A NEW VISION ON LIGHTWEIGHT FIBER-BASED BUILDING SYSTEMS USING CORELESS-FILAMENT WINDING

Fibrous surface of a lightweight fiber-based building system

P2 Presentation
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January 26, 2024

TU Delft Delft University of Technology

Introduction
PROBLEM STATEMENT – CONTEXT – OVERALL DESIGN HYPOTHESIS
– THEMATIC RESEARCH QUESTION – OBJECTIVE – METHODOLOGIES

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DEMATERIALIZATION & DECARBONIZATION – PRODUCTION OF FIBROUS
TECTONICS – MODULARITY & DEMOUNTABILITY – RESEARCH CONCLUSION

Design
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- PRELIMINARY DESIGNS

Conclusion
CONCLUSION – WHAT’S NEXT

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Standardization led to cost reduction, however..

Standardization

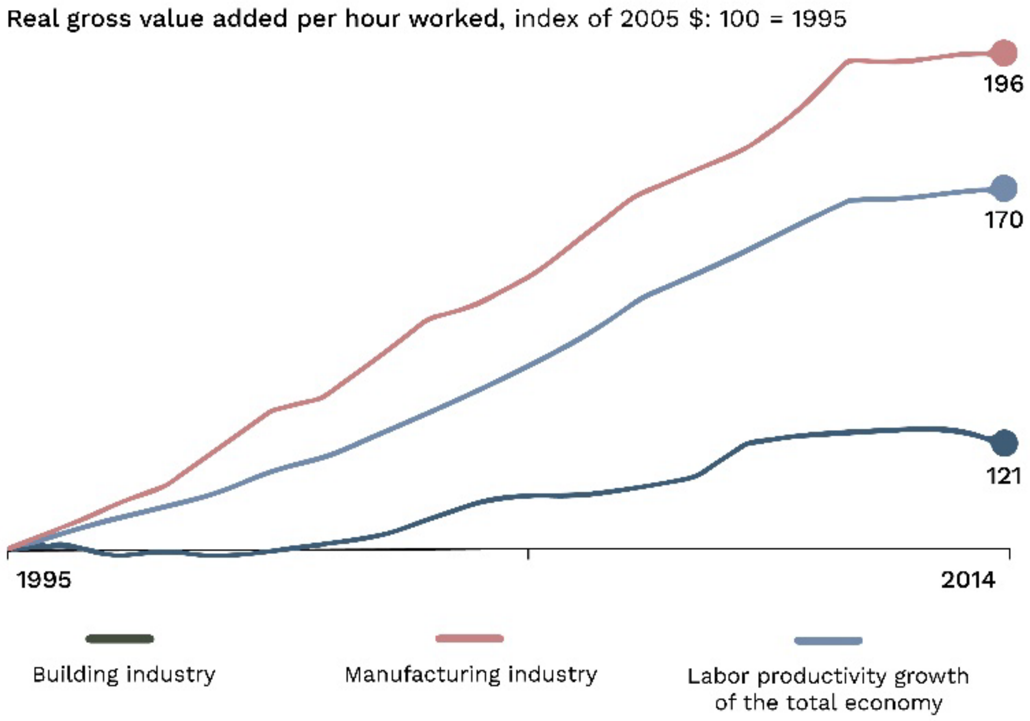
Cost savings

Illustration retrieved from: Building-industry-construction-site [Illustration]. Freepik. Accessed on January 25, 2024, www.freepik.com

Illustration retrieved from: Cost-reduction-illustration-with-decrease-price-minimising-or-falling-rate-of-profit-in-business [Illustration]. Vecteezy. Accessed on January 25, 2024, www.vecteezy.com

(ECESP, 2021)

Marginal efficiency increase in the Building Industry



Graph retrieved from: REINVENTING CONSTRUCTION: A ROUTE TO HIGHER PRODUCTIVITY [Graph]. Mckinsey. Accessed on January 25, 2024, www.mckinsey.com

(Mckinsey, 2017)

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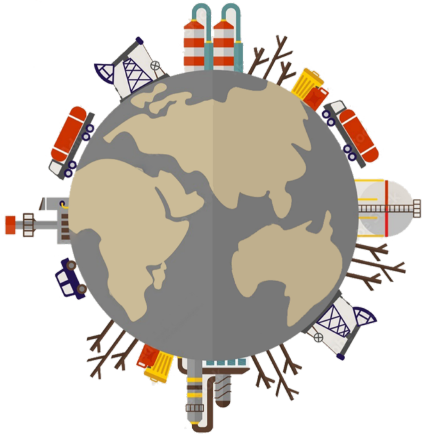
Effects of the building industry on our planet

Material Waste

Pollution and Depletion



Emissions

Illustration retrieved from: Trash container [Illustration]. Vecteezy. Accessed on January 25, 2024, www.vecteezy.com

Illustration retrieved from: Construction materials set [Illustration]. Vectorstock. Accessed on January 25, 2024, www.vectorstock.com

Illustration retrieved from: Building industrial plants polluting the environment. [Illustration]. Adobe Stock. Accessed on January 25, 2024, www.stock.adobe..com

Illustration retrieved from: Pollution concept [Illustration]. Freepik. Accessed on January 25, 2024, www.freepik.com

(ECESP, 2021)

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Demand for new resource efficient building materials and methods

~~Heavy solid structures~~

Lightweight open structures

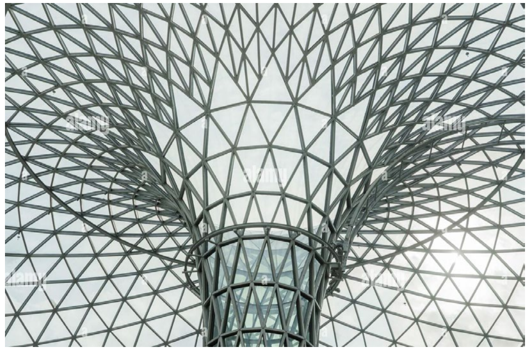

Image retrieved from: Concrete massive construction [Image]. Construcaocivil. Accessed on January 25, 2024, www.construcaocivil.info

Image retrieved from: Double-curve-funnel-shaped-skylight-architectural-glass-steel-structure-of-a-dome-parametric-design [Image]. Alamy. Accessed on January 25, 2024, www.alamy.com

Illustration retrieved from: Woman keeps heavy boulders from falling [Illustration]. Vectorstock. Accessed on January 25, 2024, www.vectorstock.com

Illustration retrieved from: Falling feather [Illustration]. Alamy. Accessed on January 25, 2024, www.alamy.com

(ECESP, 2021)

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Circular economy manufacturing cycle

Reevaluation of our traditional building methods

Dematerialization

Modularity

Demountability

Concrete

Brick

Steel

Illustration retrieved from: Circular economy manufacturing cycle [Illustration]. Vecteezy. Accessed on January 25, 2024, www.vecteezy.com

Illustration retrieved from: Welding Service with Professional Welder [Illustration]. Vecteezy. Accessed on January 25, 2024, www.vecteezy.com

Illustration retrieved from: Mixing sand for workers in construction concrete mixers [Illustration]. Dreamstime. Accessed on January 25, 2024, www.dreamstime.com

Illustration retrieved from: Contractor [Illustration]. 123rf. Accessed on January 25, 2024, www.123rf.com

“We as architects and engineers have to develop our own fabrication processes adapted for the needs of architectural and building construction” Jan Knippers

Image retrieved from: From laboratory to building practice [Picture]. Competitiononline. Accessed on January 25, 2024, www.competitionline.com

(Pérez, Guo, & Knippers, 2022)

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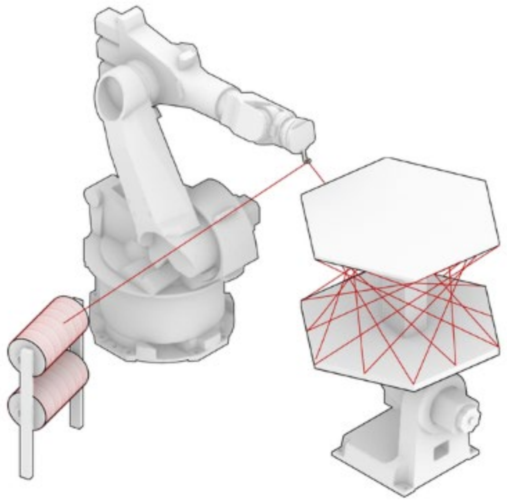
Coreless Filament Winding using Fiber Filaments



Coreless Filament Winding

Flax Fibers

Illustration retrieved from: Spatial winding: cooperative heterogeneous multi-robot system for fibrous structures [Illustration]. ResearchGate. Accessed on January 25, 2024, www.researchgate.net

Image retrieved from: Flax fibers from flax for the manufacture of linen fabric and linen fabric [Picture]. Shutterstock. Accessed on January 25, 2024, www.shutterstock.com

(Duque Estrada, et al., 2020)

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Research gap

Fibrous structural elements →

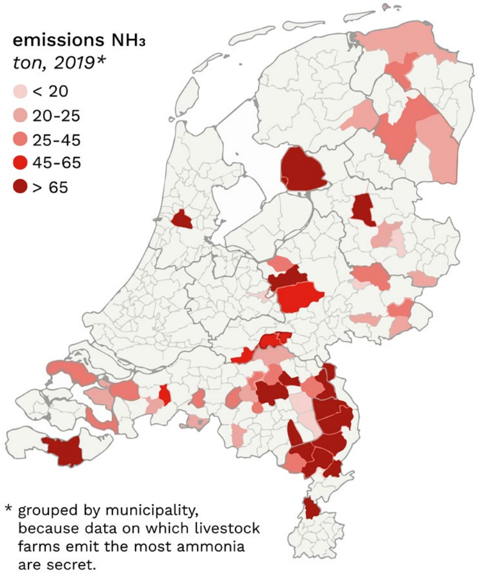
← Fibrous non-structural elements

↓

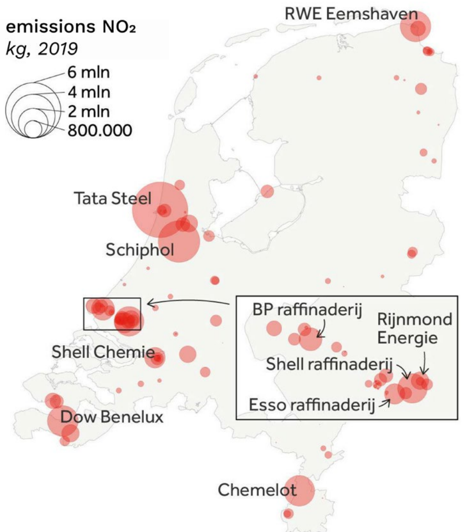
Fibrous building systems

Illustration retrieved from: 40 learning gaps stock illustrations [Illustration]. iStockphoto. Accessed on January 25, 2024, www.Istockphoto.com

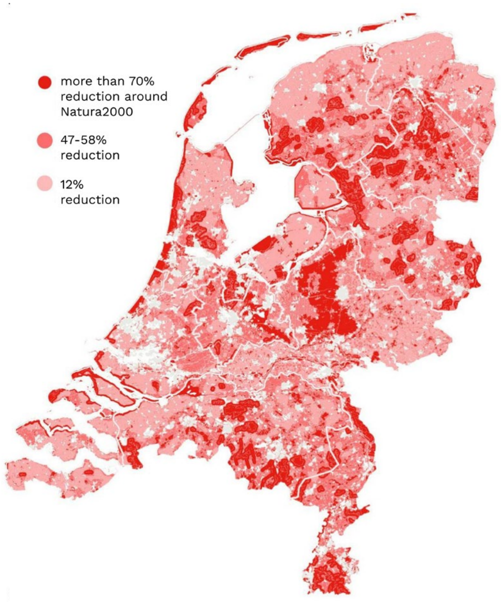
Nitrogen & Ammonia Crisis



Largest emitters of ammonia: mainly livestock farms



Largest emitters of nitrogen dioxides



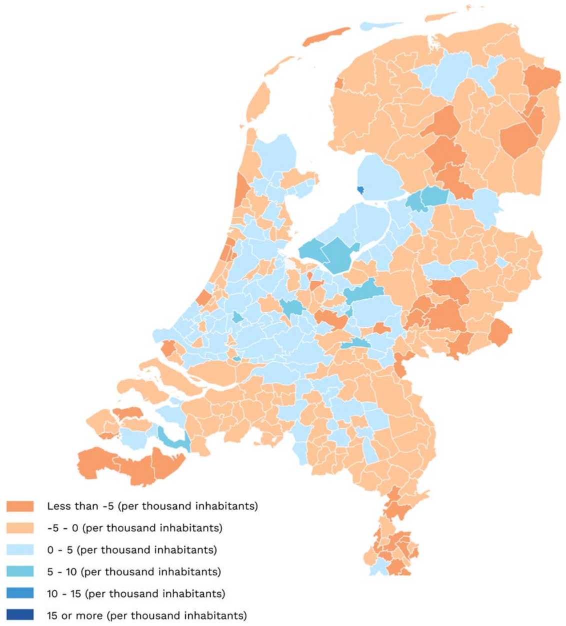
In these areas, nitrogen emissions must be reduced

