participant surveying of thermal comfort*

*Carl August Arge – a local fisherman*

The preliminary fieldwork also included the opportunity to engage with local professionals related to the fieldwork studies, as well as to expand knowledge into the relevant fields and issues in the Faroe Islands. Communication with a significant fish processing facility (Pelagos), an innovative restaurant (Ræst), local fishermen, and the municipality's harbour and planning departments provided the groundwork for this thesis program.

# CONSIDERATIONS

Fishing is an act of culture, economy, and survival to the Faroese. The fishing industries in the Faroe Islands amount for over 90% of the country's exports and 20% of its GDP.[2] This high dependency on the ocean's resources is a risk, particularly with the growing consequences of both climate change and industrial activity on marine life. Ocean warming and acidification are leading to the decline of biodiversity and fish stock, further migration of fish species, and creation of oxygen-deprived waters.[15] Industrial fishing further exacerbates such environmental issues. Certain management strategies exist to moderate damage, notably the use of fishing quotas; a partnership between the Faroe Islands and other North-East Atlantic coastal states set yearly total allowable catches on pelagic species to maintain fish stock.[18] Despite such efforts, which are not enforced worldwide,[19] global commercial fishing and aquaculture continues to grow with seafood accounting for a fifth of animal protein for humans.[15]

In consideration of the need for climate action and ecological restoration, changes to the existing fishing industry are necessary. How can such ramifications be mitigated while preserving the fishing culture and economy of the Faroe Islands? What are the current climate change projections that need to be accounted for when designing for the future? What potential do emerging technologies, namely cell-cultured meat, offer in speculating the transformation of the future of the fishing industry? How can an architectural project propose a transition from the traditional fishing industry to the forthcoming one of cellular agriculture? What kind of spaces foster a positive change in culinary culture, bridging old and new?

# AREA OF INVESTIGATION

This architectural thesis program presents a transformative timeline for the archipelago, shifting the traditional fishery, aquaculture, and processing industries toward the production of lab-grown fish proteins – an emerging technology on the cusp of economic and manufacturing viability.[6,19,24] A series of proposals suggest the evolution of this new industry and the restoration of the ocean's ecology up to the year 2100; the timeline is developed through consideration of current predictions and targets in the cellular agriculture industry[6,19,25,26] and current climate change projections.[4,15,27]

A series of principles frame the architectural investigation:
1. Communicate to consumers the industrial processes of cellular agriculture through the built environment,
2. Design programmatic and resource circularity for the production-consumption of cell-cultured fish,
3. Foster a new culinary culture for cellular agriculture with a hybridity of industrial-social spaces.

The program provides a speculative architectural proposal of a cell-cultured fish production facility, replacing a traditional fish processing facility, alongside culinary and cultural spaces. The facility aim is to manufacture production equivalent to local consumption, economic, and export demands. The current Faroese economy can continue to flourish through the more sustainable realm of cellular agriculture. The architectural project will incorporate *climatic design* (refer to page 63) and *loop design* (refer to page 67) to increase the focused importance of preserving and promoting ecology.

# PRELIMINARY PROGRAMS

**INDUSTRIAL / PRIVATE SPACES**

– Cell-cultured fish production facility*
– Laboratories

**INTERMEDIARY SPACES**

– Botanical garden / agricultural research**
– Open water aquarium / aquacultural research**
– Harbour / ship docking zone

**SOCIAL / PUBLIC SPACES**

– Restaurants
– Fish market
– Curated, educational walkway
– Ice cream shop***
– Skate park***

**PHASED OUT PROGRAMS BY YEAR 2100**

– Fish processing facility*
– Aquaculture fish farms

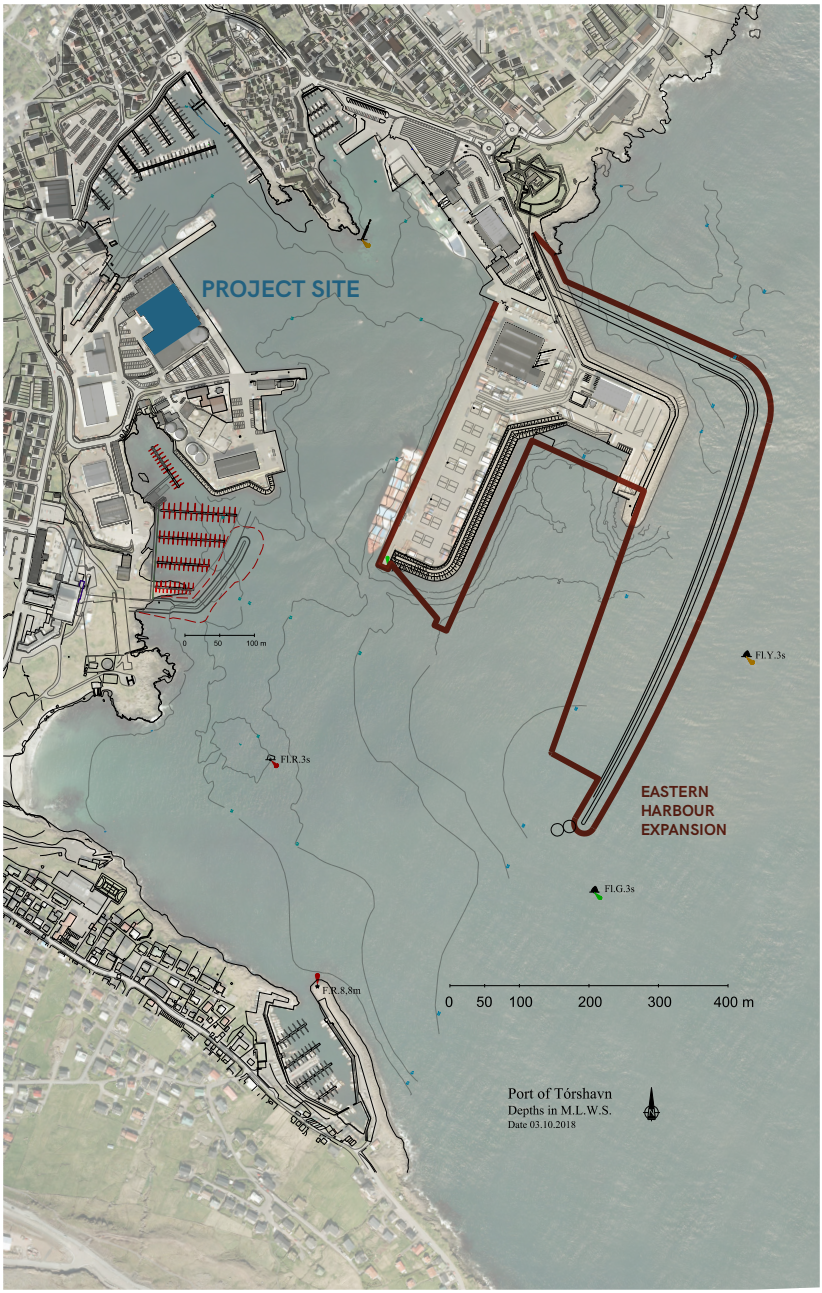
**Fish processing facility space and relevant equipment are repurposed for cell-cultured fish production facility*
***Agricultural and aquacultural research and sourcing of plant and animal cells for cell-cultured production*[4]
****Existing recreational programs in project site*

