# Healthcare in Transition

*Architecture(s) and processes at the convergence of healthcare and technology*

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*Diploma*

North Sea: Landscapes of Coexistence
*Transitional Territories Studio 2019-2020*

MSc4 Thesis Report

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Abstract

With the proliferation of data production and increase in importance of the digitization of processes in healthcare, associated programmes are radically changing in size and function.  The automation of processes in patient centres lead to faster patient recovery due to more contact time with medical staff and the collection of data and continuous monitoring via wearable technology means that less time is spent in treatment facilities. Data and automated logistics are therefore fuelling the advent of personalized care. The collection of data such as genomics data or clinical data allows for the optimization of each individual's medical journey. Technocratic processes are therefore being applied to the organic function of healing.

An organic function which can be supplemented with healing by means of the territory.
Thus, in a parallel line of inquiry, the coast is observed as a therapeutic landscape and a direct extension of treatment. Hereby, organic and engineered instruments are explored as means to challenge the current practices in western healthcare and its inherent territorialisation.

With the evolved understanding of healthcare, its physical impacts and future potentials, the research re-asserts that the notion of treatment is under transformation into the idea of well-being and continuous care. Therefore the reconfiguration of the architectonic typologies needed in healthcare allow architecture to regain its agency relative to the world of health.

Thus, in the project's proposal, digitised processes are considered equal to the healing qualities of the natural environment by highlighting mandatory access to healing and rehabilitative landscapes, thus using the intersection of nature and technology as the key driver to progress human health.

Finally, the project uses interdisciplinary design knowledge to solve multi-scaled problematics aimed at increasing efficiencies in territorial management relative to public health, via data. Hereby, the resulting medical village set within a coastal therapeutic landscape serves to the aforementioned goals.

Key words: Digital Health, Well-being, Automation, Therapeutic Landscapes

# research

# Preface
# A Pervasive Ecology of Flows

## The Scruninised Flow Scenario

The image visualises the “Srutinised Flow” scenario, asking the question: how will our cities look like with a high diversification of migration alongside a high level of surveillance of citizens?

The image further depicts observed current trends in surveillance nad exaggerates them into a scenario.
In considering the carried out the research we undertook, we observed that the number of people discplaces as a result of armed conflict, human rights violations and persecusions is continously increasing which in turn affects the number of asylum seekers.

Moreover, refugees are staying for longer periods of time in their host countries now than in the past. Given Europe’s geographic position and reputation as a beacon of stability, generosity and openness amidst growing global instability, it continues to represent a source of refuge and relief for asylum seekers.

Migration has become more globalised, mobile, connected, distant and diverse than ever before. Nevertheless, the movement is strongly guarded to protect EU citizens from the irregular migration flow. Migrants with highly diverse backgrounds (workers, students, family reunion, asylum migration and different patterns: temporary, seasonal, cyclical and permanent) are observed to move to the larger cities and metropolitan regions. Due to the lack of space in these sprawling cities, these absorb surrounding land and push rural areas further away.

There is an increased need for food and resource supply to meet the grwoing deamnds. Thanks to the Internet of Things (IoT), the coordination of these logistics and energetic requirements are coordinated in real-time.  Each electronic item communicated through sensors with dispersed central hubs; meaning that the energy is provided when required and distributed on this smart grid without waste.

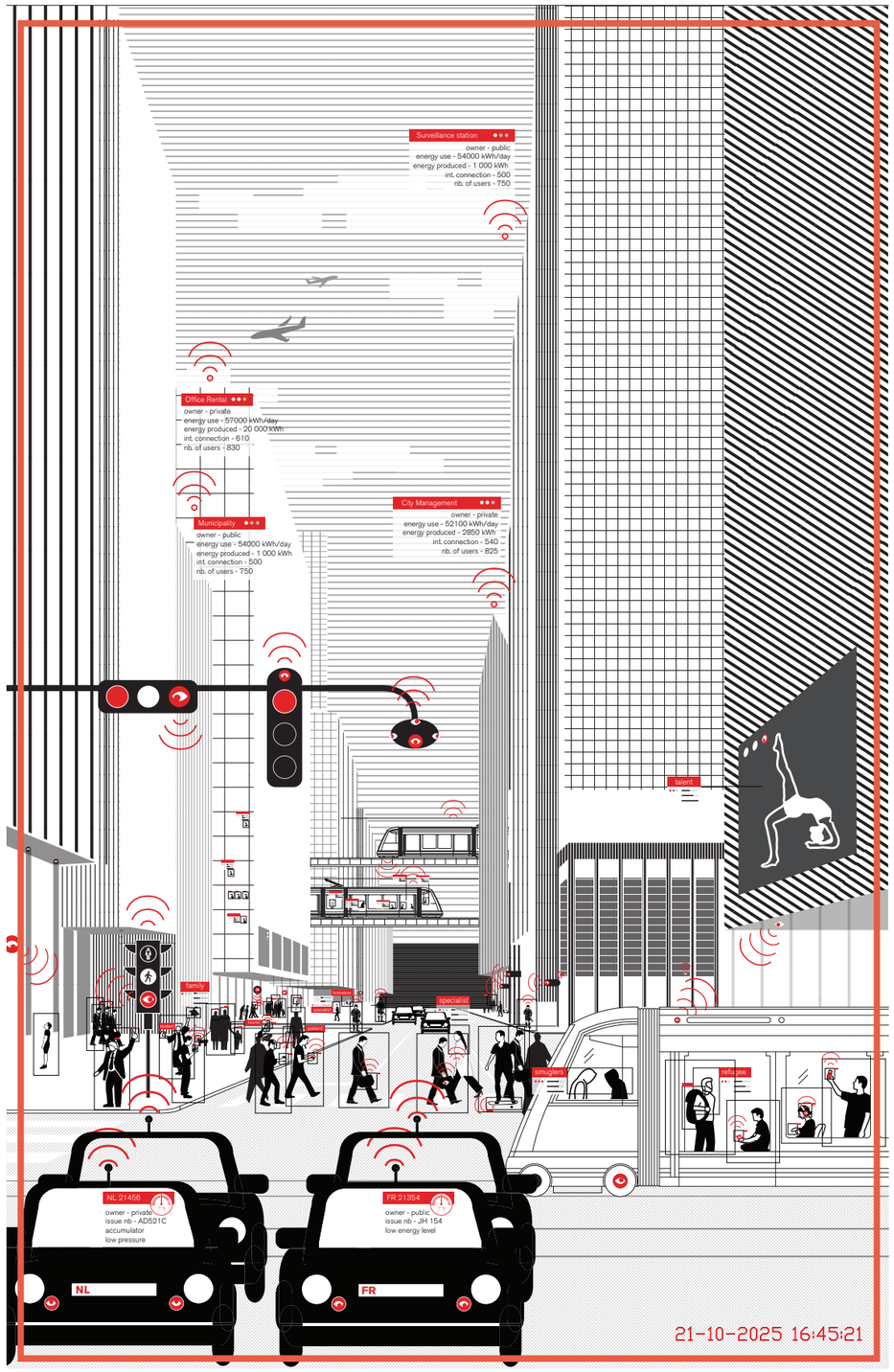
Finally, surveillance takes over the public space as recordings from cameras are processed by AI visual recognition systems veryfying the newcomers and scoring citizens in a “danger ranking”. On the various EU borders, the “Fast-Pass” system (tested in Calais after brexit) are being rolled-out for automated border crossing points.