Graphs retrieved from: Het stikstofprobleem is echt Nederlands, uitgelegd in acht grafieken [Graph]. NOS. Accessed on January 25, 2024, www.nos.nl

(Rijksoverheid, 2023)

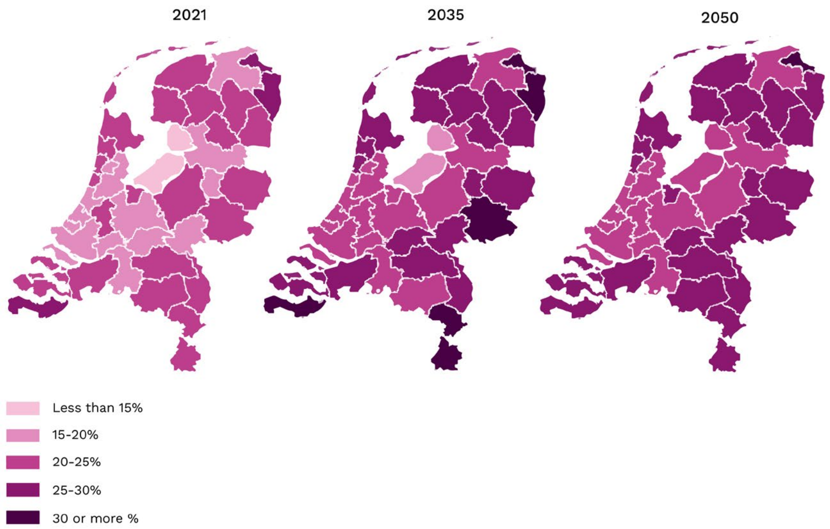
Demographic Challenges in the Northern part of The Netherlands

Population development 2022 I Natural growth



Decline in natural growth

Percentage of over-65s per COROP



Aging problem in The Northern Region

Graph retrieved from: Population Development 2022 [Graph]. Harveyotten. Accessed on January 25, 2024, www.Harveyotten.nl

Graph retrieved from: Percentage of over-65s per COROP [Graph]. Kennisvanstadenregio. Accessed on January 25, 2024, www.kennisvanstadenregio.nl

(CBS/PBL, 2019

Potentials

Modernizing these industries

Exploring synergies between the farming and construction industries

Address the Nitrogen Crisis & Enhance economic prospects

Fostering environmental sustainability

Illustrations retrieved from: Construction Worker Talking, Economic development, Meeting planning developing agenda [Illustration]. Freepik. Accessed on January 25, 2024, www.freepik.com

Illustrations retrieved from: Smart agriculture, Group of ecologists [Illustration]. iStockphoto. Accessed on January 25, 2024, www.istockphoto.com

Historically

Historic image of flax farming in Groningen, The Netherlands in the 19th century

Image retrieved from: The flax industry 19th century [Picture]. Canonvannederland. Accessed on January 25, 2024, www.canonvannederland.nl

(Brouwers, 1970), (Canonvannederland, 2021), (Hofslot, 2023)

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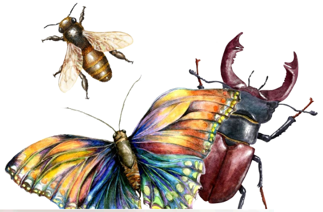
Synergy



Synergy between farmers, builders, inhabitants *AND with nature itself*

Illustration retrieved from: Male farmer with rake [Illustration]. Vecteezy. Accessed on January 25, 2024, www.vecteezy.com

Illustration retrieved from: Labor Cooperation [Illustration]. PNGtree. Accessed on January 25, 2024, www.pngtree.com

Image retrieved from: The flax plant [Image]. Beezone. Accessed on January 25, 2024, www.beezone.co.kr

Image retrieved from: Bees, Beetles and Butterflies [Image]. CornerstonesandEducation. Accessed on January 25, 2024, www.cornerstoneseducation.co.uk

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Overall Design Hypothesis

The flax farm of the future, that is constituted from **fibrous structures**, and which is constructed using **coreless-filament winding**, will have a positive impact on the layout, the efficiency of the required facilities and translates into a **new architectural language** that has a transformative impact on the **relationship between humans and their environment** and ultimately showcases the **full potential** of the use of **flax** in Architecture.

Thematic Research Question

How to create **lightweight fiber-based building systems** for large open spaces from (regionally harvested) **flax** fibers using coreless-filament winding, whereby **bespoke fibrous tectonics**, **dematerialization** and **modularity** are considered as guiding themes?

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Design Objective

- Flax farm & factory of the future
- Incorporated into the Groningen landscape
- Uses regional fibrous sources, such as Flax
- Design various potent layouts
- Space for community engagement
- Showcase the full potential of flax
- Explore the transformative impact of this new architectural language

Research Objective

- Various potent fibrous building systems made from flax

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Design

Farm and Factory typologies & materials used

- *Which materials and construction techniques, both historically and contemporary, have been used to accommodate different farm and factory typologies in The Netherlands and abroad?* → **Case study analysis**

Contextual influences

- *What are the geographical and climatic characteristics of the site, in the Groningen landscape, that needs to be considered, and how do they influence the design?* → **Context analysis, Literature review, Interview**

Infrastructure

- *What infrastructure is required for flax farm activities, including storage, processing, production and packaging and which layout is the most suitable to use in the design to promote a smooth workflow and efficiency between the facilities?* → **Literature review, Interview**

Community engagement

- *How can the architectural design of the farm include spaces for community engagement, education and events to showcase the potential and the production cycle of Flax?* → **Case study analysis, Literature review**

Architectural Language

- *How do these materials and techniques alter the way we are connected to our living environment and result in a new architectural language?* → **Literature review**

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Research

Dematerialization & Decarbonization

- *What are the characteristics of (flax) fibers that need consideration to use the material with the coreless-filament winding technique to achieve dematerialized fibrous structures?*
- *How are flax fibers harvested, processed, and finalized to be used for coreless-filament winding and how can the biodegradability of the end product be ensured?*

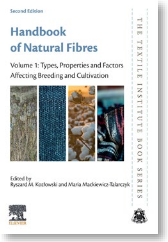
Production of fibrous tectonics

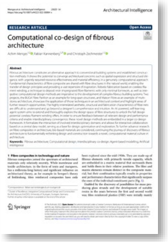
- *How can the fabrication technique of coreless-filament winding be optimally used with flax and other types of fiber-based materials resulting in dematerialized modular structures characterized by fibrous tectonics?*

Modularity & Demountability

- *How can these structural and non-structural fibrous elements be combined in a modular and demountable way, while being thermally insulated, weatherproof and structurally optimized, to form fiber-based building systems?*
- *How can computational design aid in creating fibrous structures that utilize dematerialization, are structurally optimized for the shapes needed for the program and enable form freedom?*

Literature review





Images retrieved from: Cover pages of various research papers [Image]. ResearchGate. Accessed on January 25, 2024, www.researchgate.com

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Case study analysis

ICD/ITKE Research Pavilion 2012
ICD/ITKE Research Buildings, Germany

BUGA Fibre Pavilion 2019
CD Research Buildings / Prototypes
Bundesgartenschau Heilbronn 2019, Germany

Maison Fibre 2021
ICD/ITKE Research Buildings

LivMatS Pavilion 2021
2021 ICD Research Buildings / Prototypes
Botanic Garden Freiburg, Germany

Images retrieved from: Overview of ICD/ITKE research pavilions and Demonstrators [Image]. ITKE University of Stuttgart. Accessed on January 25, 2024, www.itke.uni-stuttgart.de

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Interview

Dr. Julian Fial
Head of Production & Development

FibR® reinventing composites

Image retrieved from: Dr. Julian Fial [Image]. Regrow. Accessed on January 25, 2024, www.regrow.build

Illustration retrieved from: Logo FibR [Illustration]. FibR. Accessed on January 25, 2024, www.fibr.tech

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Research-by-Design

Images made by author (R.T. STEINFORT)

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Prototyping

Images made by author (R.T. STEINFORT)

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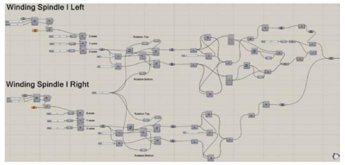
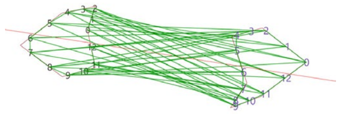
Digital prototyping





Images made by author (R.T. STEINFORT)

RESEARCH

Image made by author (R.T. STEINFORT)

Comparative analysis

Flax is the most optimal natural fiber

Appendix 2 I Performance Indicators – Filament Winding Materials

	Flax Fiber	Hemp Fiber	Sisal Fiber	Basalt Fiber	Carbon Fiber	Fiber Glass	Steel Fiber
Tensile strength (MPa)	343-1500	270-900	353	2600-4840	2000-5000	3500	660-830
Compression strength (MPa)	1200*	-	-	-	1000-3000	50-100	250-1500
Elasticity (Young's module – MPa)	58.643	30.000 – 60.000	15.720	80.000-115.000	200.000-500.000	72.000	210.000
Diameter	10-80 µm	26 µm	121-411 µm	10.6 µm	5-8 µm	10-17 µm	-
Fiber length	10-100 cm	1 – 5 cm	80-120 cm	50 cm	∞	∞	∞
Density (g/cm³)	1.4-1.5	1.48	1.45	1.85-2.75	1.75-2.00	1.5	7.8
Fire resistance	Bad	Bad	Bad	Superior	Good	Good	Good
Fire retardance	Varies	Varies	Varies	Superior	Good	Good	Good
Burning/Melting point	237 °C	118-131 °C	163 °C	1500-1700 °C	< 1000 °C	1200-1700 °C	1425-1540 °C
Moisture absorption	Good	Good	Good	Good	Good	Good	Good
Moisture resistance	Bad	Bad	Bad	Good	Good	Good	Good
Thermal conductivity (W/mK)	0.038	0.038-0.042	0.038	0.031-0.0038	0.63	0.04	45
Growth duration (days)	100	90-120	1000-1800	-	-	-	-
Growing season	Spring	Spring	Summer	-	-	-	-
Origin	Flax Plant	Hemp Plant	Sisal Plant	Volcanic rock	Synthetic polymer	Glass	Steel ore
Organic/Inorganic	Organic	Organic	Organic	Inorganic	Inorganic	Inorganic	Inorganic
Texture	Soft, shining	Soft, shining	Coarse/ rough	Fine grained	Soft/ Smooth	Soft/ Smooth	Smooth, but hard
Color	Beige/light grey	Off white/ brown	Off white/ brown	Brown/Black	Black/grey	Light yellow /white	Grey metallic
Sound absorption coefficient	0.93	0.93	0.6-0.7	0.22-0.75	<0.1	0.9-0.95	0.2
Biodegradability	Yes	Yes	Yes	No	No	No	No
Eco-friendliness	Yes	Yes	Yes	No	No	No	No
Chemical Resistance	Moderate	High	Moderate	Very high	Very high	Very high	Corrosion

Table made by author (R.T. STEINFORT)

(Sources are listed in Appendix 2)

Comparative analysis

Flax is the most optimal natural fiber

Advantages

- High tensile strength
- Separation of fibers
- Optimal thermal insulators

Disadvantages

- Dematerialization & material characteristics
- Flammable
- Biodegradable & hydrophilic
- Not naturally weatherproof

	Flax Fiber	Hemp Fiber	Sisal Fiber
Tensile strength (MPa)	343-1500	270-900	353
Compression strength (MPa)	1200*	-	-
Elasticity (Young's module – MPa)	58.643	30.000 – 60.000	15.720
Diameter	10-80 µm	26 µm	121-411 µm
Fiber length	10-100 cm	1 – 5 cm	80-120 cm
Density (g/cm³)	1.4-1.5	1.48	1.45
Fire resistance	Bad	Bad	Bad
Fire retardance	Varies	Varies	Varies
Burning/Melting point	237 °C	118-131 °C	163 °C
Moisture absorption	Good	Good	Good
Moisture resistance	Bad	Bad	Bad
Thermal conductivity (W/mK)	0.038	0.038-0.042	0.038
Biodegradability	Yes	Yes	Yes
Eco-friendliness	Yes	Yes	Yes

Table made by author (R.T. STEINFORT)

(Sources are listed in Appendix 2)

Life Cycle of Flax

- Harvested in 100 days
- Biological Cycle

Production phase

- Coreless-Filament Winding

End-of-Life phase

- Reuse
- Modular
- Shredding
- Decomposed
- Upcycled
- Particle boards or insulation