# PROJECT SITE

The harbour of Tórshavn remains a significant cultural (etymology of the city name) and economic part of the city. The eastern harbour has been undergoing expansion, a decision in 2015 influenced by the fact that an estimated 700 families have economic dependency on the harbour activities.[1]

This thesis program is situated in the western harbour of Tórshavn, a clash of industrial, social, and educational spaces. The proposed project site replaces two partially abandoned industrial buildings that once housed the last of Tórshavn's fish processing plants in 2010 (Bakkalao, United Seafood). The buildings are no longer adequately fit for modern production and are severly underused today, with no long-term permanent strategy planned for the buildings' reuse.[1]

The project envisions a revitalization of the western harbour to support the economic strengthening of the eastern side, through further hybridization of a new cellular agriculture industry and cultural spaces.


PROJECT SITE
EASTERN
HARBOUR
EXPANSION
0 50 100 m
Fl.Y.3s
Fl.R.3s
Fl.G.3s
Fl.R.8,8m
0 50 100 200 300 400 m
Port of Tórshavn
Depths in M.L.W.S.
Date 03.10.2018


*03 – Skatepark*

*04 – Ice cream shop*

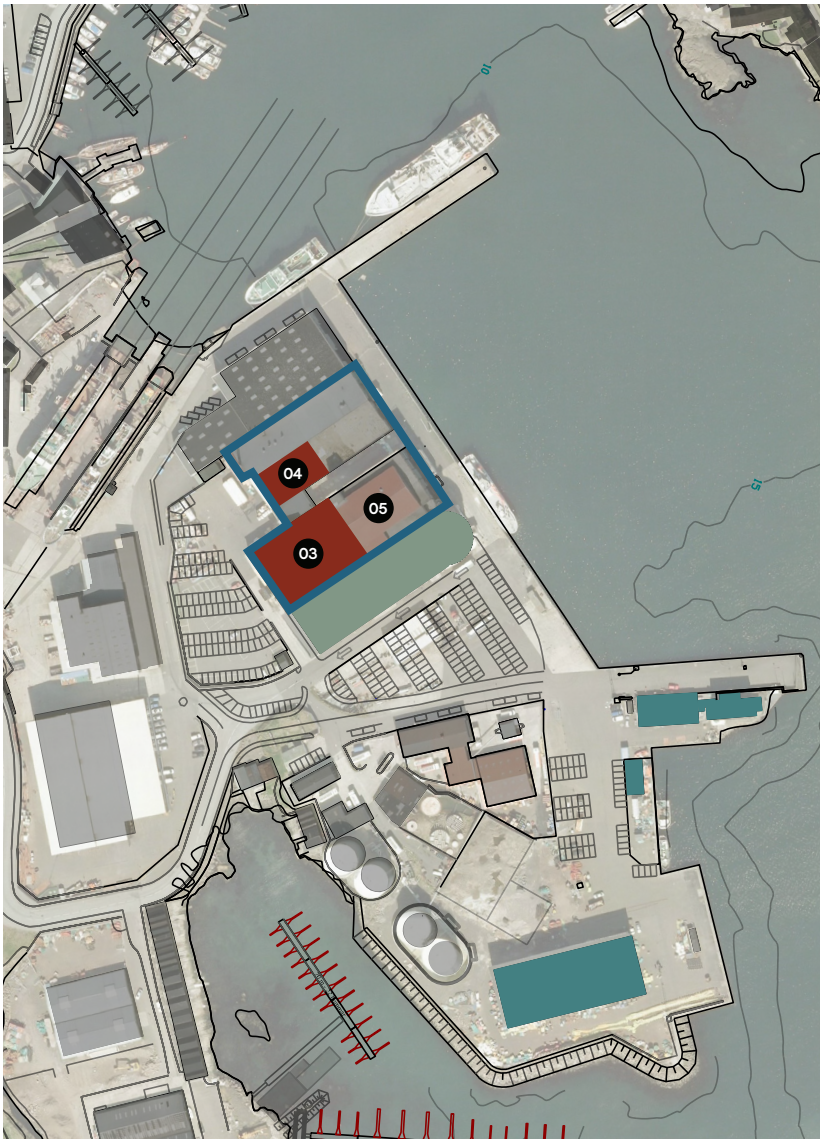
*05 – Old fish processing facility*