The Observed Society

Illustration
Source: Group Member, Z. Rosinska







## Scrutiny

(based on the Atlas (collective studio work): (a) projections,(b) scenarios, and (c) limits)

The former illustration depicts the outcome of our collective research phase which adressed the various flows and phyicalities of information in countries surrounding the North Sea. I reaserching past and present trends, along with potientials for future ones, we exptrapolated four possible scenarios intersecting the flows of individuals: migration and their inherence surveillance. Hereby the narrative is set within the context of increased digitisation, surveillance and a general production, processing and storage of information.

This adjacent map depicts the scenario of a Europe in which surveillance, information and data are paramount. Although quite dystopian in nature, I anchored my personal fascination in how the production of data can be used to open up channels to efficientise public procurement systems.

Medical data is increasing in its porduction and in its management to allow for a healthier population. Additionally, in tracking the health of the growing number of individuals, namely in cities, precise consensus can made regarding the health of a city, region or even population group. In looking to infrastructure, data can allow a prediction of the required facilities with the help of predictive analytics.
Data is thus used in a positive and informative light.

### A Watched Territory

Scale: 1 : 1 000 000
Source: EU Comission, EU member states' surveillance bodies.

EU territory
border workers
Biggest cities - political importance
Most important cities - financial hubs

Airport traffic
nb of passangers per year
70-80 MLN
60-70 MLN
50-60 MLN
40-50 MLN
30-40 MLN
20-30 MLN
10-20 MLN
train stations
train infrastructure
ferry routes

Surveillance HQ
Tech Hubs in EU
Refugee camps

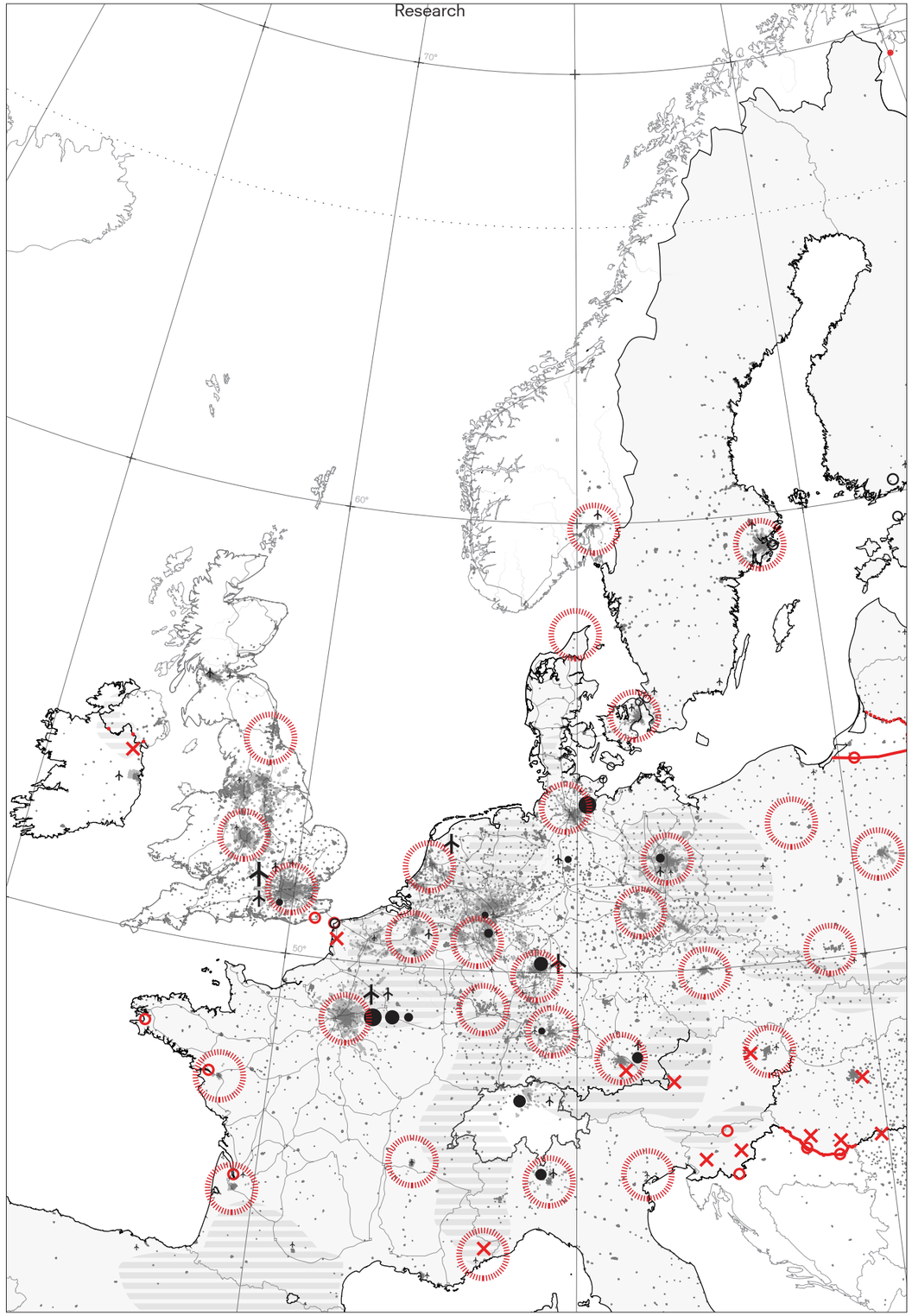
Railway stations
nb of passangers per year
200-205 MLN
160-180 MLN
140-160 MLN
120-140 MLN
100-120 MLN
80-100 MLN

The bussiest Passenger Ports,
nb of passangers per year
13 MLN
10-12 MLN
8-10 MLN
6-8 MLN