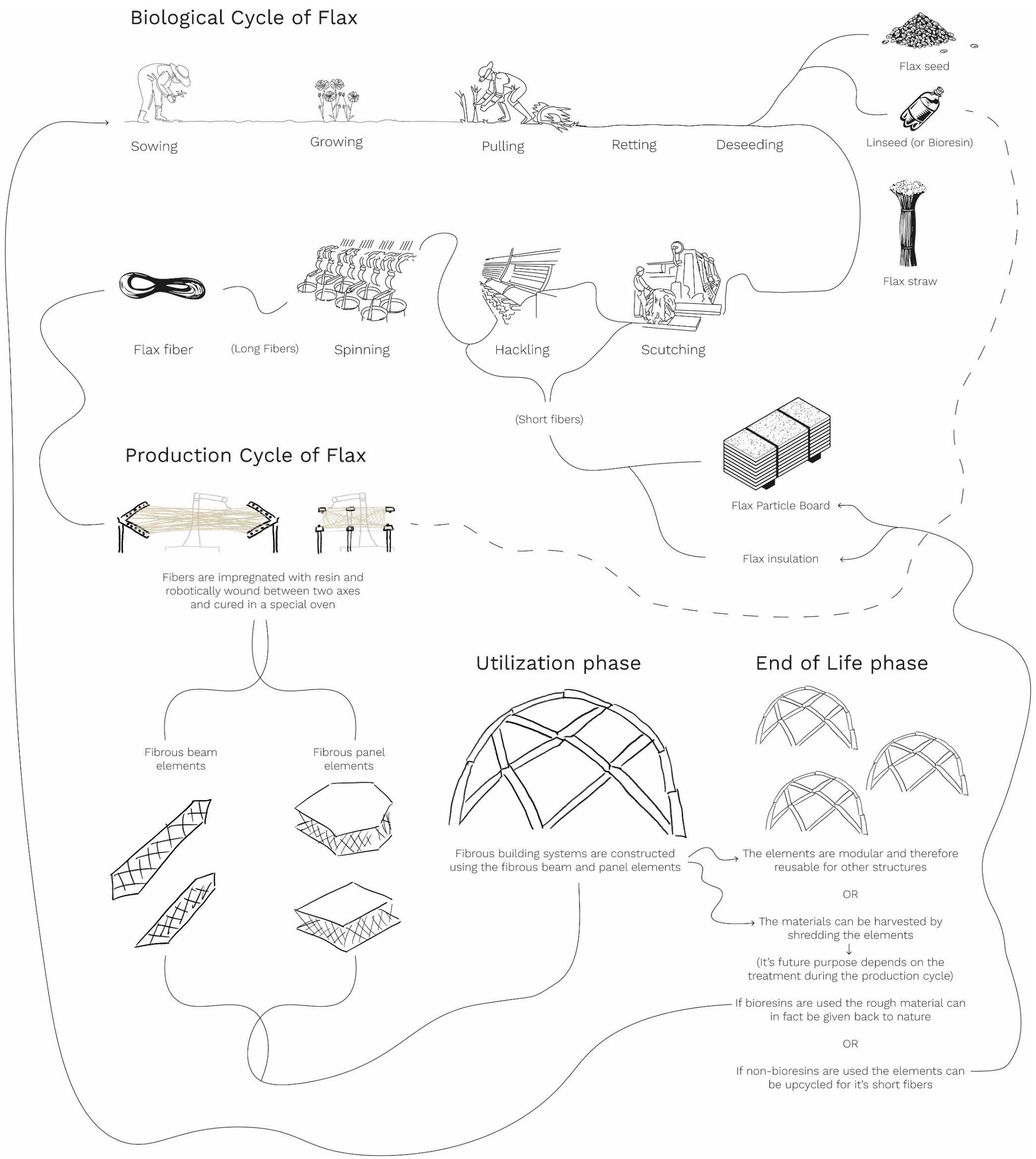


Diagram made by author (R.T. STEINFORT)

DEMATERIALIZATION
&
DECARBONIZATION

PRODUCTION OF FIBROUS TECTONICS

MODULARITY
&
DEMOUNTABILITY

RESEARCH
CONCLUSION

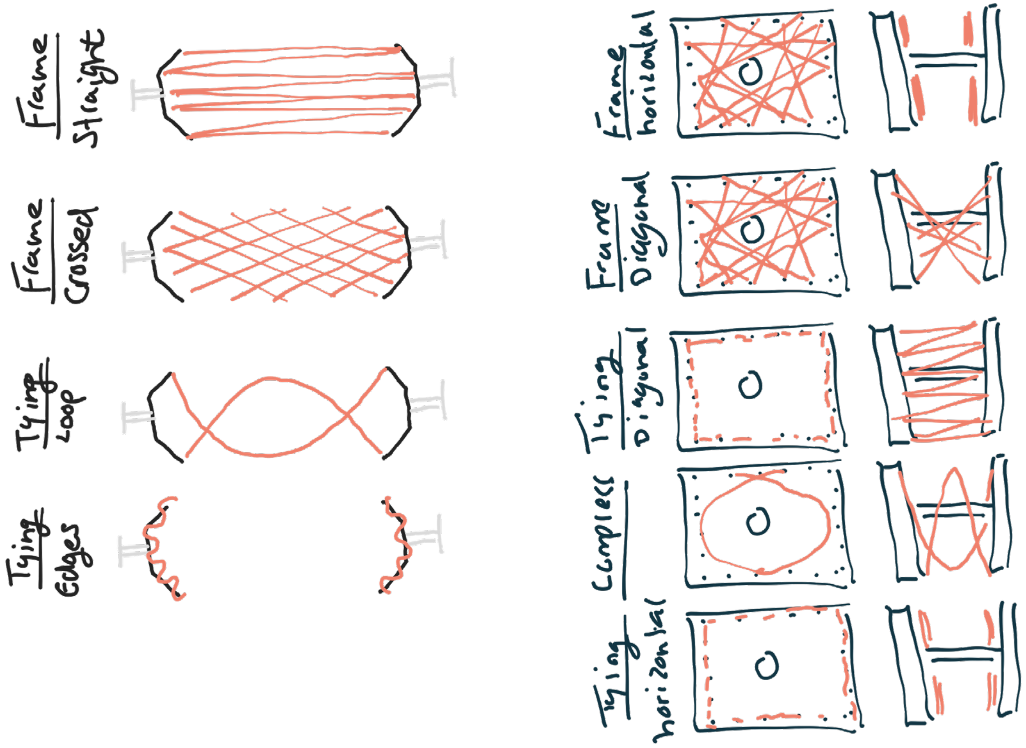
Production process

- Coreless-filament winding technique uses fiber filaments
- That are wound upon two boundary frames and the fibers are impregnated with resin

Images retrieved from: Fabrication sequence of a fibre reinforced composite building element [Image]. ITKE University of Stuttgart. Accessed on January 25, 2024, www.itke.uni-stuttgart.de

The key factors

- Fiber-to-fiber interaction and orientation
- Winding syntax
- Structural abilities



Diagrams made by author (R.T. STEINFORT)

DEMATERIALIZATION
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DECARBONIZATION

PRODUCTION OF FIBROUS TECTONICS

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&
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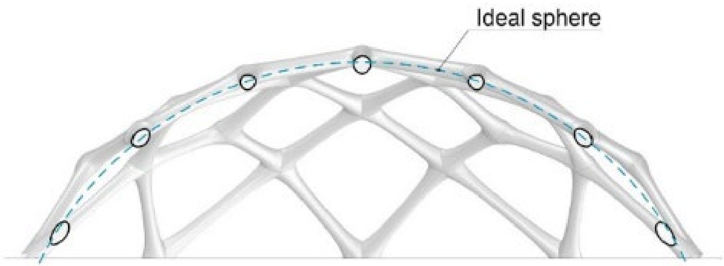
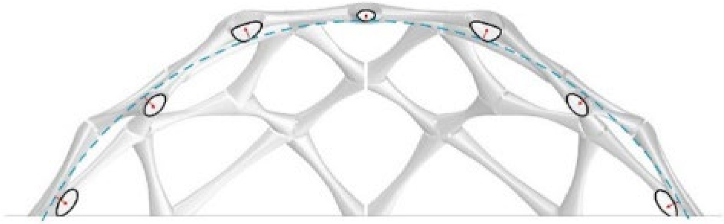
RESEARCH
CONCLUSION

Fibrous tectonics

- Tailor made
- Interrelationship between structure and artistic values
- Also visible between the elements and their specific function
- Bespoke fibrous tectonic structures



Original geometry (global FEM iteration 1)


Optimized final geometry (global FEM iteration 2-5)

Images retrieved from: Overview of ICD/ITKE research pavilions and Demonstrators [Image]. ITKE University of Stuttgart. Accessed on January 25, 2024, www.itke.uni-stuttgart.de

Potential Forms

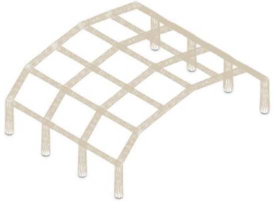
- Endless building- and element shapes are possible on two conditions:
- Be wound upon the robotic setup
- Demolded

Images retrieved from: Overview of ICD/ITKE research pavilions and Demonstrators [Image]. ITKE University of Stuttgart. Accessed on January 25, 2024, www.itke.uni-stuttgart.de

Potential Forms

- Research-by-Design
- Structural typologies
- From conventional towards non-conventional forms

Conventional ⟷ **Unconventional**



Hangar 1

Dome

Double barrel

Tree column

Hangar 2

Barrel

Crossed barrel

Fibrous column

Diagrams made by author (R.T. STEINFORT)

Potential Forms

- Research-by-Design
- Structural typologies
- From conventional towards non-conventional forms
- Straight spans are not optimal I Axial compression

Diagrams made by author (R.T. STEINFORT)

DEMATERIALIZATION
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DECARBONIZATION

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&
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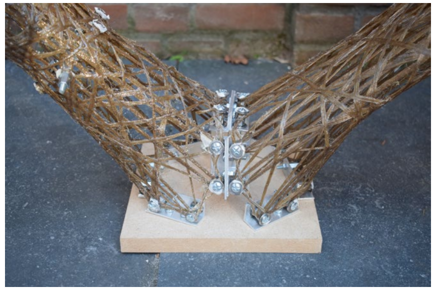
RESEARCH
CONCLUSION

Prototyping

- Connections are demountable
- Able to be thermally insulated
- Fiber-based building systems
- Modular
- Form freedom & flexibility
- Production process



Images made by author (R.T. STEINFORT)

DEMATERIALIZATION
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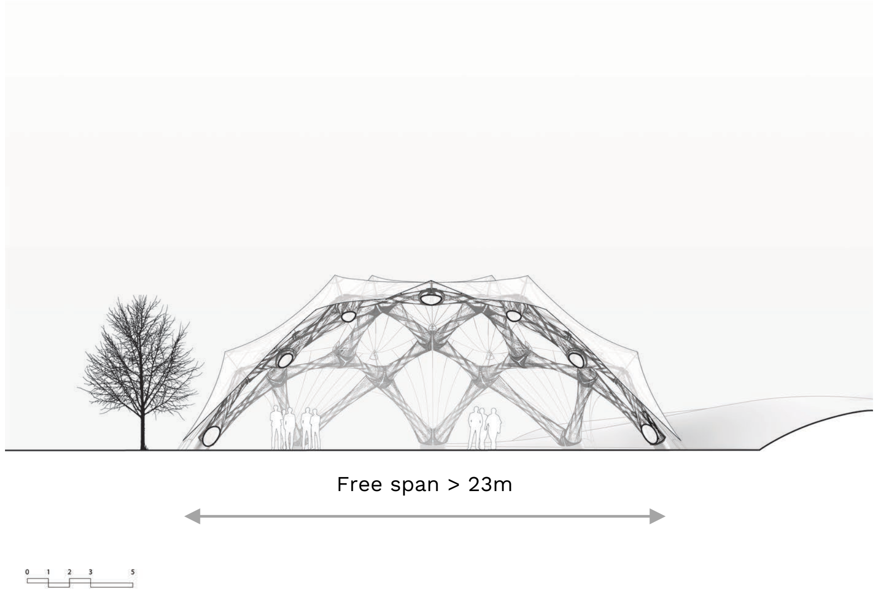
MODULARITY
&
DEMOUNTABILITY

RESEARCH
CONCLUSION

Case study analysis

- Long spans are possible with fibers, including flax fibers



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DEMATERIALIZATION
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&
DEMOUNTABILITY