**PROJECT SITE (OLD FACTORY BUILDINGS)**

**RECREATIONAL**

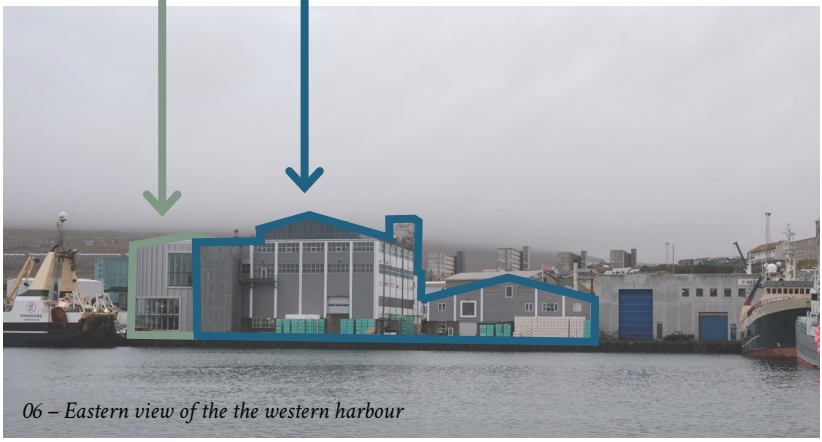
**FISHING INDUSTRY-RELATED**

**EDUCATIONAL**



*Old fish processing facilities*

*Parts of Faroese University and other businesses are adjacent*



*06 – Eastern view of the the western harbour*

*07 – Western view of the western harbour*

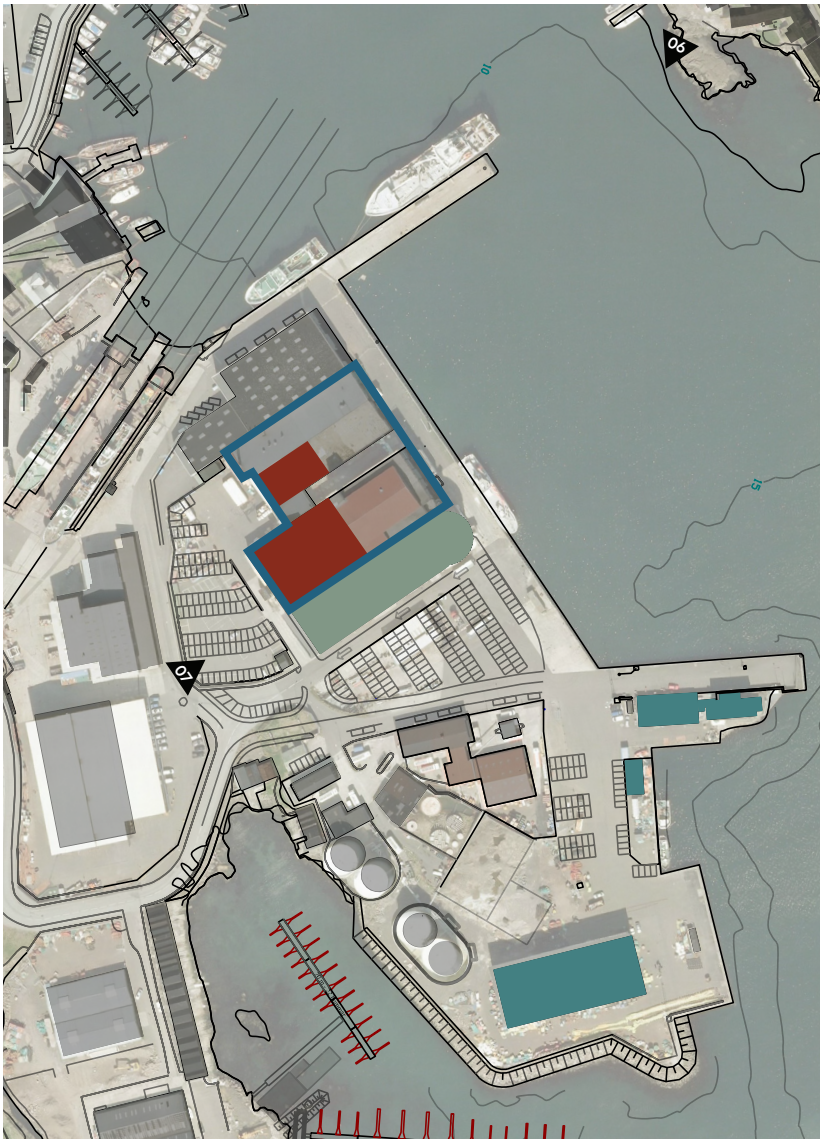
*Small, transitory businesses (ice cream shop, skatepark) occupy little of the old facilities' space*

**PROJECT SITE (OLD FACTORY BUILDINGS)**

**RECREATIONAL**

**FISHING INDUSTRY-RELATED**

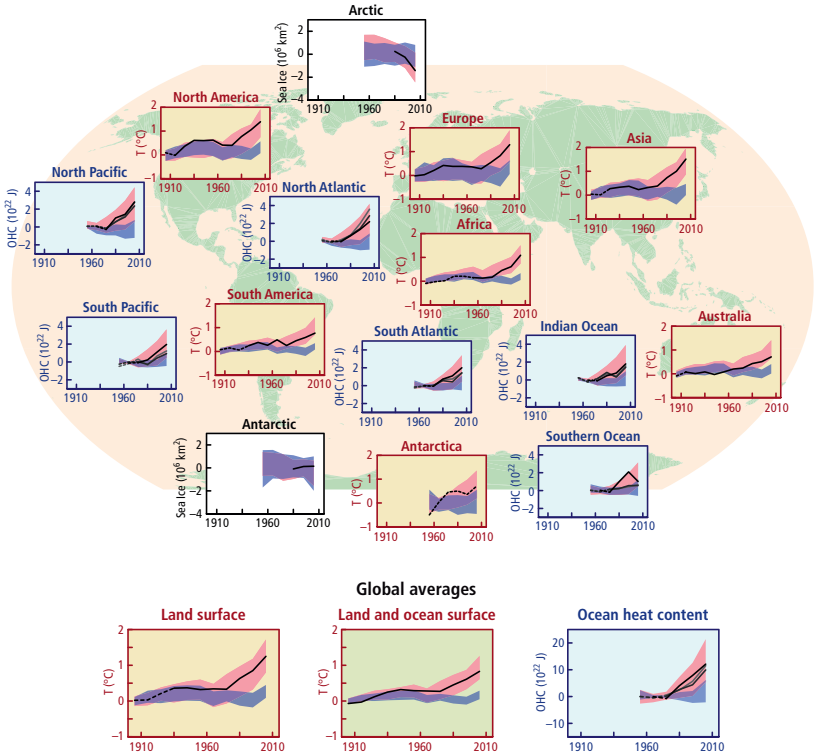
**EDUCATIONAL**



# THEMATICS

*What are the current climate change projections that need to be accounted for when designing for the future?*

*Observed temperature changes (black line) compared to projections*







# CLIMATE TIMELINE

This thesis program includes a series of proposals to suggest the evolutionary shift from commercial fishing and aquaculture to cell-cultured fish production. A consideration of the current climate change projections to year 2100 informs the time frame for the proposing of design interventions. Projection data is provided by reports from the IPCC (the UN's Intergovernmental Panel on Climate Change) and thoroughly gathered in *The Uninhabitable Earth: Life After Warming* by David Wallace-Wells.