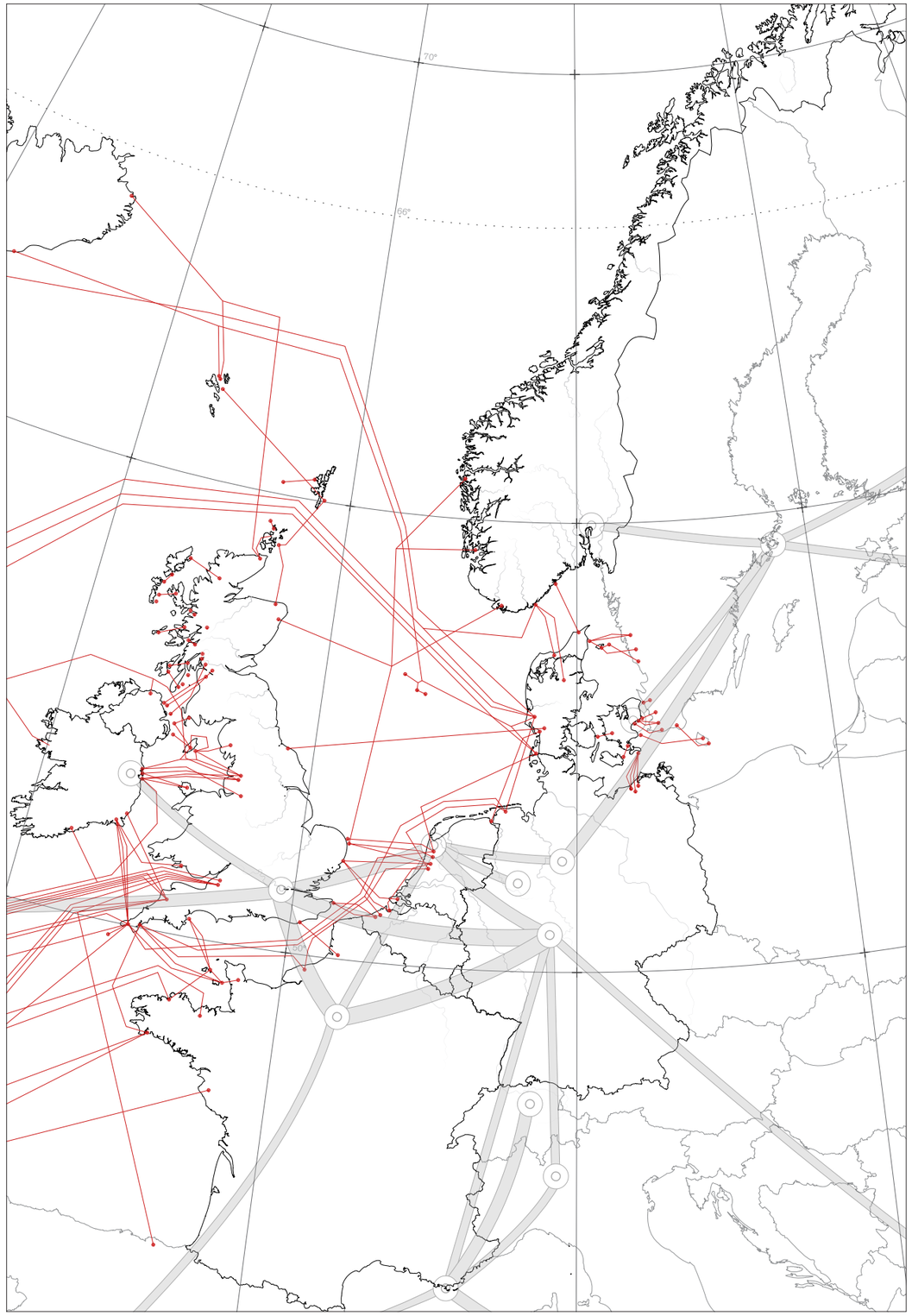


## Territory of Information

## Information Flows

The removal of barriers in intra-European mobility, the end of the Cold War and advent of globalisation shrunk time/space for information flow. The growth of capitalism, neo-liberalism and the effects of the third industrial revolution (computerisation and automation of processes) increased information flow. With telephone and telegram lines and radio/satellite signals already forming a basis for communication between countries and continents, the development of the internet, private and public networks at the end of the millenia induced the need to create a backbone of infrastructure to serve the needs of inforamtion flow. Firstly using cable and then optic fibre cables as they were developed, underwater lines have become the norm and backbone to our global networked connectivity (along with satellites). The adjacent map depicts underwater lines prinarily in the North Sea region (cables in other regions e.g. Mediterranean are not shown).

Parallel to this are the top hub cities (as ranked by international capacity in Gbps) and their highest capacity links. The cities with the highest capacity in Europe are Frankfurt, London, Amsterdam, London (global leaders) followed by Stockholm and Marseille. The thickness of the line indicates the size of capacity, therefore, the London-Amsterdam line depict that both are hubs but the London-Dublin line show that Dublin is a spoke (city with a lower capacity link).




Data Infrastructure: Fibre Optic Cable Network

Scale: 1 : 1 000 000
Source: Telegeoography Global Internet Map, 2018; Telegeography Submarine Cable Map 2019.

Submarine Optic Fibre Cables

Capacity Traffic (in Gbps)

Data Traffic Node

## Footprint of Information

Continuing on the physicality of data, the proliferation and increased access to the internet and commodification of data has resulted in an increase of infrastructure to handle its traffic.
To clarify terminologies, a server is a form of powerful computer or device affiliated to a network which handles network resources. A data centre is infrastructure (e.g. a building) containing and supporting a vast amount of computing hardware.

This page depicts the number of data centres in Europe (2,547). The number of data centres in countries around the North Sea (1,055) is highlighted to show the region's importance relative to the flow of information.

As a logical relationship, the increase in the production of information results in the increase in the requirements for facilities to handle its storage.
Often referred to as entities of post-anthroposcene architecture, there is a perverse parallel between the necessity for facilites to handle information produced by human beings but which are themselves hostile to accommodate human beings.