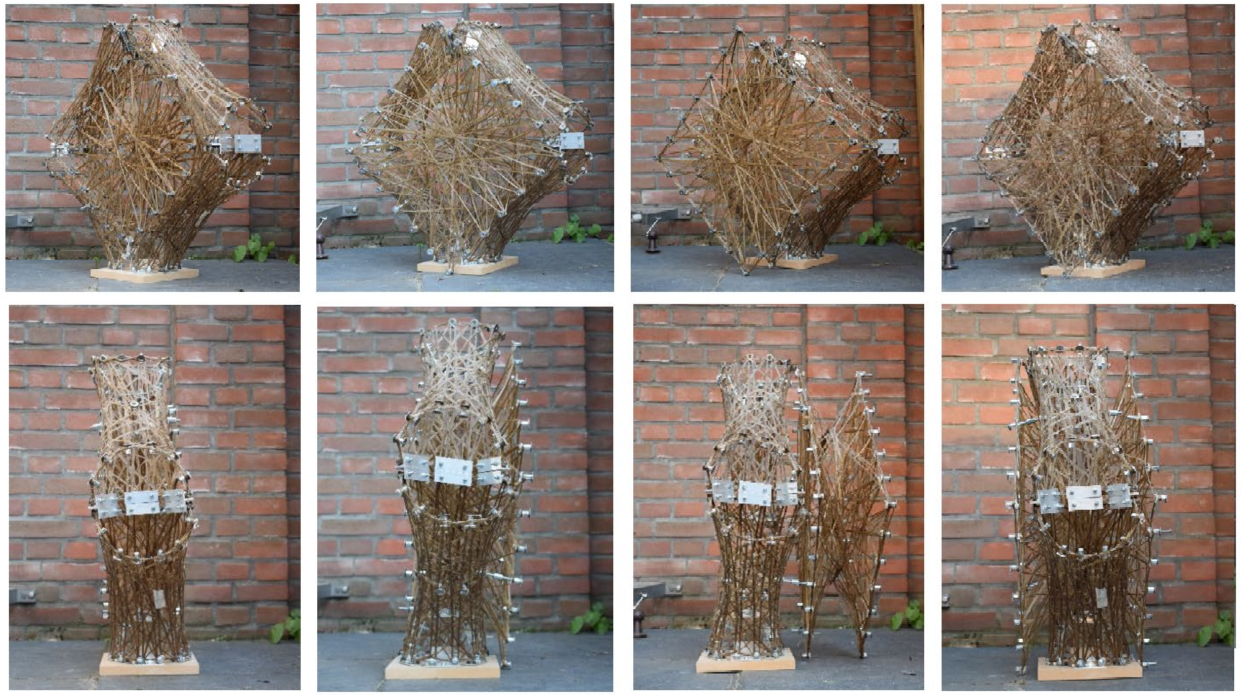
**RESEARCH
CONCLUSION**

Thematic Research Question

How to create **lightweight fiber-based building systems** for large open spaces from (regionally harvested) **flax** fibers using coreless-filament winding, whereby **bespoke fibrous tectonics**, **dematerialization** and **modularity** are considered as guiding themes?

Research Conclusion

- A combination of four fiber-based building systems



System 1 System 2 System 3 System 4

Images made by author (R.T. STEINFORT)

DEMATERIALIZATION
&
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MODULARITY
&
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RESEARCH CONCLUSION

Research Conclusion

- Proof for viability
- Not suitable for all functions
- A combination of various fibers is recommended
- Form language with bespoke fibrous characteristics
- Potential to develop **a novel architectural language**

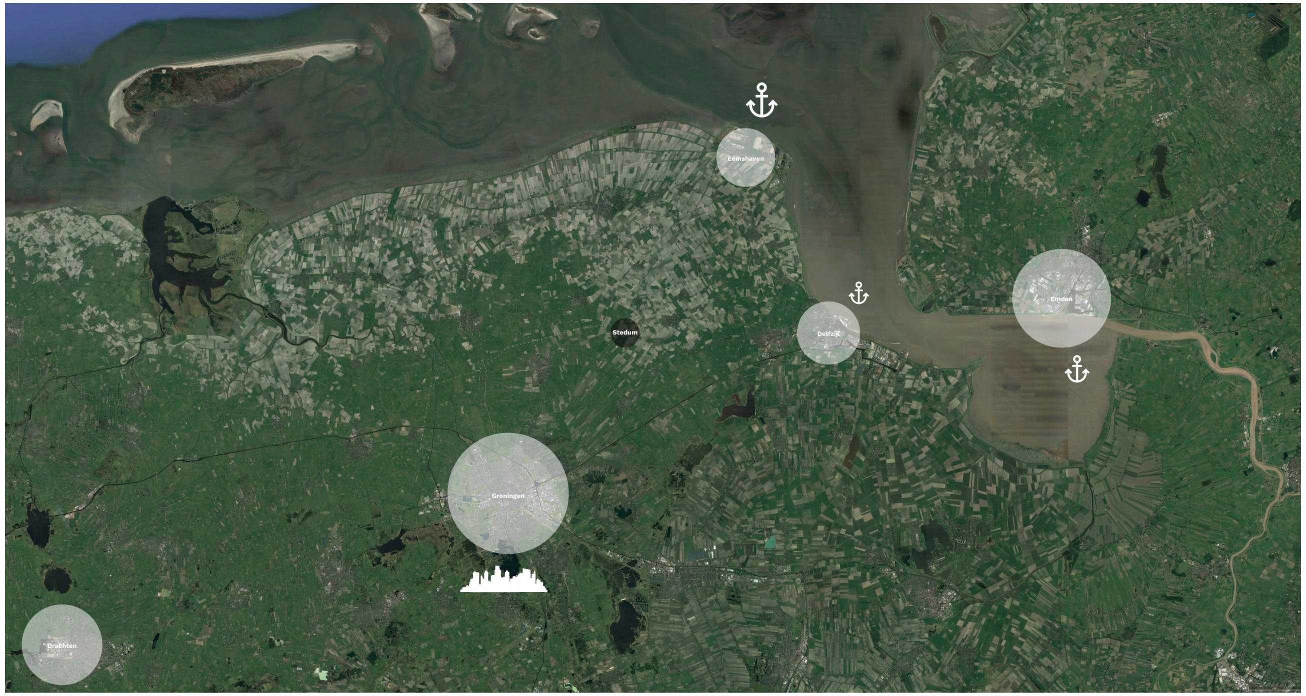
Images made by author (R.T. STEINFORT)

DESIGN

Image made by author (R.T. STEINFORT)

Context

- Northeast Groningen, The Netherlands
- Stedum
- 1000 inhabitants



Satellite view of Northeastern Netherlands I Scale 1:500.000

Image adjusted and retrieved from: Google Earth [Image]. Google Earth. Accessed on January 25, 2024, www.earth.google.com

(Google Earth, 2024)

LOCATION

PROGRAM

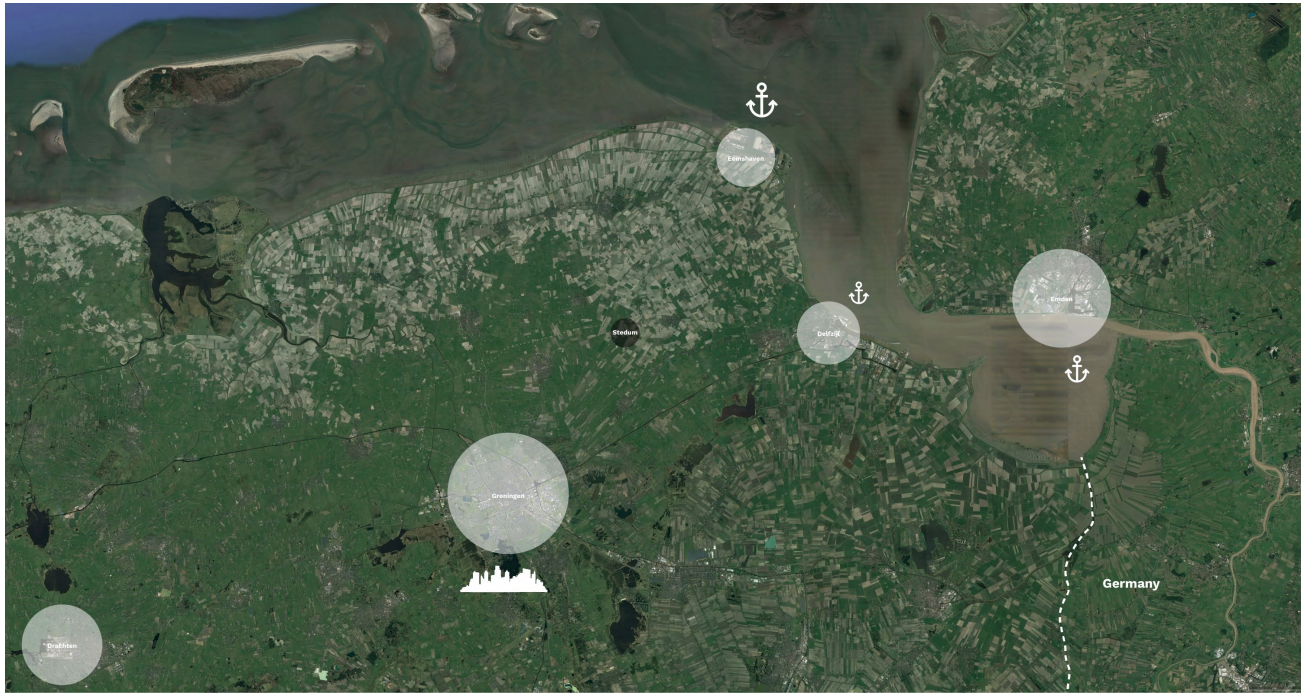
CONCEPT PRINCIPLES

DESIGN VISION

PRELIMINARY DESIGNS

Advantages

- Close to the German border
- International transport



Satellite view of Northeastern Netherlands I Scale 1:500.000

Image adjusted and retrieved from: Google Earth [Image]. Google Earth. Accessed on January 25, 2024, www.earth.google.com

(Google Earth, 2024)

Advantages

- Close to the German border
- International transport
- Close to the Capital of The Province
- Roads to major highways
- A7
- A28

Satellite view of Northeastern Netherlands I Scale 1:200.000

Image adjusted and retrieved from: Google Earth [Image]. Google Earth. Accessed on January 25, 2024, www.earth.google.com

(Google Earth, 2024)

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PRELIMINARY DESIGNS

Advantages

- Close to the German border
- International transport
- Close to the Capital of The Province
- Roads to major highways
- A7
- A28
- Close to major ports
- Eemshaven
- Delfzijl

Satellite view of Northeastern Netherlands I Scale 1:200.000

Image adjusted and retrieved from: Google Earth [Image]. Google Earth. Accessed on January 25, 2024, www.earth.google.com

(Google Earth, 2024)

LOCATION

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PRELIMINARY DESIGNS

Advantages

- Close to the German border
- International transport
- Close to the Capital of The Province
- Roads to major highways
- A7
- A28
- Close to major ports
- Eemshaven
- Delfzijl
- Surrounded by Agricultural fields

Satellite view of Stedum, Groningen I Scale 1:50.000

Image adjusted and retrieved from: Google Earth [Image]. Google Earth. Accessed on January 25, 2024, www.earth.google.com

(Google Earth, 2024)

Advantages

- Close to the German border
- International transport
- Close to the Capital of The Province
- Roads to major highways
- A7
- A28
- Close to major ports
- Eemshaven
- Delfzijl
- Surrounded by Agricultural fields
- Flax Museum situated
- Collective memory flourishing flax industry
- Proposed site

Satellite view of Stedum, Groningen I Scale 1:20.000

Image adjusted and retrieved from: Google Earth [Image]. Google Earth. Accessed on January 25, 2024, www.earth.google.com

(Google Earth, 2024)

Disadvantages

- Low population capacity
- Rural area
- Current infrastructure sufficient?

Satellite view of Stedum, Groningen I Scale 1:20.000

Image adjusted and retrieved from: Google Earth [Image]. Google Earth. Accessed on January 25, 2024, www.earth.google.com

(Google Earth, 2024)

LOCATION

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CONCEPT PRINCIPLES

DESIGN VISION

PRELIMINARY DESIGNS

THE FLAXTORY

AGRICULTURAL

HARVESTING 1500 m2

Storage area for vehicles, equipment and flax bales

INDUSTRIAL

MANUFACTURING 2000 m2

Storage area for flax bales and flax roving

Enough space for the manufacturing machine (length approximately 40m)

Offices for farmers & workers

FABRICATION & EXPERIMENTATION 1600 m2

Storage area for fiber elements and fiber molds

Manufacturing area for the robot setups

COMMERCIAL

OFFICE 600 m2

Spacious office area
Restrooms and canteen

CULTURAL

COMMUNITY 600 m2

Expositions, multipurpose room

	Harvesting	Processing	Fabrication	Office	Community
Program	Agricultural	Industrial	Industrial	Commercial	Cultural
Function	Storage	Manufacturing	Fabrication & Experimentation	Design Lab Promotional Finances Etc.	Engagement center for the public
Rooms	**Harvesting Hall** Storage Area (Long storage) - Vehicles - Equipment - Flax Bales	**Manufacturing Hall** Storage Area (Short storage) - Flax Bales - Flax Roving's Office - For farmers & workers agricultural & industrial	**Fabrication Hall** Storage Area (Long storage) - Fiber elements - Fiber molds Manufacturing Area - Robot layout -	**Office Hall** Office islands, Meeting rooms, **General** Restrooms, Cateria, Locker Rooms, Amphiteater, Resting area	**Community Center** Expositions, Multipurpose room (for events), Try out room, Reception, Space to sell?
Wishes	Spacious area also for traffic	Spacious & Safe area also for traffic	Sterile and quiet environment	Warm & Inspirational environment	Educational & Inspirational
Dimensions					
Area	1500 m^2	2000 m^2	1600 m^2	600 m^2	600 m^2
Width $_{min}$	20 m	20 m	20 m	20 m	10 m
Length $_{min}$	30 m	50 m	40 m	20 m	10 m
Height $_{min}$	9 m	9 m	6 m	6 m	6 m
Span $_{min}$	10 m	10 m	< 20 m*	<10 m	10 m
Climate					
Dry	Yes	Yes	Yes	Yes	Yes
Heated	No	No	Yes	Yes	Yes
Acoustics	N/A	N/A	Yes	Yes	Yes or N/A
Ventilated	Natural	Natural	Mechanical	Mechanical	
Regulations					
Fire proof	Low	Low	Medium	Medium	Medium