*What potential do emerging technologies, namely cell-cultured meat, offer in speculating the transformation of the future of the fishing industry?*

*The first cell-cultured beef cost $1.2 million per pound in 2013 and has dropped to $100 per pound in 2019*[6]

# CELL-CULTURED MEAT

Cellular agriculture is the primary emerging technology this thesis program focuses on in speculating future industry development and transformation. Although a precise estimate on the environmental impact/benefits of cell-cultured meat is unknown, the current consensus is that lab-grown meat will have greater land and water conservation impact than traditional meat production.[6,24] Cell-cultured chicken nuggets became available in Singapore in December 2020,[25] and cultured seafood by a Singaporean startup is expected to be released by 2022.[19] Chase Purdy's *Billion Dollar Burger: Inside Big Tech's Race for the Future of Food* is a central source in covering this developing technology today.

HAVIÐ – *a current exhibition at the National Gallery of the Faroe Islands focuses on the cultural, economic, and environmental aspects of the fishing industry*

*How can negative environmental effects be mitigated while preserving the fishing culture and economy of the Faroe Islands?*


*Fish processing facility in the Faroe Islands*

# PRODUCTION DEMAND

The Faroe Islands produced 702,548 tons of fish catch and aquaculture in 2019, with 587,303 tons (83.6%) representing 93.7% of all Faroese exports in the same year and 20% of the country's GDP.[2] These significant numbers need to be considered in transitioning the conventional fishing and aquaculture industries to the future of cell-cultured fish production. A similar production goal is targeted to sustain the economy of the Faroe Islands through more sustainable and ecologically preserving manufacturing.



Jonathan Kim

*Reference: Nest We Grow, Kengo Kuma & Associates + College of Environmental Design UC Berkeley*

*How can an architectural project speculate a positive cultural transformation from conventional fishing industry to the future of cellular agriculture?*

*Chef Poul Andrias Ziska and his restaurant KOKS are credited for introducing Faroese cuisine to the world*[28]

# CULTURAL HUB

With the advancing transformation of the food industry from conventional to futuristic, the accompanying culinary culture also undergoes change. Communication and education of the new cellular agriculture industry catalyze an acceptance and integration of cell-cultured meat into the existing Faroese culinary culture and diet. Curated architectural spaces will highlight modern production techniques to the public, as well as preserve old culinary traditions and develop new cultural ones.

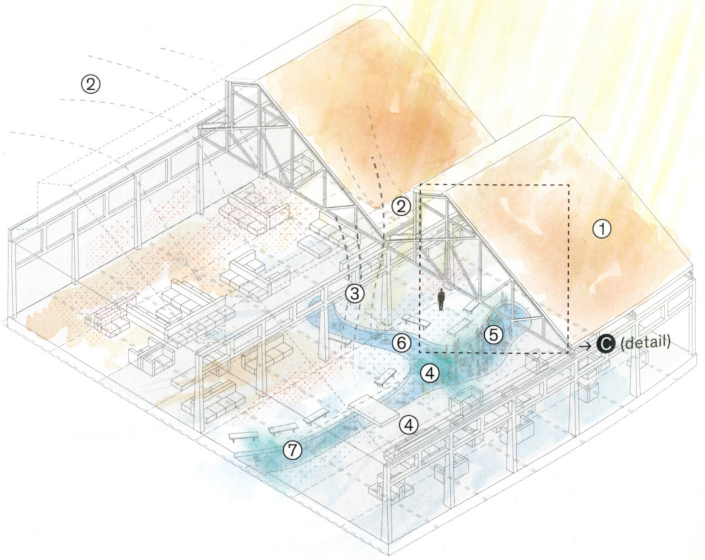
# METHODOLOGY

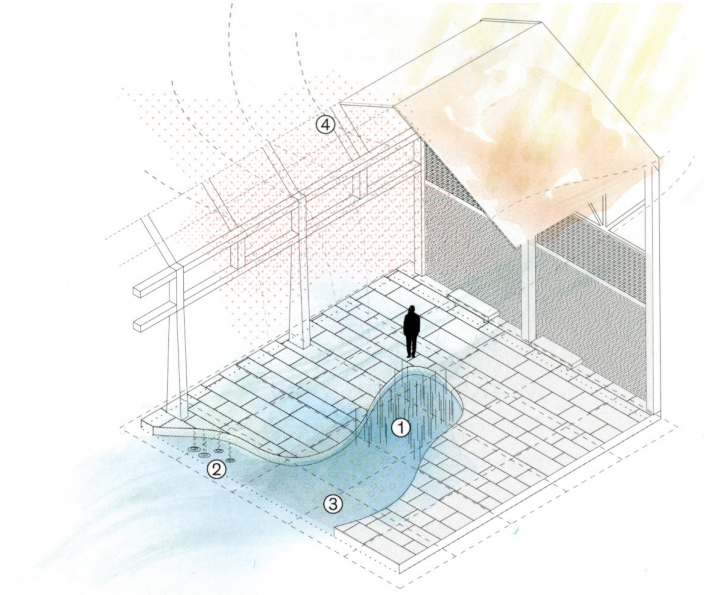

*Reference: Hans Tavsens Park og Korsgade, SLA*

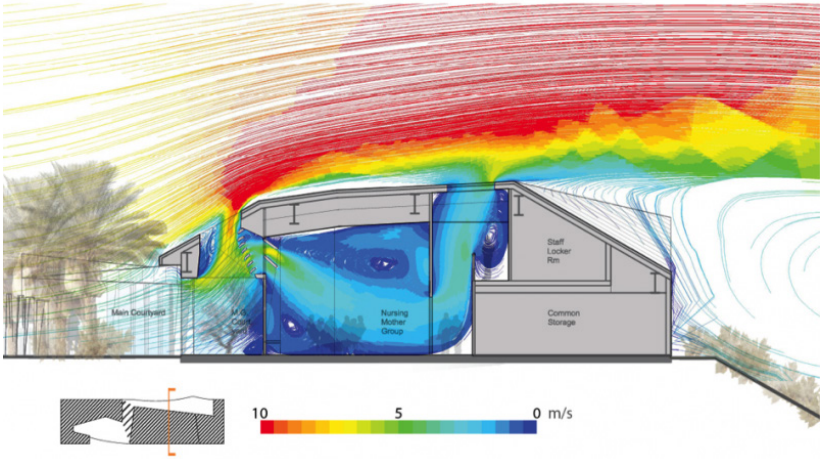
# CLIMATIC DESIGN

Building design considerations include realistic projections of climate change ramifications for rising temperature[4,15] and sea level.[27,29] Climatic performance strategies will relate to both programmatic needs and the exploration of thermal sensation in spatial microclimates. Desktop analysis of climatic conditions and thermal comfort in Tórshavn will be done using Ladybug Tools.[30] Theories of thermal delight[31] and embodied energy design[32] will be regarded in the building design process.