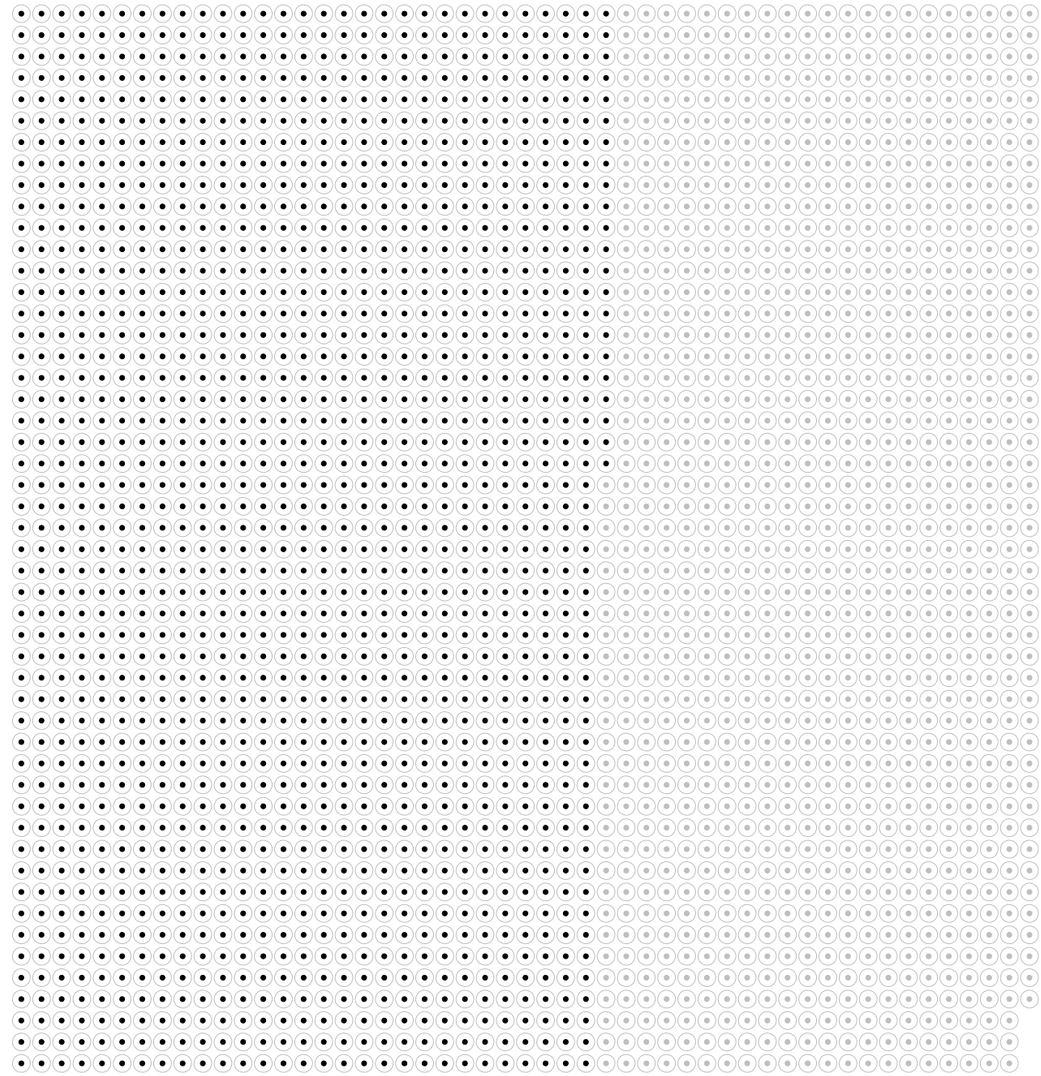
Data Centres in Europe

Source: Data Centres in EU: CloudScene, 2019.

- Data centres in North Sea countries (EU)
- Data Centers outside of North Sea countries (EU)







**Data Centres in Europe**

| | | | | | |
|---|---|---|---|---|---|
| **United Kingdom** | **(415)** | Ireland | (44) | Georgia | (2) |
| **Germany** | **(417)** | **Denmark (43)** | | Iceland | (4) |
| Spain | (96) | Portugal | (16) | Serbia | (6) |
| **Netherlands** | **(247)** | Ukraine | (46) | Belarus | (2) |
| **France** | **(249)** | Slovakia | (14) | Gibraltar | (1) |
| Austria | (59) | Hungary | (12) | Malta | (4) |
| Sweden | (90) | Croatia | (6) | Cyprus | (5) |
| Poland | (116) | **Norway** | **(36)** | Slovenia | (10) |
| **Belgium** | **(65)** | Luxembourg | (23) | Bosnia & Herzeg. | (1) |
| Bulgaria | (21) | Turkey | (28) | Monaco | (1) |
| Italy | (115) | Greece | (11) | Moldova | (3) |
| Romania | (21) | Finland | (34) | Liechtenstein | (1) |
| Russia | (117) | Latvia | (14) | Azerbaijan | (1) |
| Switzerland | (98) | Lithuania | (13) | Guernsey | (1) |
| Czech Republic | (37) | Macedonia | (2) | | |

**Data Centres with the most data traffic and number of service providers**

**Equinix FR5**
Frankfurt, GER
Service Providers: 244

**TeleHouse London Docklands North**
London, UK
Service Providers: 374

**Equinix AM7**
Amsterdam, NL
Service Providers: 234

## Typological Study

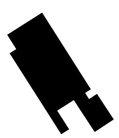
In a move to distance myself from archetypes too close to data infrastructure (namely data centres, cable landing stations or servers), I explored a selection of typologies which are affected by, but aren't direcly related to data infrastructure. Information transmission, storage and access is a flow affecting almost every social activity - which are in turn related to their respective architectural typologies.

This catalogue is a palette of existing conditions and the first step in questioning the relationship between data and the respective type. What is the typical data "flow" through this typology and how can we reimagine it is the question at the centre of this exlporation.

This lead to the selection of typologies related to healthcare as a fascination due to their proximity to population flows and data.

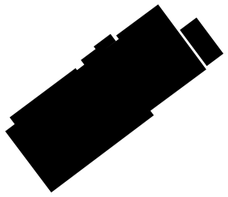




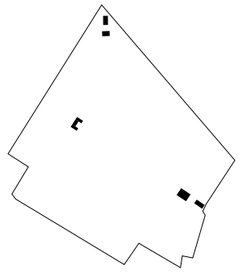


**Rotterdam-The Hague Airport**
Airport, Rotterdam, NL

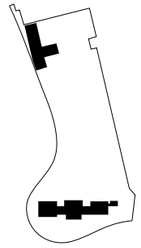
**National Bank of Denmark**
Bank, Copenhagen, DK



**Glasshouse**
Glasshouse, Massdijk, NL



**Assisstens Cemetery**
Cemetery, Copenhagen, DK



**Hortus Botanicus**
Botnaical Garden, Leiden, NL

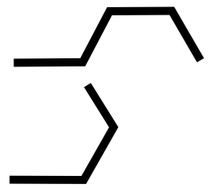
**Guy's Hospital**
Hostpital, London, UK