Table made by author (R.T. STEINFORT)

LOCATION

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CONCEPT PRINCIPLES

DESIGN VISION

PRELIMINARY DESIGNS

Concept principles

- Structural typologies
- Research-by-Design
- Most optimal structural forms

Dome

Tree column

Crossed barrel

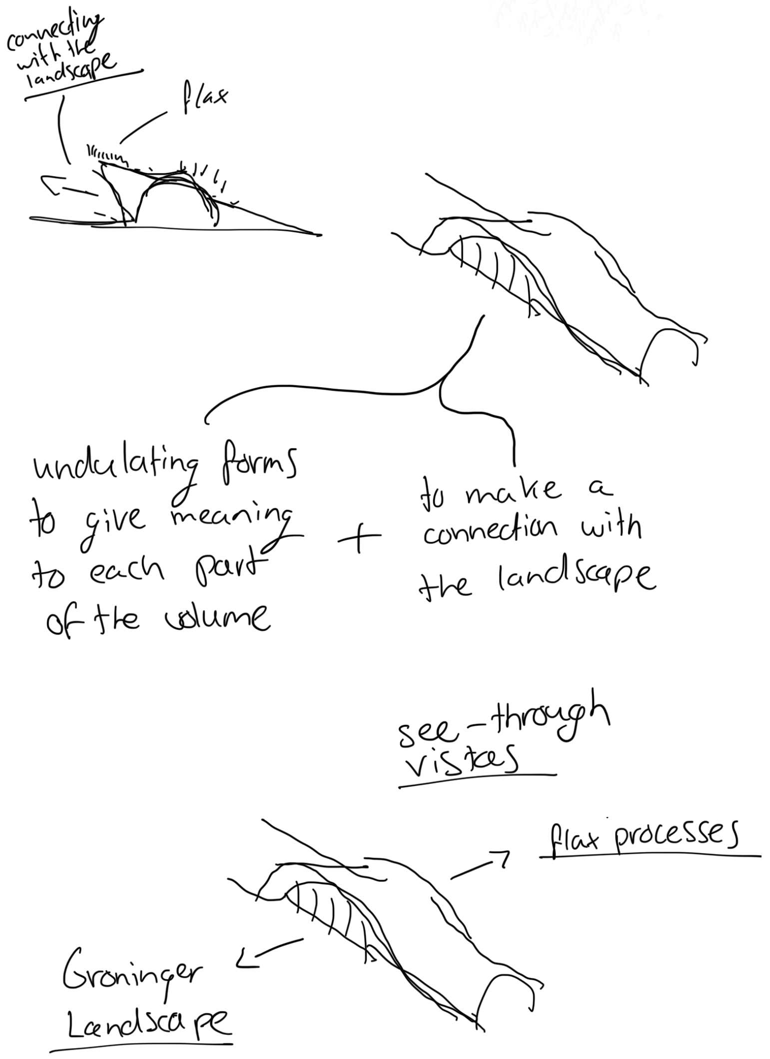
Fibrous column

Diagrams made by author (R.T. STEINFORT)

Design vision

The exterior needs to be:

- Connected to the landscape
- Undulating forms
- Identity
- See-through vistas
- Groningen Landscape
- Vice versa to the processes inside



Diagrams made by author (R.T. STEINFORT)

LOCATION

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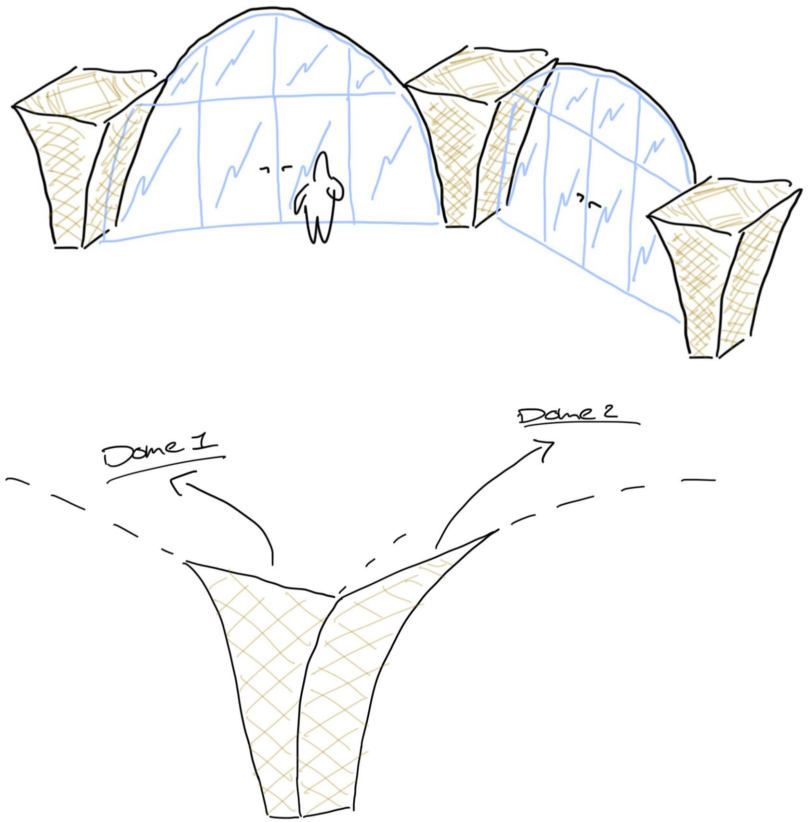
DESIGN VISION

PRELIMINARY DESIGNS

Design vision

The interior needs to be:

- Transparent to create indoor vistas to the other facilities
- Inspire and visual connection
- Fibrous tectonics
- Able to be sensed by the employees and the visitors
- Inspirational environment
- Campus atmosphere



Diagrams made by author (R.T. STEINFORT)

LOCATION

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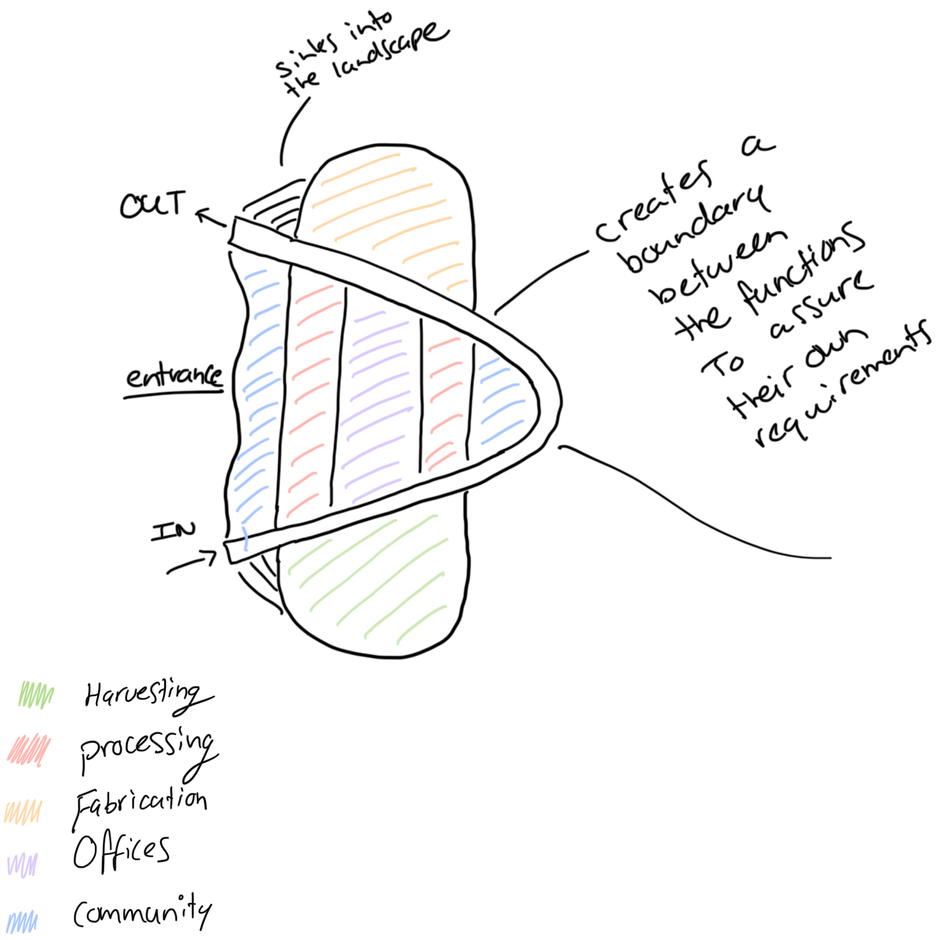
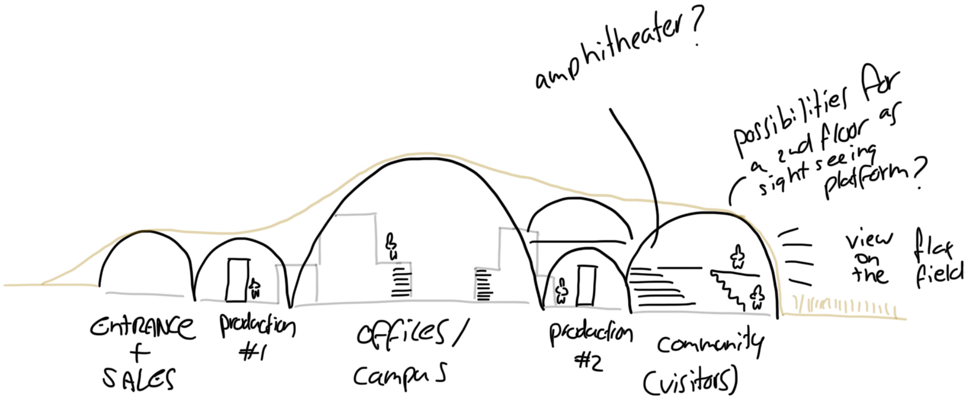
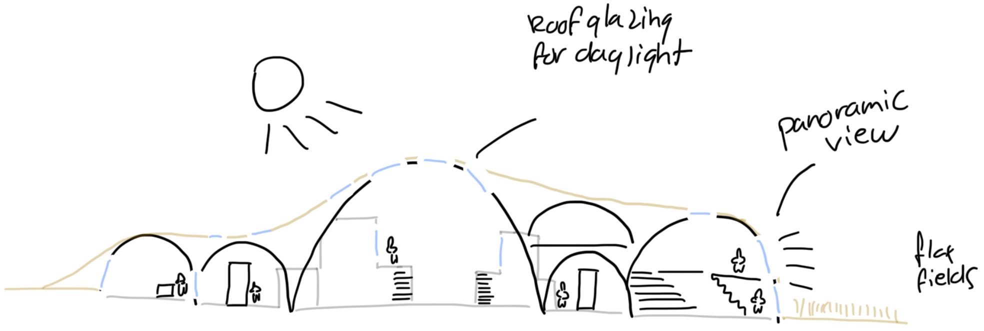
Concept 1 Embracing forms