*Reference: SESC Pompéia Community Center, Lina Bo Bardi*



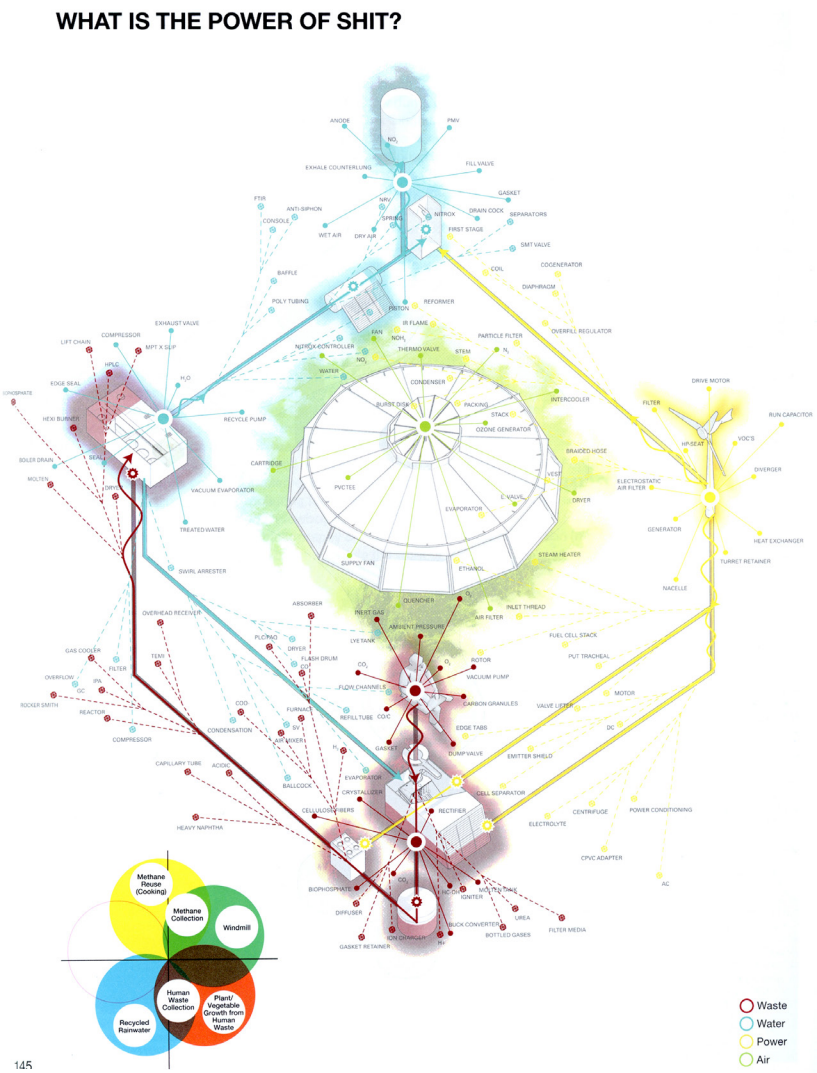





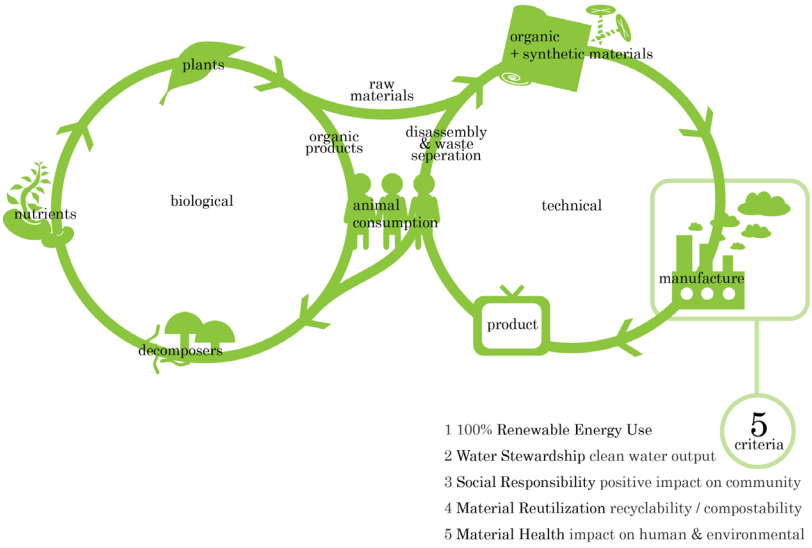

*Example of a CFD simulation of cooling through a building section*

# COOLING/HEAT TRANSFER

Organization of building programs will reflect the possibility to transfer the cooling or heating requirements between adjacent spatial settings. This consideration can be simulated through computational fluid dynamics (CFD) tools. Ideas of curating spatial atmospheres[33] in the built environment opens the possibility to design a building proposal of varying spatial microclimates.



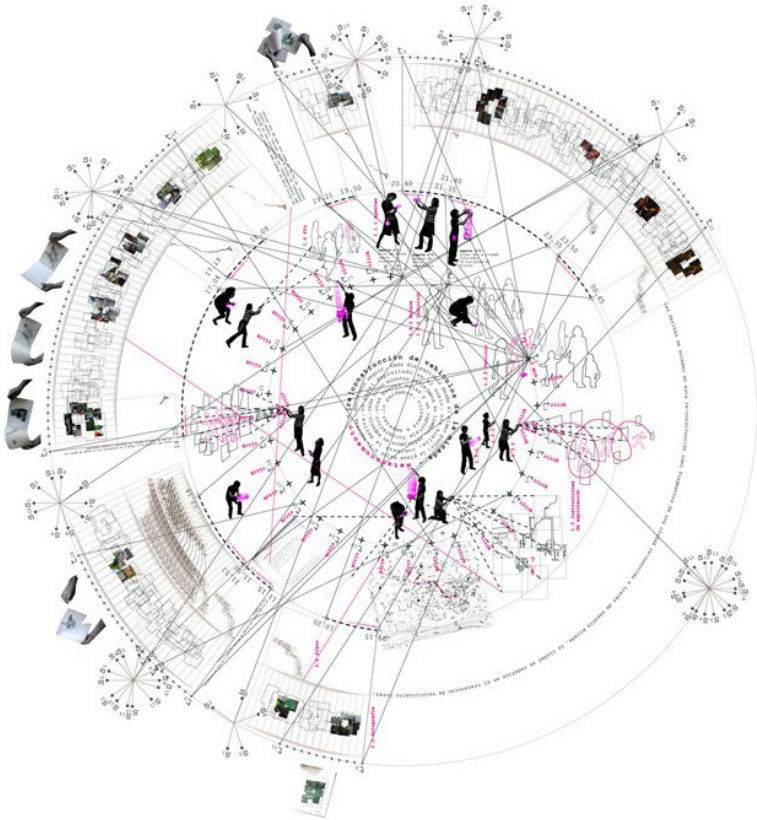

*Reference: Ecological House, Graham Caine and the Street Farmers*




*Cradle to Cradle implements two linked cycles of biological and technical resources*[34]

# LOOP DESIGN

The current aquaculture farming and future cell-cultured meat farming depend on multiple elements in their production processes. Theories of circular economy,[34] closed loop systems,[35] and feedback loops[36] inform the potential of creating a more holistic and sustainable production method in this thesis program.