**Royal Library of the Netherlands**
Library, The Hague, NL

**Selfridges**
Department Store, Birmingham, UK

**Astrup Fearnley Museet**
Museum, Olso, NO

**Scottish Parliament Building**
Parliament, Edinburgh, UK



**Bijlmermeer**
Residential, Amsterdam, NL

**Noma**
Restaurant, Copenhagen, DK

**City Hall**
Governmental Building, London, UK

**Gare du Nord**
Railway Station, Paris, FR

**Amazon Fulfillement Centre**
Factory, Tilbury, UK

**Royal Courts of Justice**
Judicial, London, UK

**Royal Academy of Fine Arts**
Educational, Antwerp, BE

**Hotel New York**
Hotel, Rotterdam, NL

## The Data of Health
## Dutch Statistics

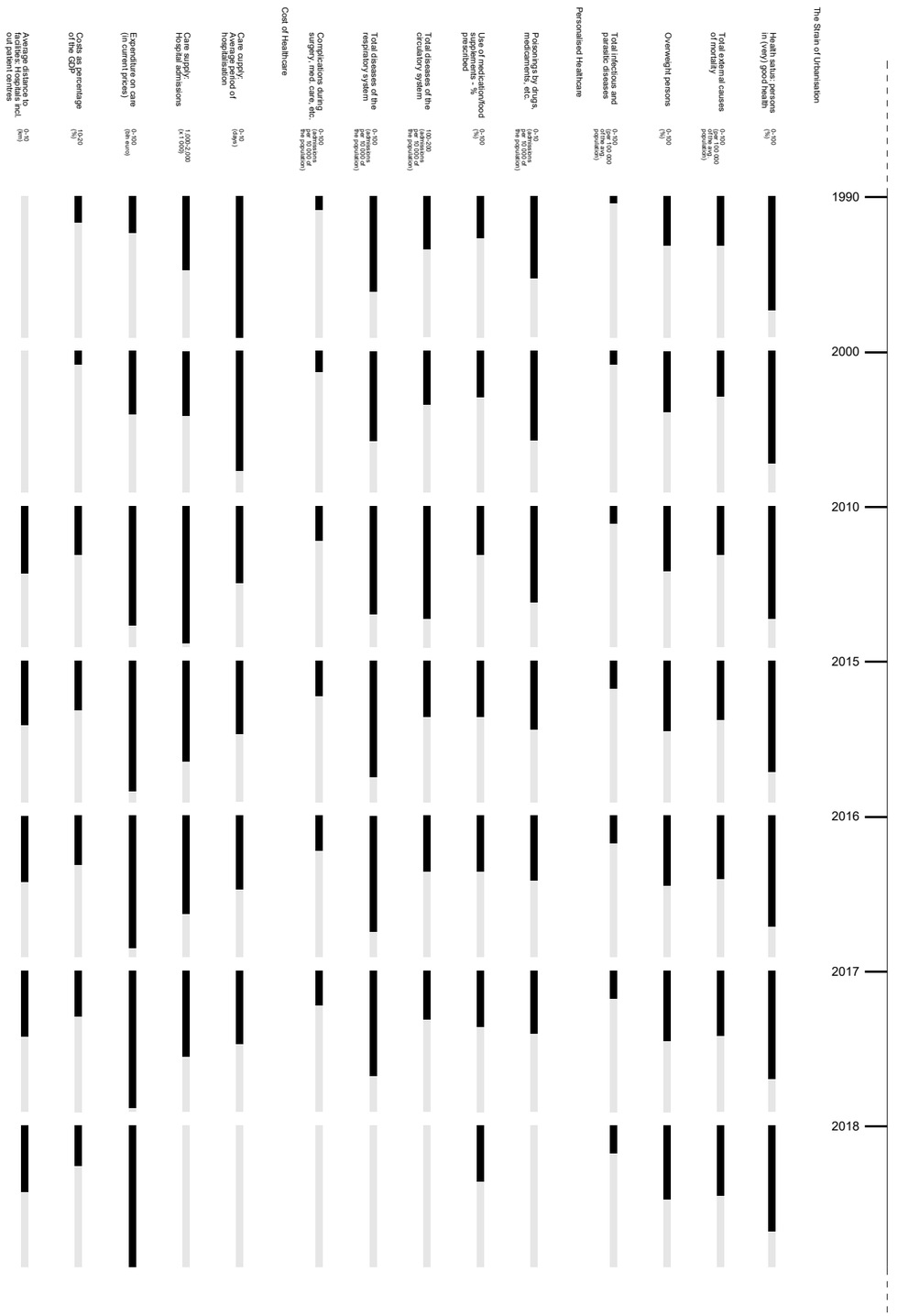
Via a thorough overview of the future trends in healthcare within the Netherlands, different observations were made which informed the project.

With the amelioration of the provision of health services, the time spent in hospitals is decreasing over time. However, growing populations in urban centres and new instances of illnesses isn't reducing the amount of hospitalised individuals as a general.

Treatment is becoming faster and more efficient due to technological advancements and especially due to the digitisation of healthcare. A special attention is to be given to conditions emerge in urban centres (injuries and chronic illnesses) as these are increasing over time due to growth in population and should be met by a flexible and resilient healthcare system and facilities.







## e-Health Trends
## Personalised Care

With an increase in the consumption of wearable technology and self monitoring technologies within the mainstream, there is a growth in demand from consumers to monitor their own health. The use of wearables has tripled over the last four years (2019). These devices which collect real-time data are being seen as beneficial by insurers and healthcare providers as pointers towards the population's general health...should the produced data be available for consultation.

Marketed as "taking control of your own health", these technologies have prompted the medical industry, insurers and tech firms to develop more devices spanning various collection methods: fit bits, smart watches, patches, wearable monitors and so on.

There is a crucial question regarding who owns the produced information and who has access to it in a time where data has become a commodity.

According to Deloitte (2018):

- Insurers: can lessen the rising cost per patient using wearables as a means of increasing cus-tomer life value
- **Hospitals: WT incentivises behaviour that reduces hospital visits and readmissions due to poorly managed personal health**
- Trend: WT is becoming more conventional as its use will grow
- Device connectivity will expand as more accurate WT sensors are developed

Digital Health Ecosystem Report (McKinsey, 2019) highlights:

- Healthcare stakeholders need to adapt to digital transformation
- Personalisation and convenience have become the norm for consumers, and they are extending their demands for digital-powered experiences to healthcare
- There is a demand for hyper-convenient care - be it at home or in medical facilities
- Companies embracing WT and digitisation in general can leverage innovation
- Health systems are turning to telemedicine and AI to combat labour shortages
- Pharma companies and medical device makers are diving into digital tech to branching into new revenue streams and optimise processes

o Therefore, the digital health tech territory is being colonised by current tech firms and entrants which are luring consumers from traditional healthcare players through their "consumer-first tech-focussed approaches". The digitisation of processes and experiences in healthcare is shifting and increasing in speed according to demand.

Netherlands: In a country like the Netherlands, where healthcare is totally democratised, could we imagine a general, country-wide health-tech platform required by all to have to monitor the population's health?

"Key digital health solutions like telehealth, digital therapeutics, genetic testing services, AI, wearables, cloud computing, and blockchain are catalyzing the healthcare industry's digital revolution" - Business Insider, DIgital Health Ecosystem, 2019.

Health-Technology Catalogue

Collecction of tools and systems contributing to the digitisation of health and its processes of cure and care. The displayed items include wearable technology, sensors, automated equipement and robots.
Source: Own Drawings.

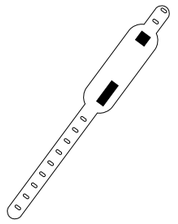




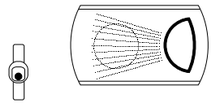
SMART WATCH

HEALTH TRACKER

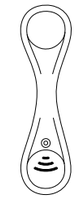
PATIENT MONITORING DEVICE



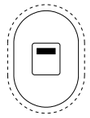
PATIENT IDENTIFICATION DEVICE (RFID)



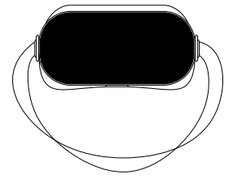
REMOTE CARDIO MONITORING DEVICE (CARELINK)



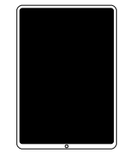
MONITORING TRANSDERMAL PATCH



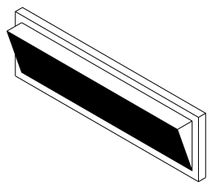
TRANS-DERMAL BODY PATCH



VIRTUAL REALITY HEADSET

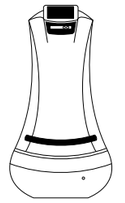


VIRTUAL ASSISTANT (PAD)