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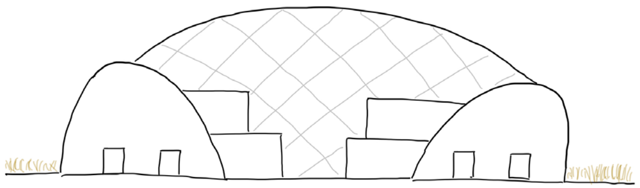
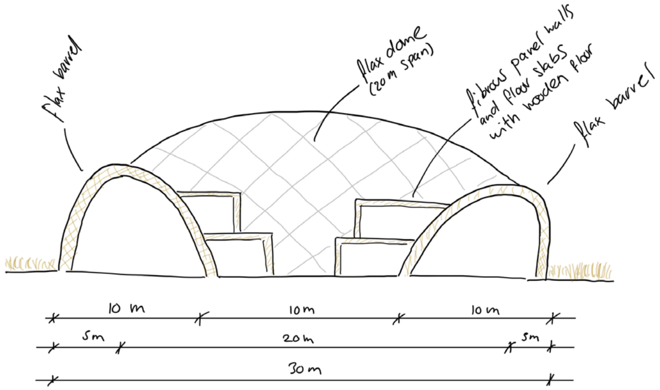
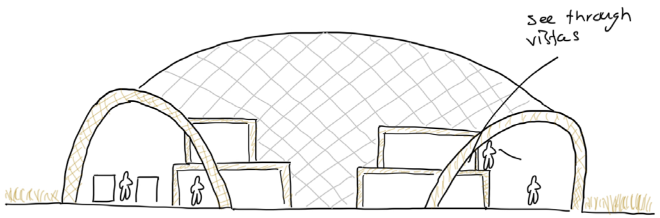
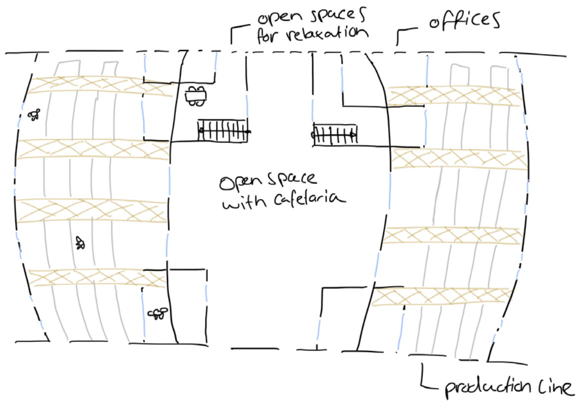
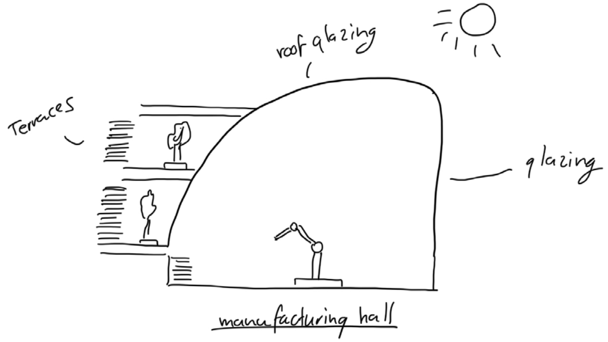
Concept 1 Embracing forms

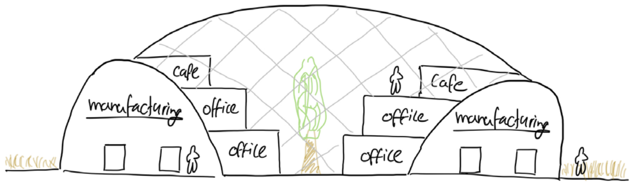






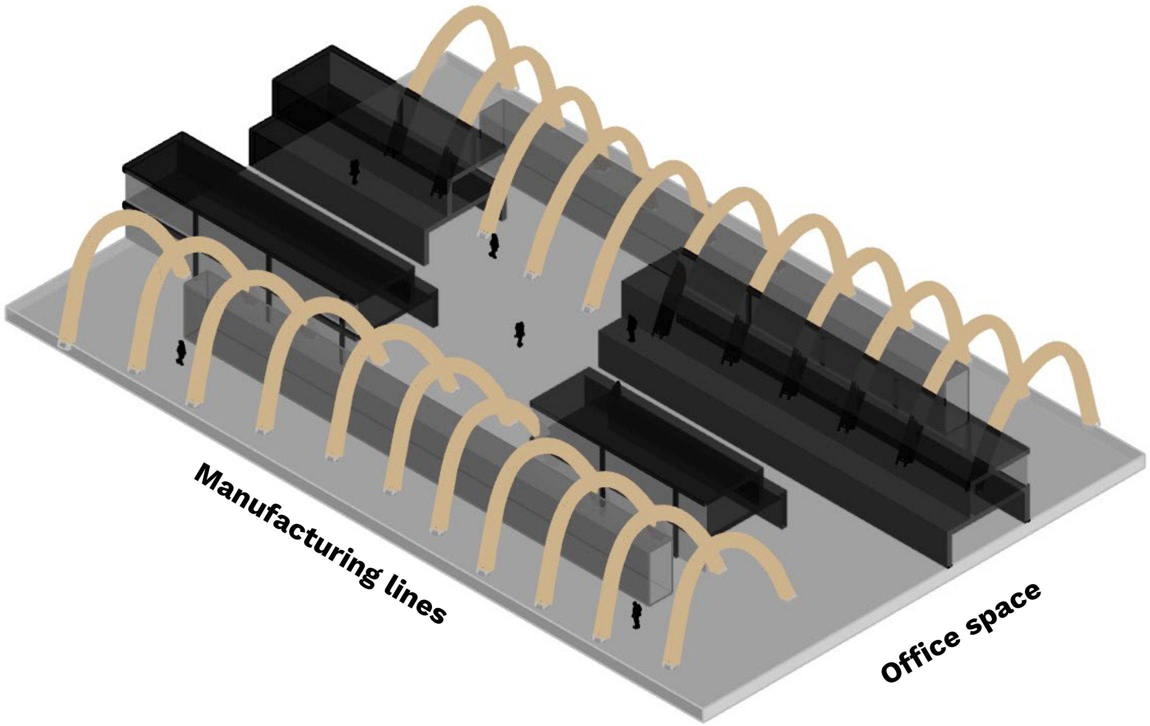






Diagrams made by author (R.T. STEINFORT)

Concept 1 Embracing forms



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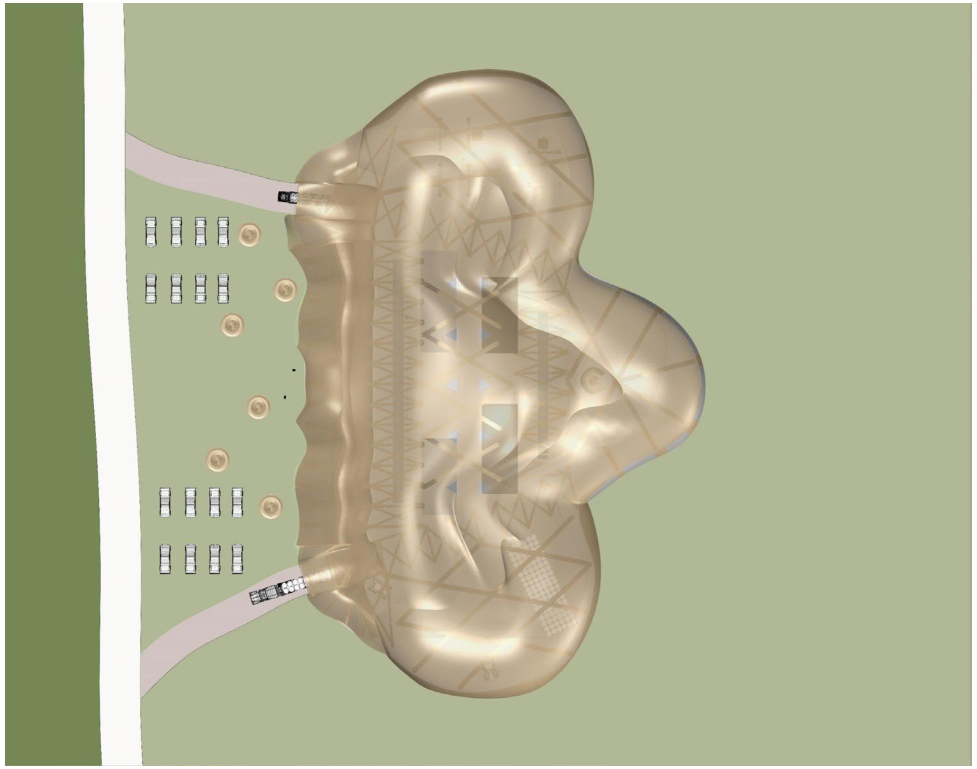
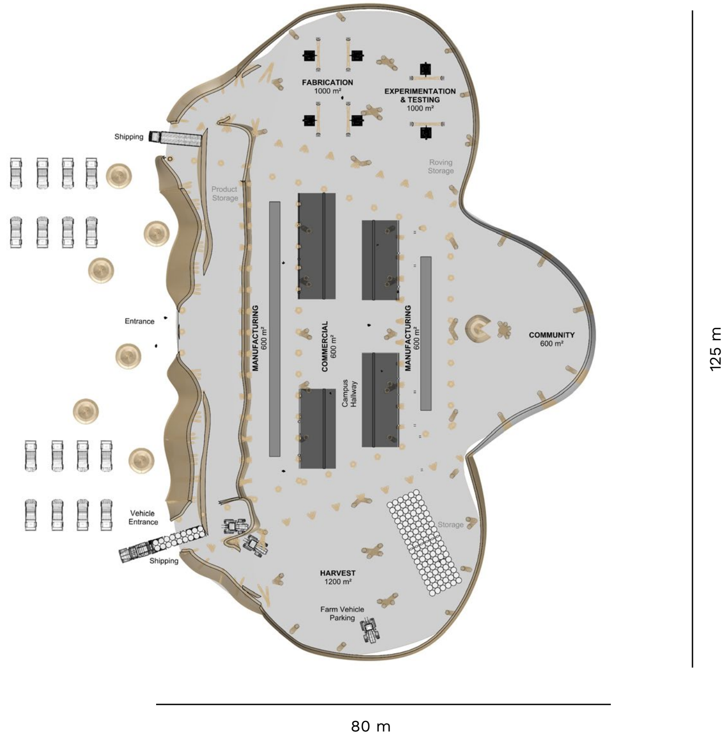


Top Elevation



Plan

Drawings made by author (R.T. STEINFORT)

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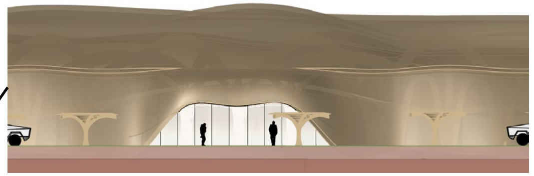
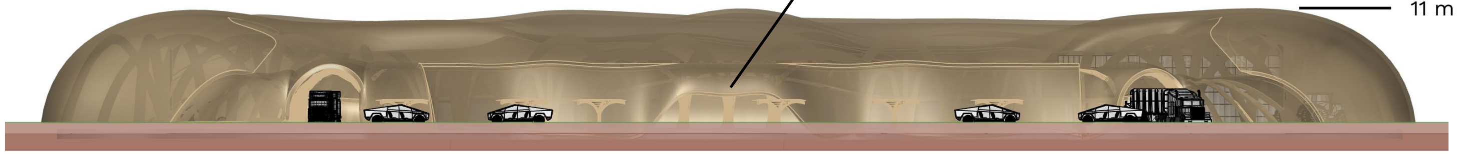
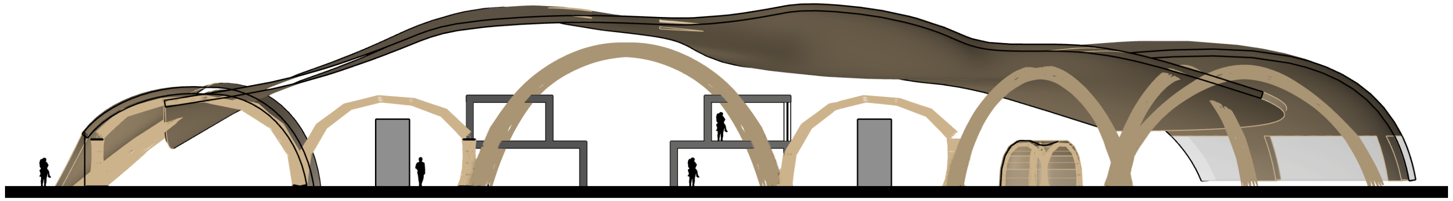
Concept 1 Embracing forms

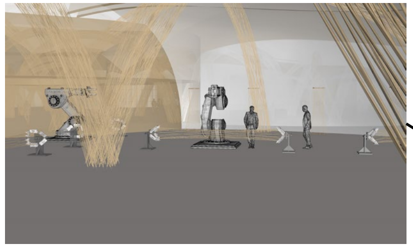


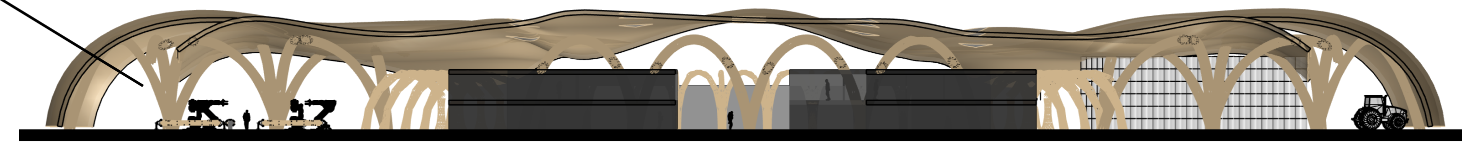


Front Elevation



Cross Section Reception Manufacturing Offices Offices Manufacturing Community





Longitudinal Section Fabrication Offices Campus Offices Harvest

Drawings made by author (R.T. STEINFORT)