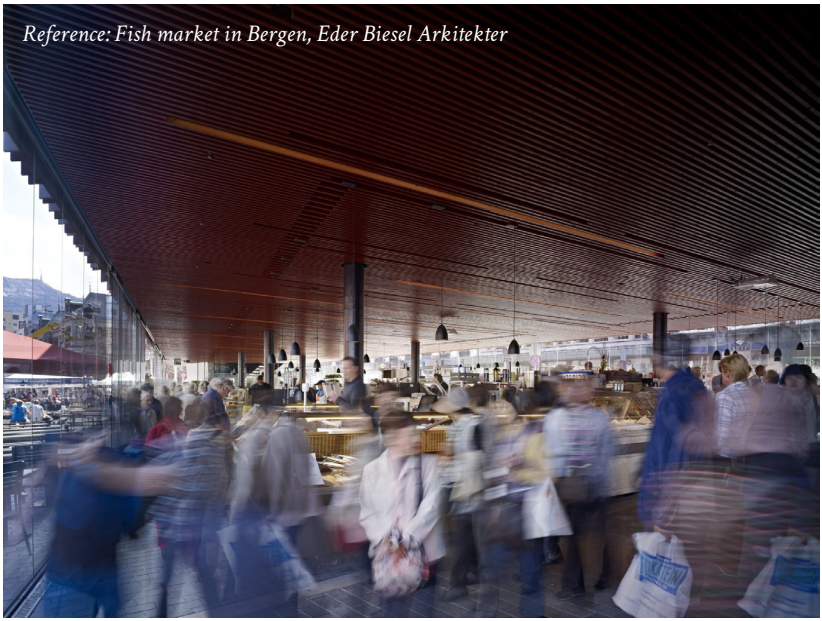
*Example of a program relationship study*

*Reference: Unraveling Modern Living, Tatiana Bilbao Estudio*

# PROGRAM HYBRIDITY

The intersection of cell-cultured fish production with culinary and cultural spaces will create hybridity and unique spatial configurations. The exploration of industrial versus social, private versus public, and interior versus exterior will guide the hybridity of the proposed built environment.

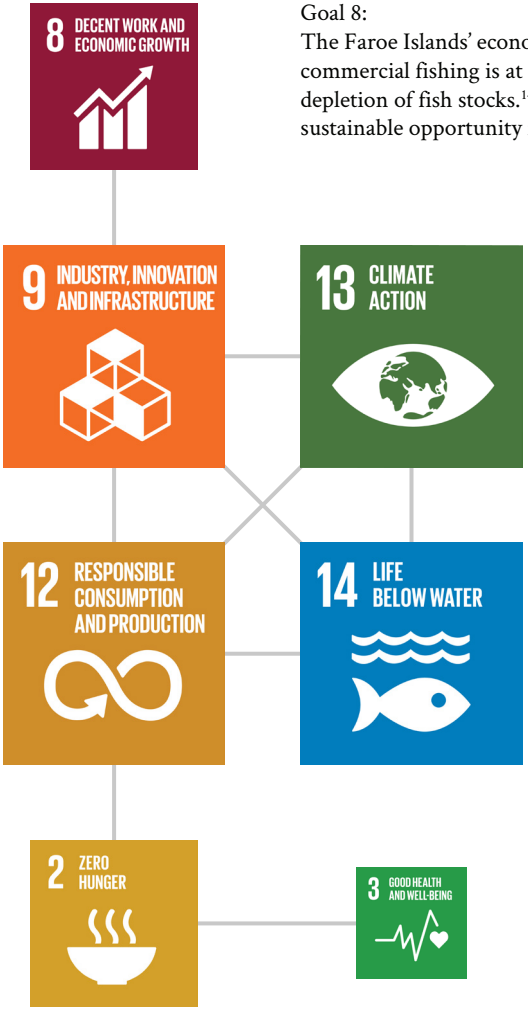

*Reference: Sydney Fish Market, 3XN*


*Reference: Fish market in Bergen, Eder Biesel Arkitekter*

# CIRCULATION OF PEOPLE

Within the aforementioned hybridization of programs, consideration of the movement of people will be studied. A difference in circulation requirements – from stricter requirements of lab-controlled environments, to the flow of people in a public market – will develop the layering and intersecting of programs and spaces.

# UN SDGs




Goal 8:
The Faroe Islands' economic dependency on commercial fishing is at risk with the world's depletion of fish stocks.[14] Cellular agriculture is a more sustainable opportunity for new economic growth.

**Goals 9, 12, 13, 14: This thesis program primarily focuses on these four Sustainable Development Goals. The innovation and implementation of a new cellular agriculture industry will lead to more sustainable food production practices, reduction of commercial fishing, and restoration of fish stocks and ocean ecology.**

Goals 2, 3:
Cell-cultured meat can support the world's increasing food production demands. Additionally, cellular agriculture production is inherently sterile and will lead to cleaner and safer foods.[6]

# COLLABORATORS

– Carl August Arge, fisherman

**A-PLAN arkitekt- og planleggingarvirkið**
– Jórun í Dali, architect

**Det Kongelige Akademi / Royal Danish Academy**
– Daniel Sang-Hoon Lee, Associate Professor
– Emanuele Naboni, Visiting Researcher, Associate Professor of Sustainable and Climatic Design

**Ocean Rainforest**
– Magni Arge, Executive Chairman (Board of Directors)

**Pelagos**
– Jóhan Páll Joensen, CEO

**Ræst**
– John Mikkelsen, manager (Ræst and heima í Havn restaurant group)
– Sigmundur Nielsen, head chef

**SMJ Consulting Engineers**
– Heini Ellingsgaard, manager Energy & Environment

**Tórshavnar havn**
– Bárður Michelsen, engineer

**Tórshavnar kommuna**
– Marita Svartá, city planner

# SCOPE OF SUBMISSION

The thesis program is submitted on 11 February 2021 and thesis material is to be delivered on 26 May 2021. The scope of submission is a preliminary proposal.