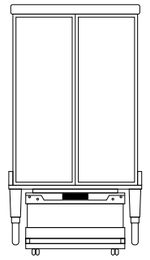


IN-ROOM OPTICAL SENSORS (CONTACT-FREE)

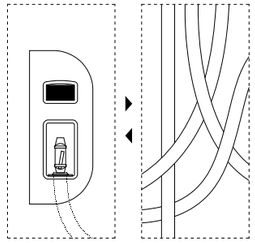
CENTRALISED CLINICAL COMMAND CENTRE



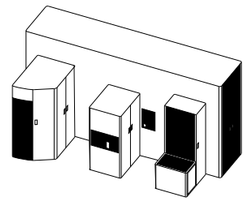
AUTONOMOUS SERVICE ROBOT



AUTOMATED TRANSPORT



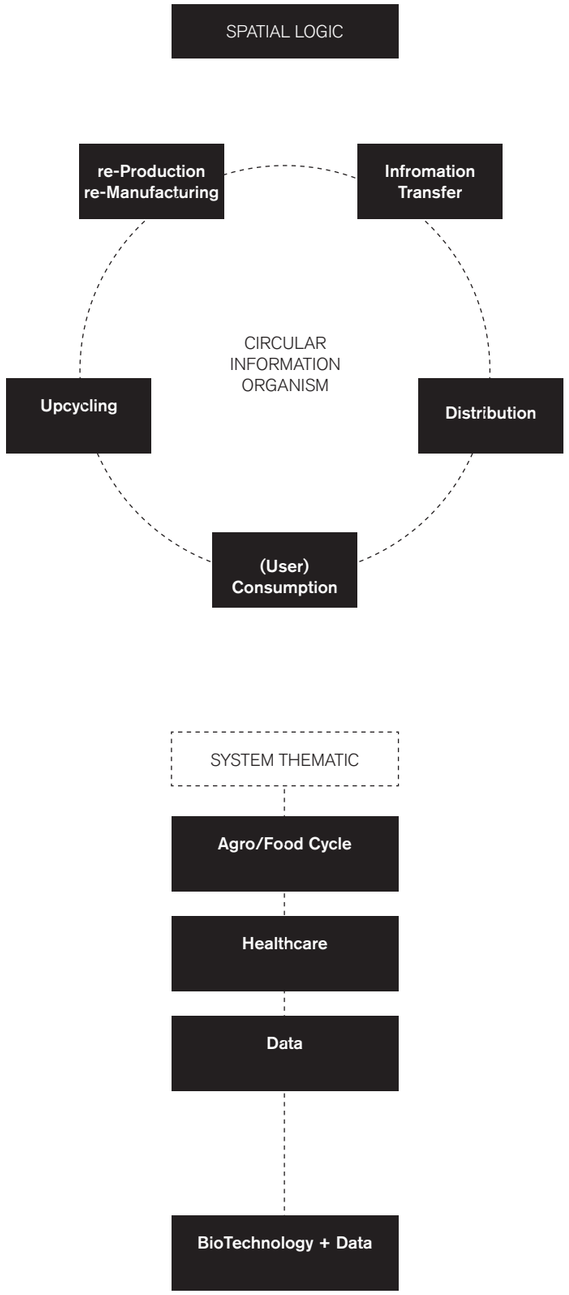
PNEUMATIC TUBE SYSTEM



PHARMACY AUTOMATION

## Digitisation of Healthcare

Having chosen the typologies affiliated to healthcare as sources of interest, it is primordial to map the various disruptions occurring across its spectrum and typologies.








INFRASTRUCTURE - Food & Medicine
Medicine Plant

-

INFRASTRUCTURE & AI SYSTEMS
Research Laboratory
-

INFRASTRUCTURE - Food & Medicine
Automated Greenhouse

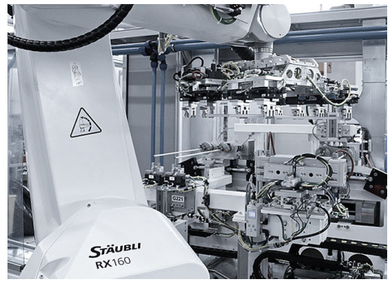
-

TREATMENT
Operation Thetre

-

INFRASTRUCTURE
Medical Tools and Machinery

-



## Disruptions

The accompanying infographics illustrate the disruptions occuring in the world of healthcare in terms of its physical infrastructure and in terms of its patient experience/journeys.

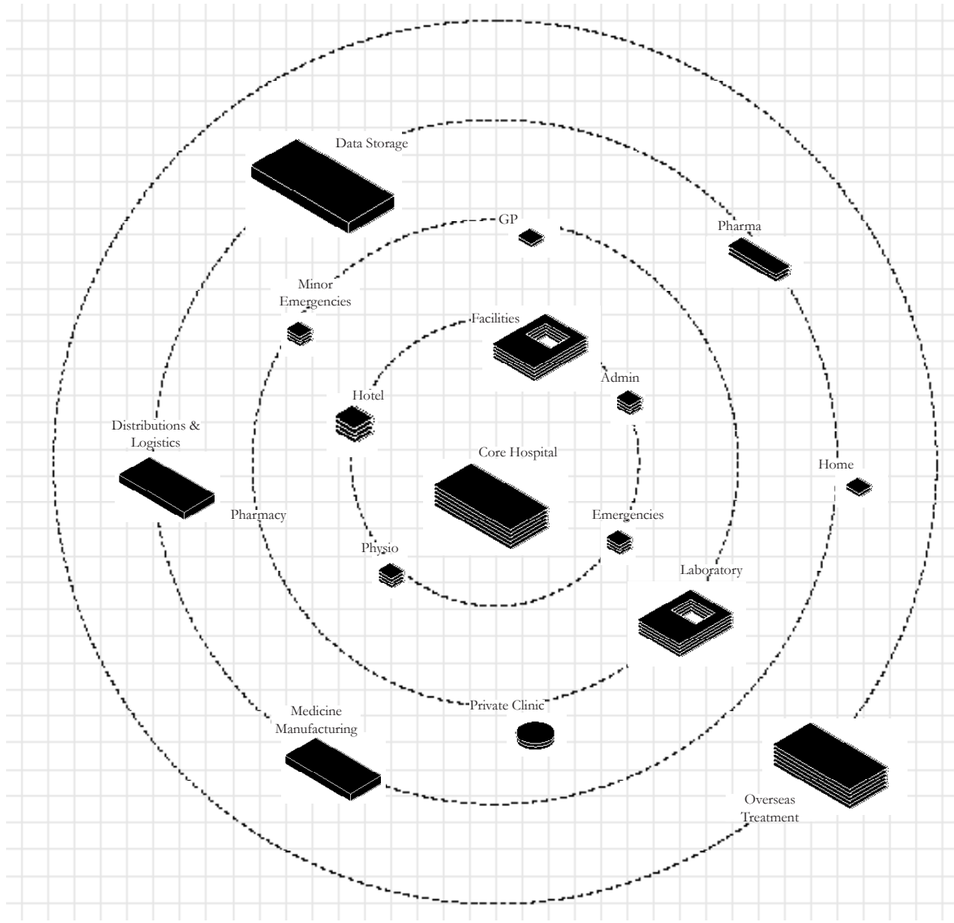
In addressing the sprawl of medical facilities, the growth of healthcare's footprint is evident as more elements of life are treated as part of well being. Added to this, digitisation and automation bring new typologies into the playing field. This results in a sprawl of facilities covering increasing footprints.