LOCATION

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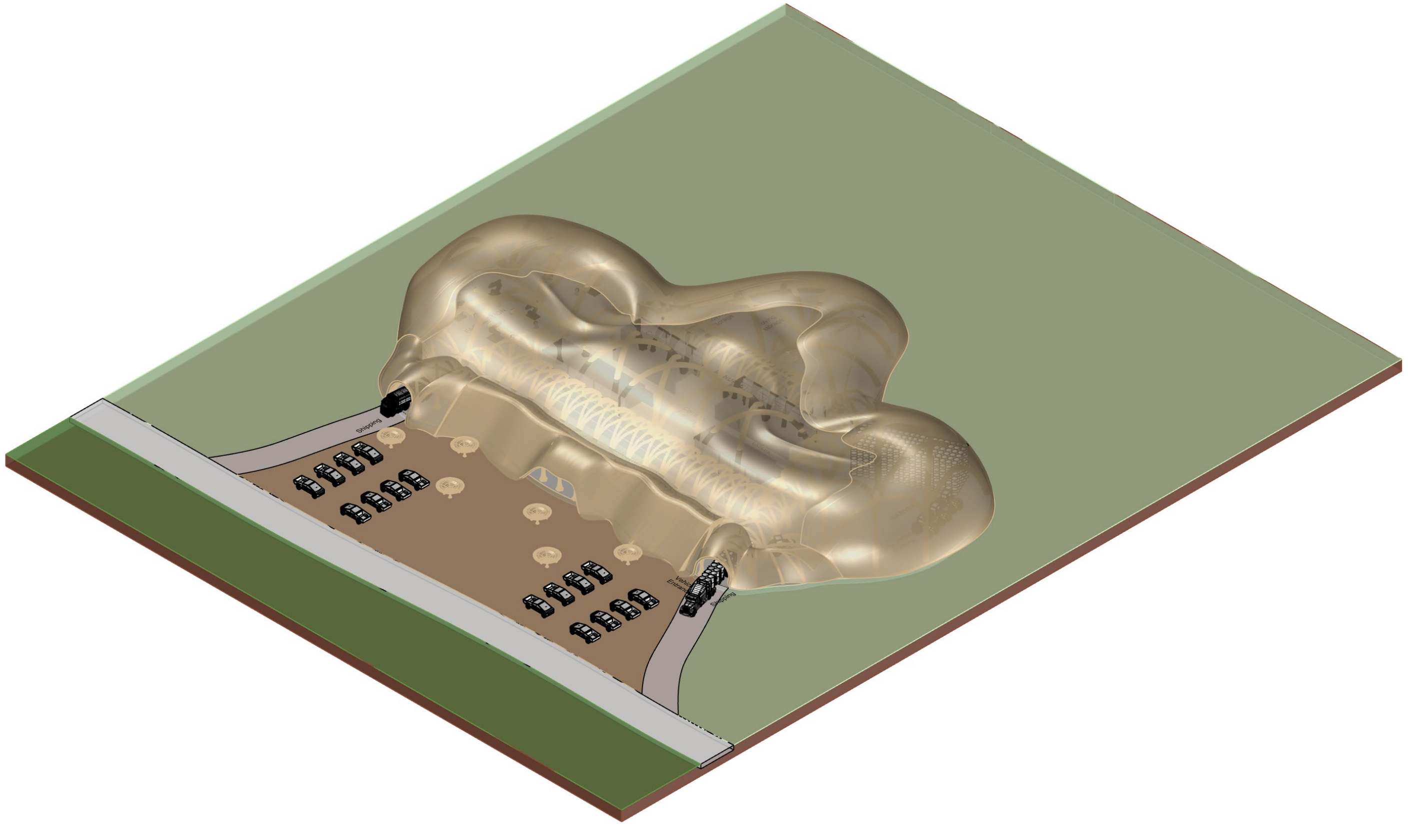
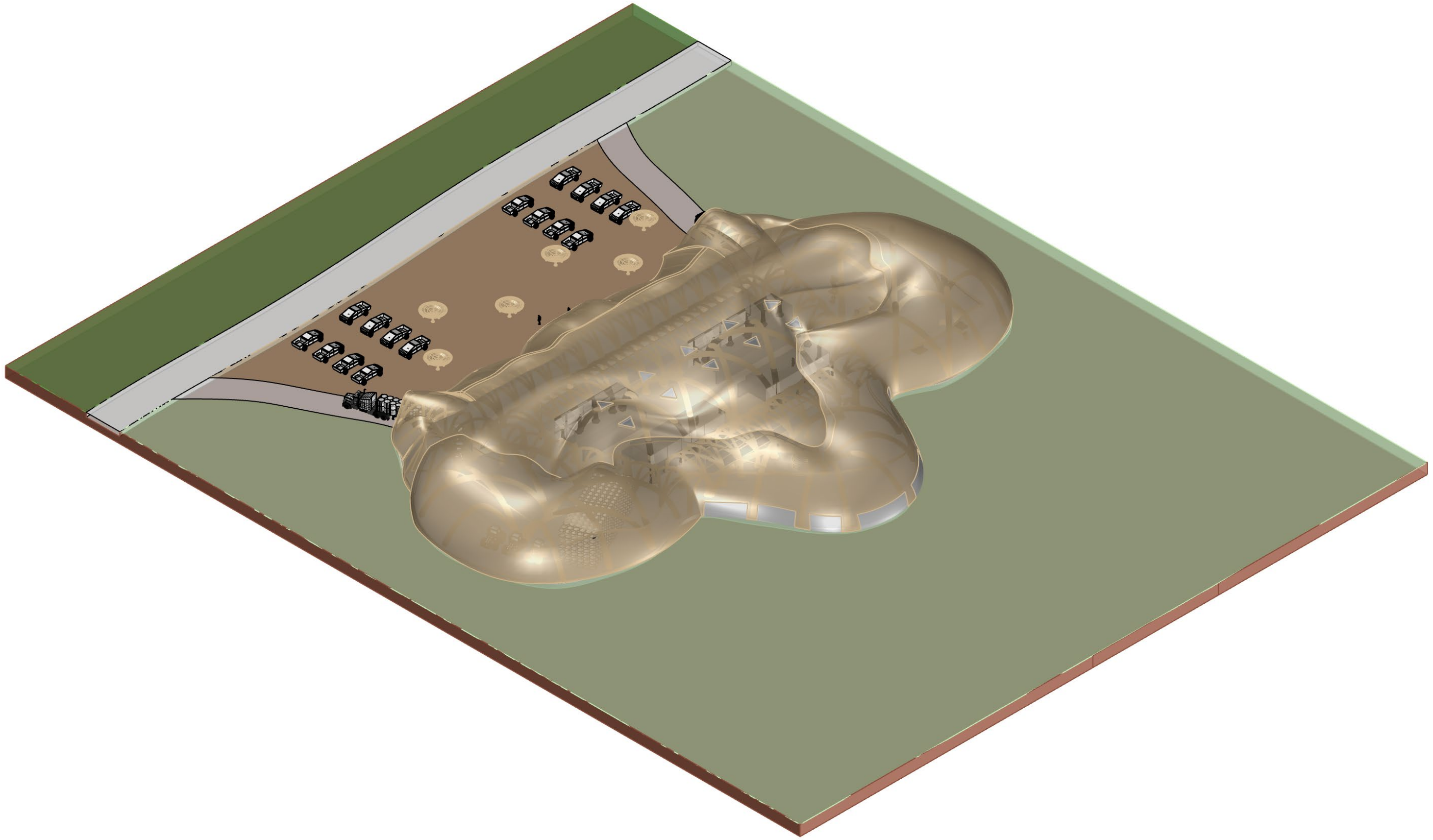
Concept 1 Embracing forms



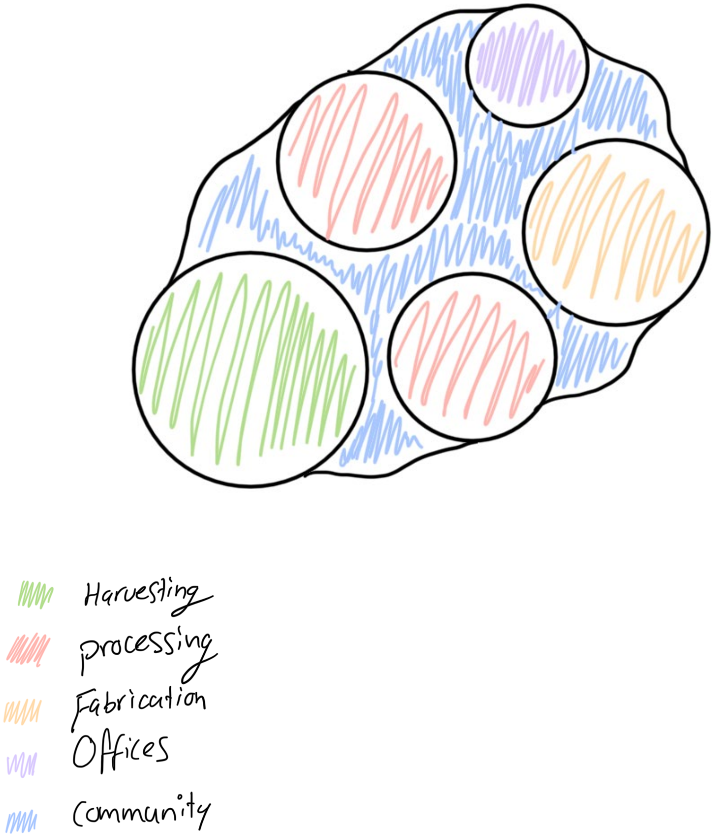
Drawings made by author (R.T. STEINFORT)

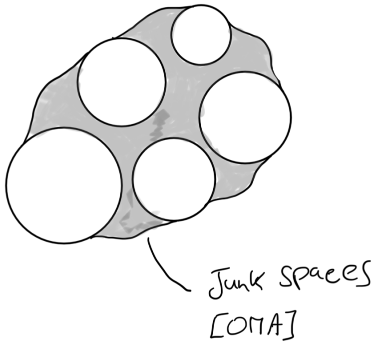
Concept 1 Embracing forms

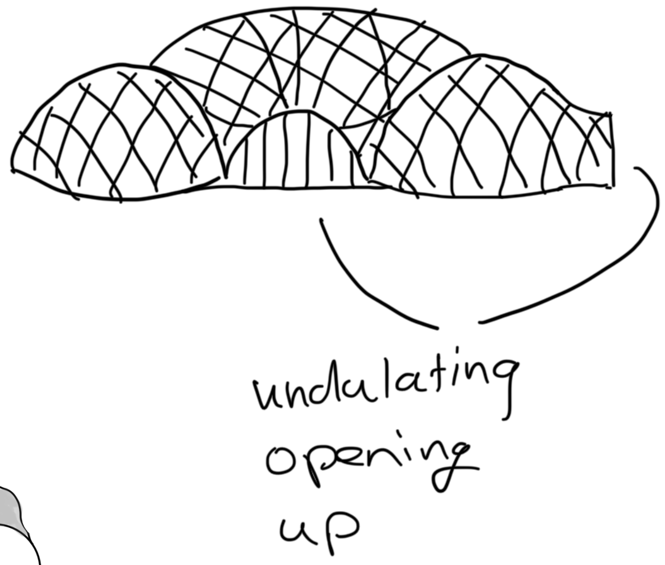


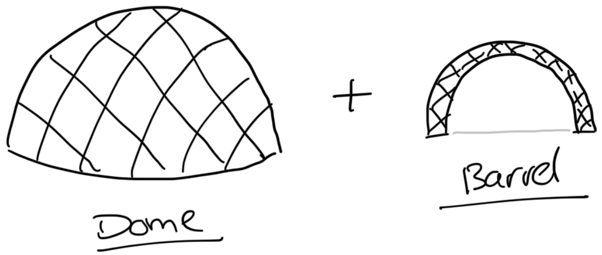
Drawings made by author (R.T. STEINFORT)

Concept 2 Intertwined domes









Diagrams made by author (R.T. STEINFORT)