**MACRO SCALE**

– Drawings/diagrams (relation to the archipelago, ocean, and trade countries)

**URBAN SCALE**

– Site plan (relation to city, harbour, ocean, and relevant industries)

**SITE SCALE**

– Site plan (relation to west harbour and water access)

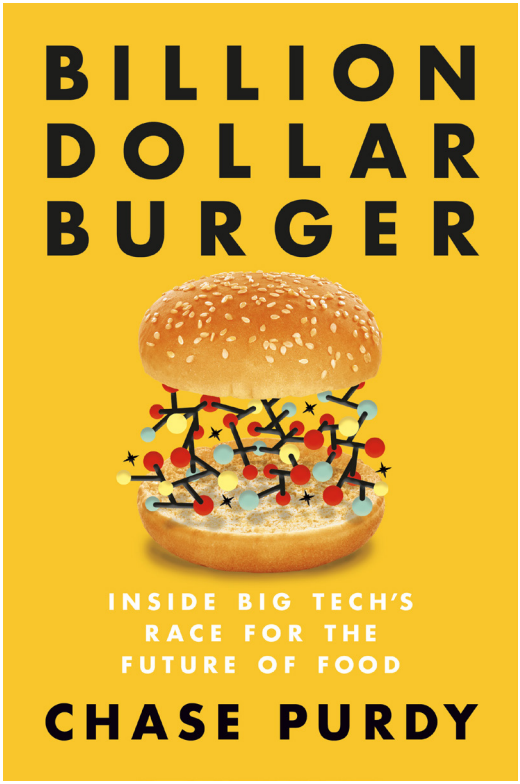
**BUILDING SCALE**

– Drawings (plans, sections, elevations)
– Visualizations
– Axonometrics (industrial processes, programmatic, spatial, diagrams)
– Diagrams (circulation, climatic design, design communication, production loop, program hybridity)
– CFD simulations (cooling/heat transfer between program spaces)
– Timelines (project timeline*, cellular agriculture forecast, climate change forecast)

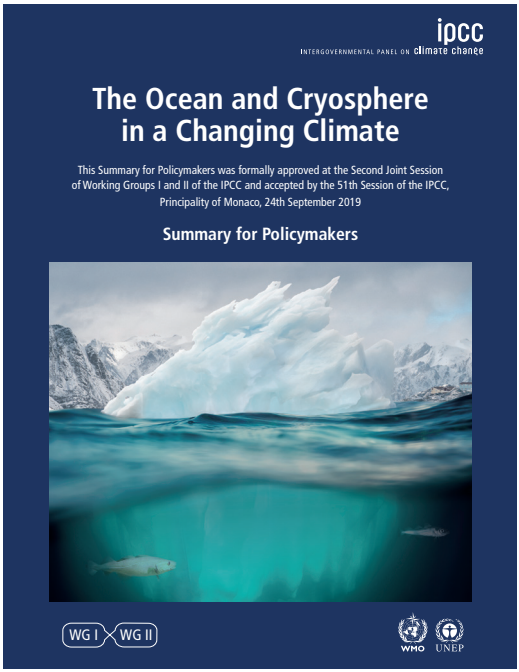
**A few design interventions are planned between year 2021 and 2100 based on forecast projections of cellular agriculture and climate change*

# APPENDICES

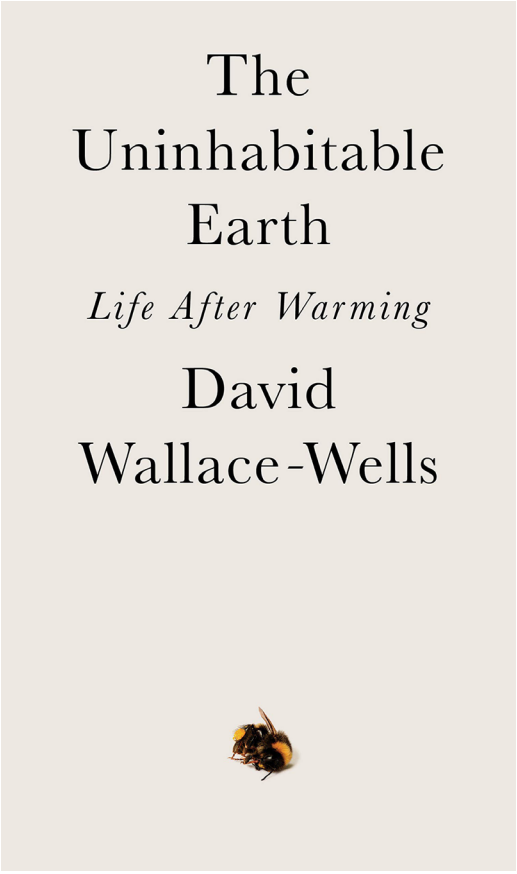
# PRELIMINARY LITERATURE



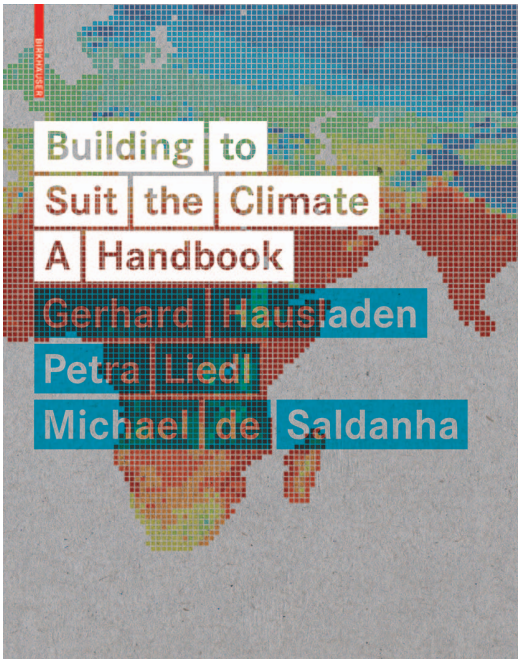

Chase Purdy's *Billion Dollar Burger: Inside Big Tech's Race for the Future of Food*[6] outlines the historical and present day developments in the emerging cell-cultured meat industry. Purdy provides an overall, yet crucial understanding to cell-culturing processes.