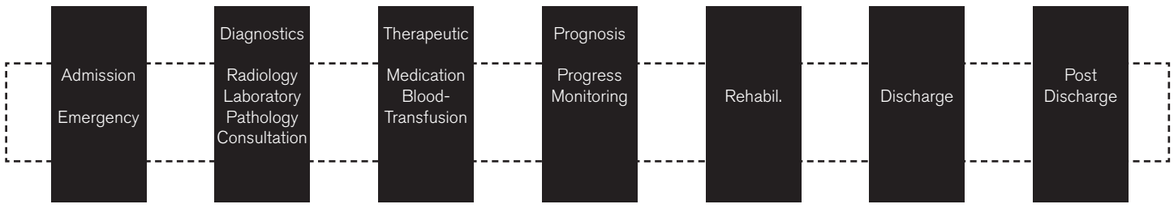
In re-imagining the futures of healthcare systems to be decentralised and accessible, there will need to be merges and amalgamations of typologies to create hybrid treatments facilities. This will efficientise the access to healthcare and reduce its footprint.

If we then factor-in the shift towards a continuity of care, the patient experience adapts to this and creates a circular loop between cure and care rather than a linear one.







## The Dutch Case
## Digitisation of Healthcare in the Netherlands

In 2016, the national healthcare expenditure reached a value of approximately 83.8 billion euros. In the Netherlands, every resident or employee is obliged to take a basic health insurance to cover medical costs from, for example, visits to a general practitioner or the hospital. The Dutch government decides on the cover provided by this package and health insurance companies are obliged to accept everyone who meets the requirements, regardless of age or state of health.

An important characteristic of Dutch health insurance, though, is the so-called “principle of social solidarity”: the overall costs of health care are paid by everybody. It is since 2008, for example, compulsory from the age of 18 to pay a total mandatory excess before the basic health insurance reimburses medical costs. In this way, everybody contributes to certain types of healthcare such as maternity care. In 2017, the total mandatory excess reached a value of 385 euros. In 2005, the total health expenditure as share of GDP in the Netherlands reached a value of approximately 12 percent.

Subsequently, this increased to approximately 14 percent in 2015. In 2017, the gross government expenses for primary care reached a value of approximately 5.5 billion euros.

Information obtained from the Dutch Government: Standard Health Insurance.

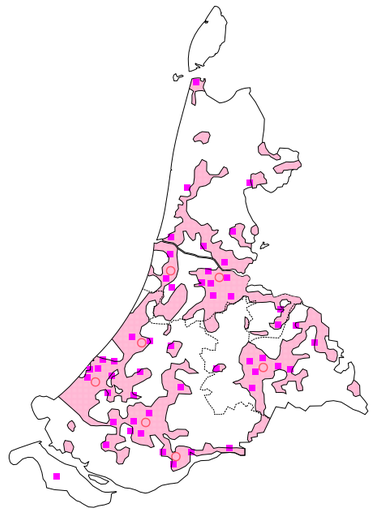
Trends:
General population health is decreasing with increasing mortality related to infectious, chronic and environmental causes. Increasing urbanisation (urban sprawl) is contributing to worsening health and chronic conditions.

Innovation in treatment is making healthcare more efficient. Personalisation of care through prescribed medicines. Complications during treatment still exist due to increasingly complex and personal conditions – digitisation of care could solve this.

Treatment is faster, but hospital admission is stable as population is not getting healthier. Complex conditions, increasing population, rise in number of facilities and ageing facilities are increasing cost of healthcare.







**Sprawl of Public Health**
Nethrlands and Randstadt

## Flexibility
## Modularity in Light of Uncertainty

Considering heealthcare is a condition which affects all nation states in Europe (and globally), the future of its footprint should be thoroughly evaluated. The accomapnying map demonstrates the projected percentage in peopulation change up until 2050.

The varying degrees of growth and shrinkage indicate variations in future population sizes. These specific and local conditions call for varying demands of future treatment centres. Hereby, the notions of flexibility and modularity wil be taken to inform the resultant design proposal.

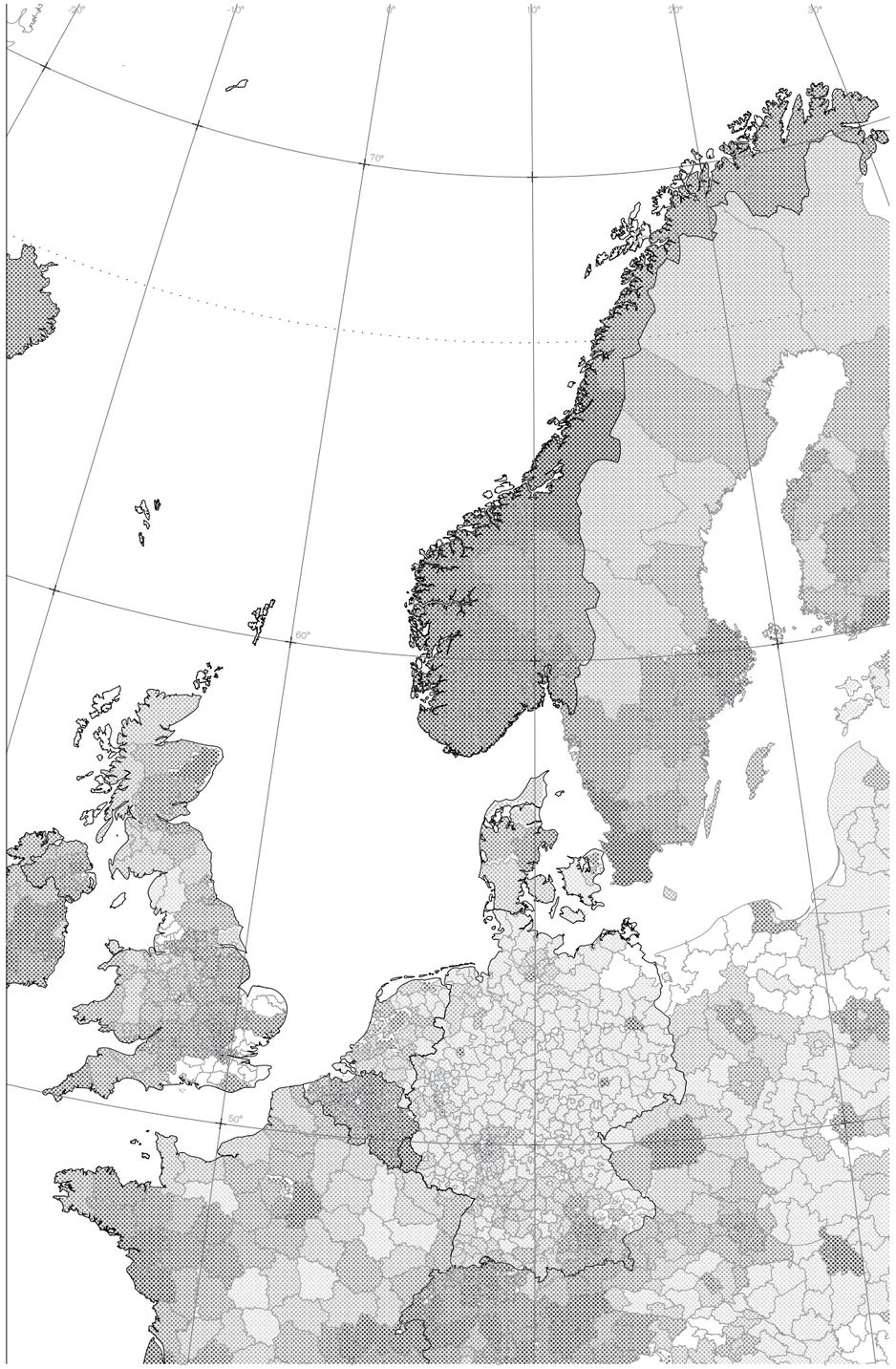
### Projected precentage change of the population in 2015-50