LOCATION

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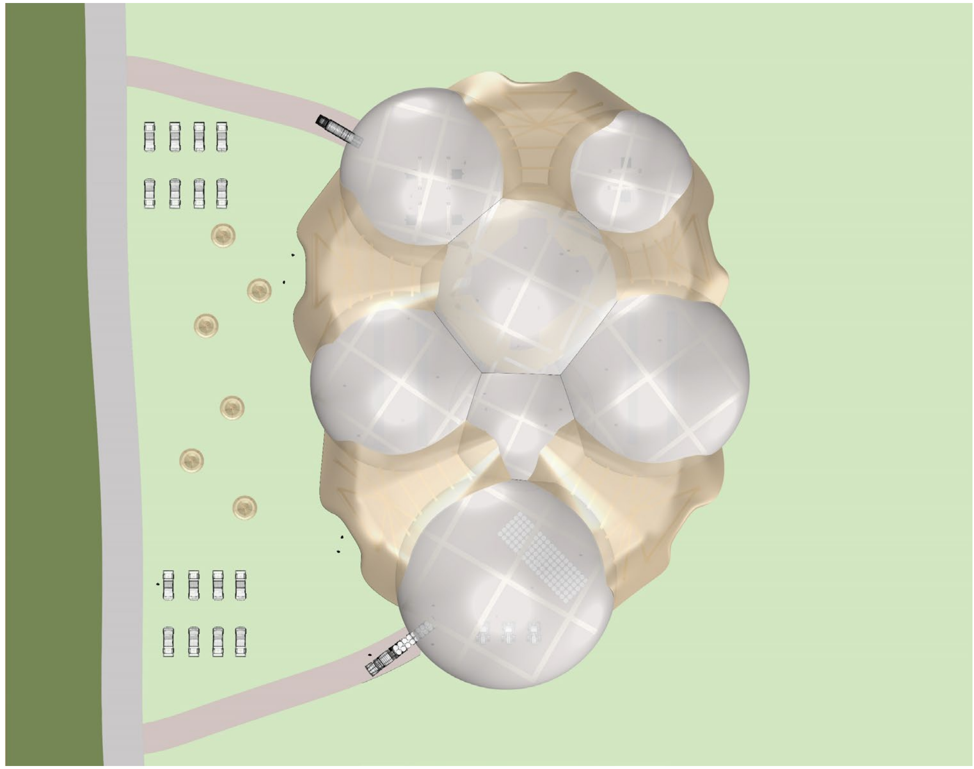
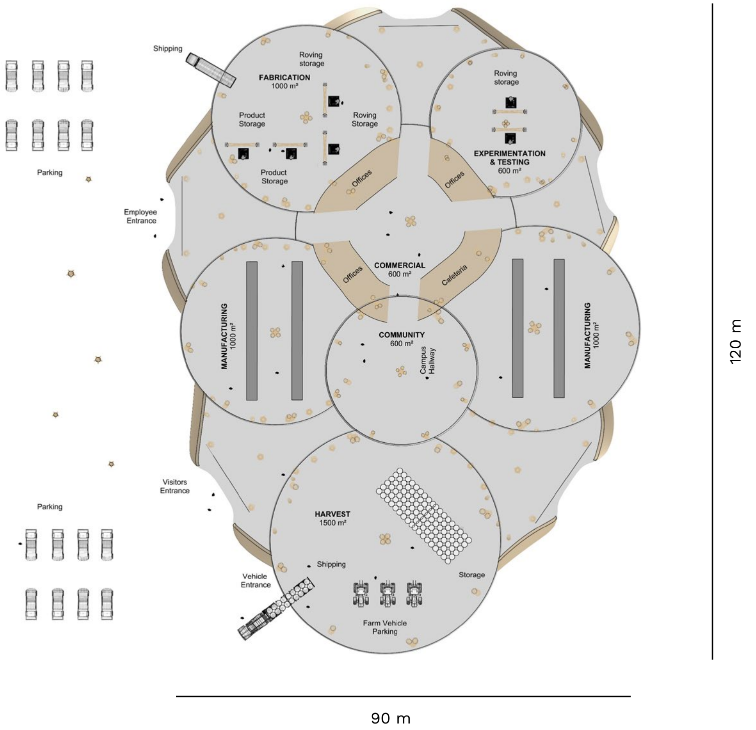
Concept 2 Intertwined domes



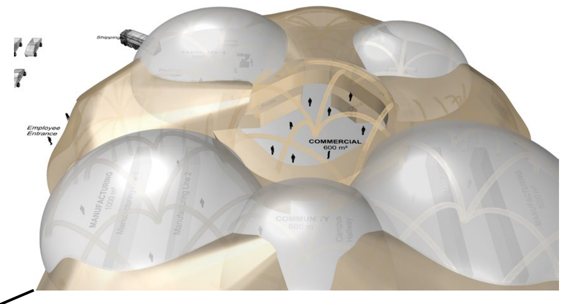
Top Elevation

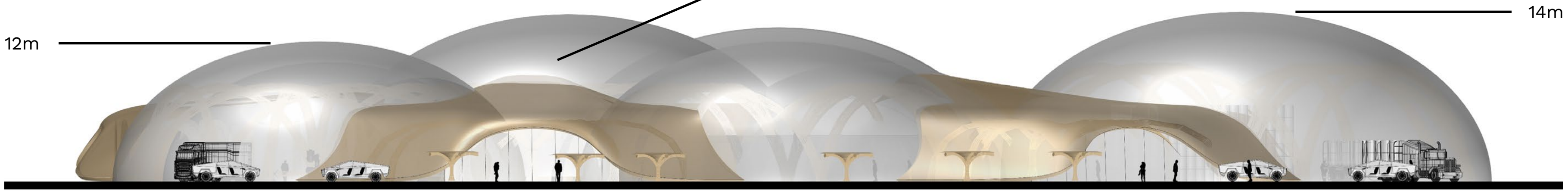


Plan

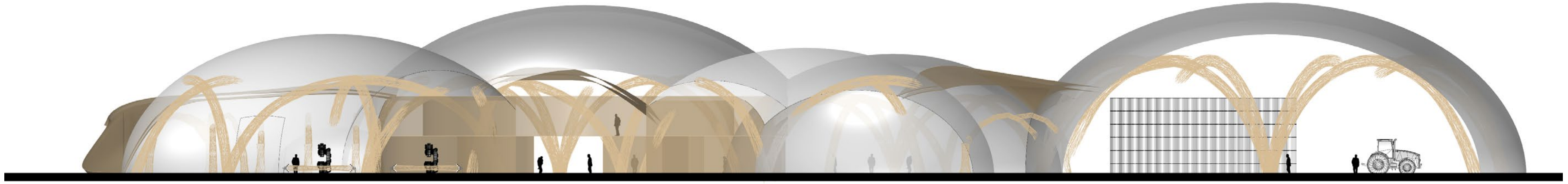
Drawings made by author (R.T. STEINFORT)

Concept 2 Intertwined domes





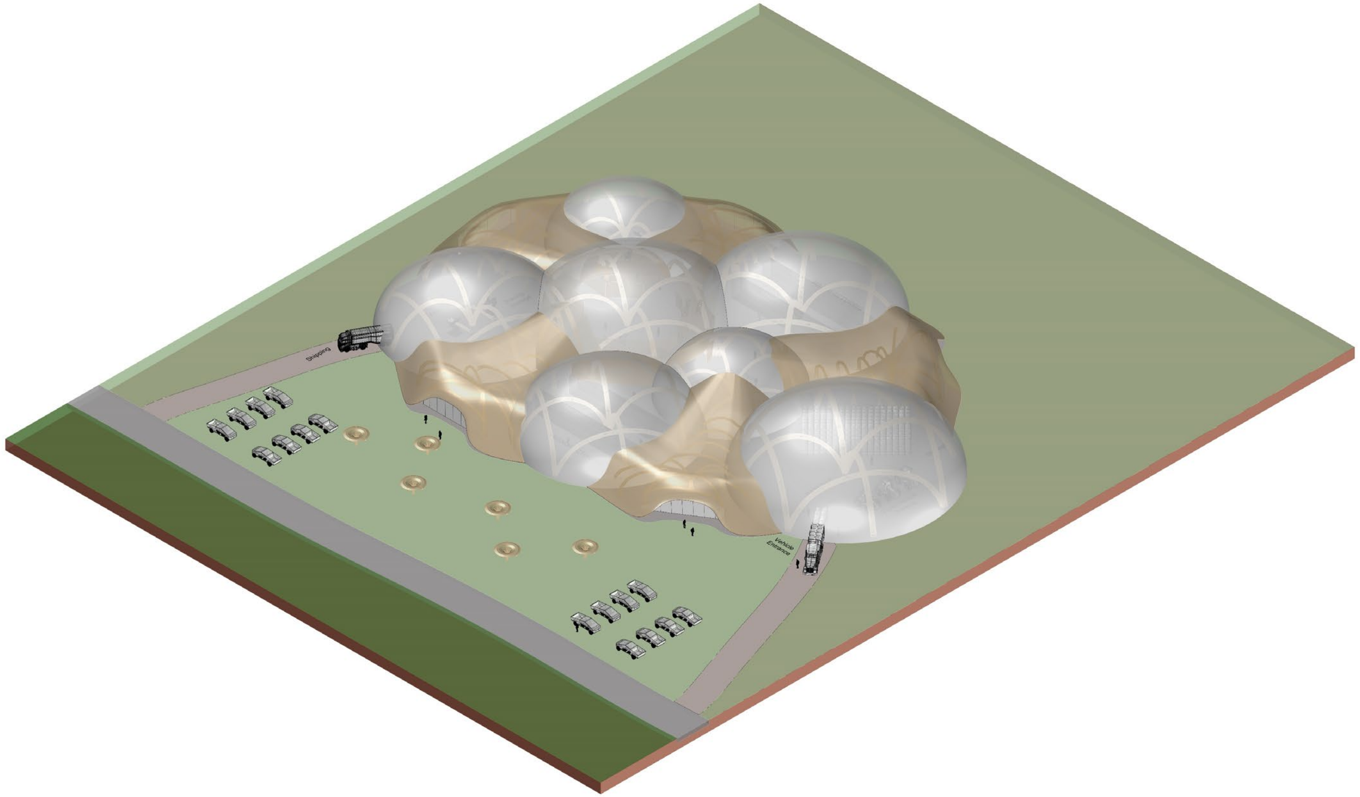
Front Elevation



Longitudinal Section Fabrication Offices Community Harvest

Drawings made by author (R.T. STEINFORT)

Concept 2 Intertwined domes



Drawings made by author (R.T. STEINFORT)

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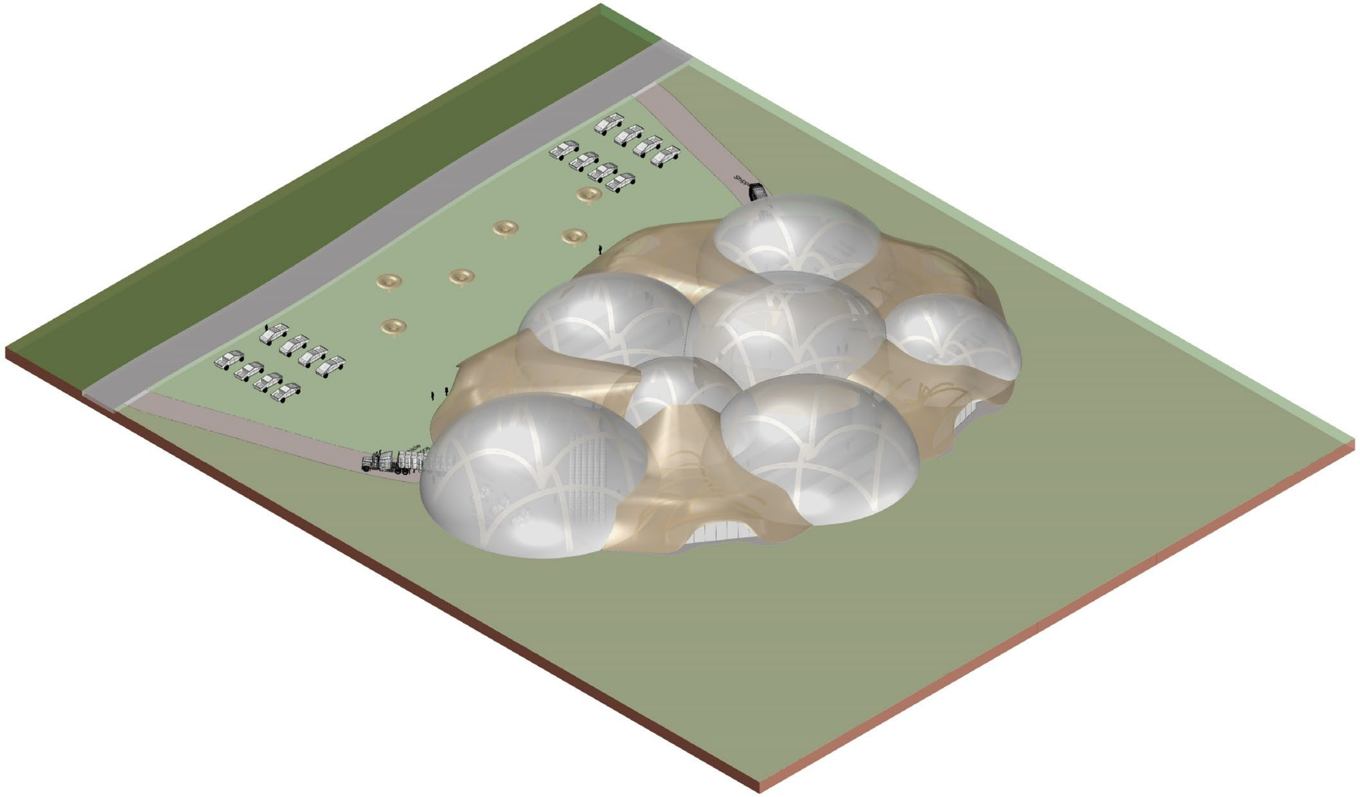

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CONCLUSION

Image retrieved from: Which is better for your health: long walk or fast walk? [Image]. MANNERS. Accessed on January 25, 2024, www.manners.nl

CONCLUSION

WHAT'S NEXT?

- Façade skin (weatherproof)
- Foundation, alternatives for concrete?
- Zoning plan for the area?
    - Height and size restrictions?
    - Which functions can be implemented?
- Possibilities for a 2nd floor with these fibrous panel built up?
- Which spans are precisely possible with these kind of structures made from Flax?
- And what structural typology can help with increasing the maximum span size?