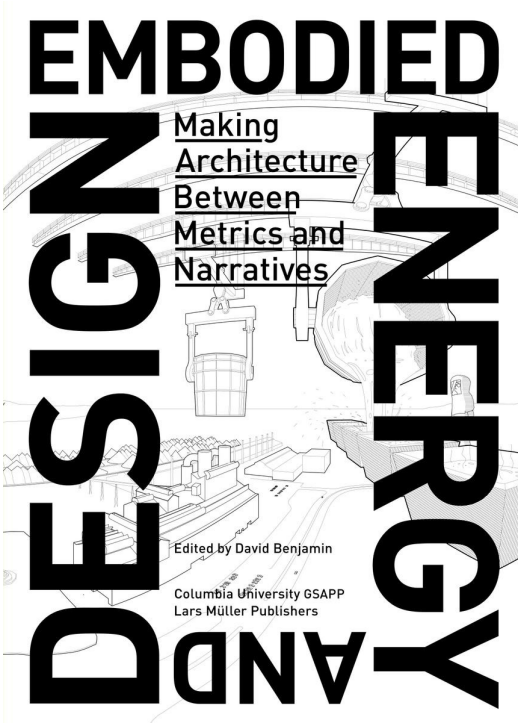

The IPCC's *The Ocean and Cryosphere in a Changing Climate*[27] is perhaps the most up to date (2019) report on understanding risks of sea level rise and climate change on mountain, polar, coastal, and marine ecosystems and life.



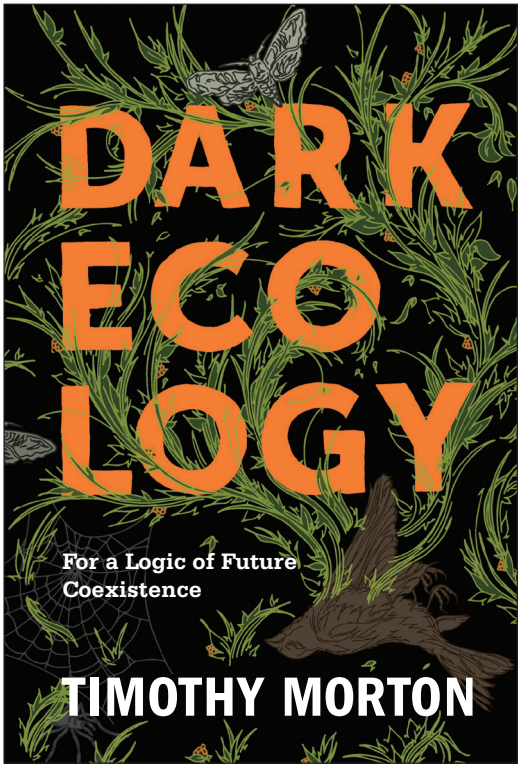

David Wallace-Wells' *The Uninhabitable Earth: Life After Warming*[15] presents a bleak outlook on the climate change effects to come. The book is a comprehensive, data-driven collection of climate change projections.



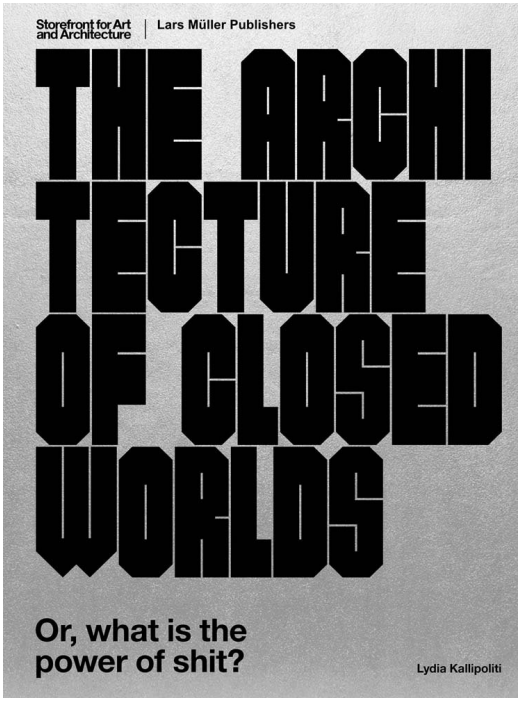

*Building to Suit the Climate: A Handbook*[37] demonstrates climatic design principles through different climatic and geographic regions. Tips for building structure, skin, and systems are presented for each climate zone.




*Embodied Energy and Design: Making Architecture Between Metrics and Narratives*[32] serves as a reference for understanding the embodied energy implication in architectural construction. Sustainable design strategies and material technology are discussed.




Timothy Morton's *Dark Ecology*[36] explains a fundamental basis in understanding today's ecological thinking and philosophy. He theorizes that ecology and ecological awareness are twisted loops – unable to be smoothened out as issues of agrilogistics and global warming are attempted to be resolved.




Lydia Kallipoliti's *The Architecture of Closed Worlds: Or, what is the power of shit?*[35] covers the historical and theoretical development of closed systems in architecture. Twentieth century case studies illustrate designs circulating energy, resources, and waste.

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# CV

## EDUCATION

**Royal Danish Academy**
Copenhagen, Denmark
2019 – 2021

**MA in Architecture –**
**Architecture and Extreme Environments**

**Carleton University**
Ottawa, Canada
2012 – 2017

**Bachelor of Architectural Studies**
*High Distinction*

**École Spéciale d'Architecture**
Paris, France
2015

**Exchange**
*Year 3, semester 6*

## PROFESSIONAL

**Helen & Hard**
Oslo, Norway
2018 – 2020

**Intern (praktikant)**
*3D modelling, visualizations, drawings, diagrams, physical modelling, video editing, presentations*

**RATIO Architecture**
Vancouver, Canada
2017 – 2018

**Designer / Intern**
*Drawings, 3D modelling, case study research*

**Gensler**
London, UK
2015 – 2016

**Part 1 Architectural Assistant**
*Retail branding design guidelines, visualizations, drawings, 3D modelling, masterplan plot regulations*

## SKILLS

**Software**

*Adobe CC, ArchiCAD, AutoCAD, Cinema4D, Grasshopper, QGIS, Revit, Rhino, SketchUp, Twinmotion, V-Ray*

**Technical**

*3D printing, casting, lasercutting, metalwork, photography, textile, woodwork*

**Languages**

*English (proficient)*
*French (intermediate)*
*Korean (basic)*
*Norwegian (intermediate)*