The EU population is projected to increase by 3.4 % between 2015 and 2050. The population projections indicate that the EU-28's population would grow slowly to reach a peak of 525.6 million in 2048, with the number of inhabitants increasing by 17.1 million persons. The EU-28's population is then projected to fall slightly to 525.5 million by 2050. According to the UN, in high-income countries, net migration is projected to account for 82 per cent of population growth. In most of these countries, the population size would decrease without future migration (UN DESA, 2015). The global migration is expected to increase or at least stay constant due to population growth in low-income countries, coupled with labour market shortages and ageing populations in high-income countries.

- <-10 %
- -10<0 %
- 0<10 %
- 10<25 %
- >25 %







## Future Projections

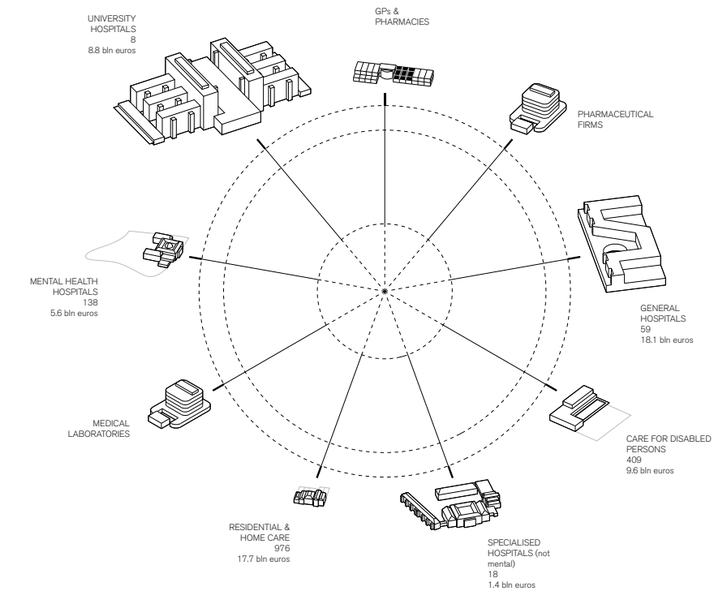
With an increase in the production of health data, future projections on the required capacities can be measured. This, in line with growing populations, economic shifts and consumerism are xpected to disrupt hospitals worldwide.

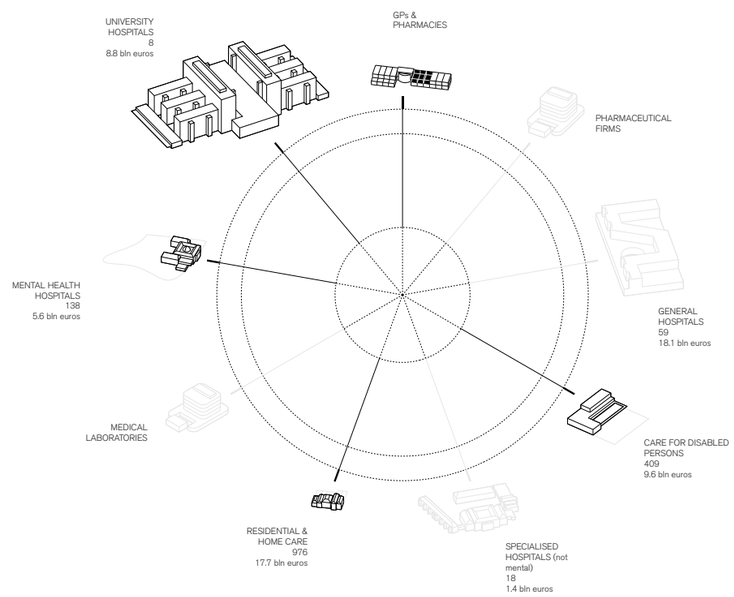
Whilst some project that in patient services will be relegated to the home sphere, populations are not getting healthier, therefore acute treatment facilities will still be required along with out-patient services.

This idea of a continuity of care or a “healthcare system without walls, as Deloitte (2017) point out, calls for a efficient healthcare systems, good designs and the necessity to cater to different contexts - flexibility and optimisation.







## Territory for Healing

## The Coast
## Seascape

In a parallel line of inquiry, we explore, in line with the studio's fascination with the North Sea, the possibilities for a therapeutic method of healing via the sea and land's threshold: the coast.

We start with the Sea. Aelbert Cuyp's "Mass at Dordrecht" demonstrates masterful execution of seascapes, a genre of depiction moving away from landscapes and portraiture.

First experienced in Antiquity and through Biblical depictions as a place of fear and danger, the sea proved to host a hostile character. Its avenues of connections were seen as dangerous and its shores as place of natural disasters striking fear.

As medical practices refined themselves through constant iterations throughout the past centuries, water and the coast came to play a decisive role in the treatment and well-being of patients with very particular diseases.

Note: Bruno van den Elshout's New Horizons series depicting the North Sea and its visually soothing characteristics – reinforcing the proposal's ideal to reconcile healthcare within the tradition of a maritime setting.





**"The Maas at Dordrecht"**
c. 1650
Aelbert Cuyp

**"New Horizons"**
Bruno van den Elshout

## Therapeutic Landscape
The Sea as a Healing Territory

The Sea as a healing territory: It is through painting and poetry that the sea appeared in a flattering light - French poetry and Dutch seascape painting – and bringing people to the shore for leisure. But it is the medical prescriptions written in the 18th and 19th c. for the English upper class to bathe in cold sea water which begun its cultural appreciation.

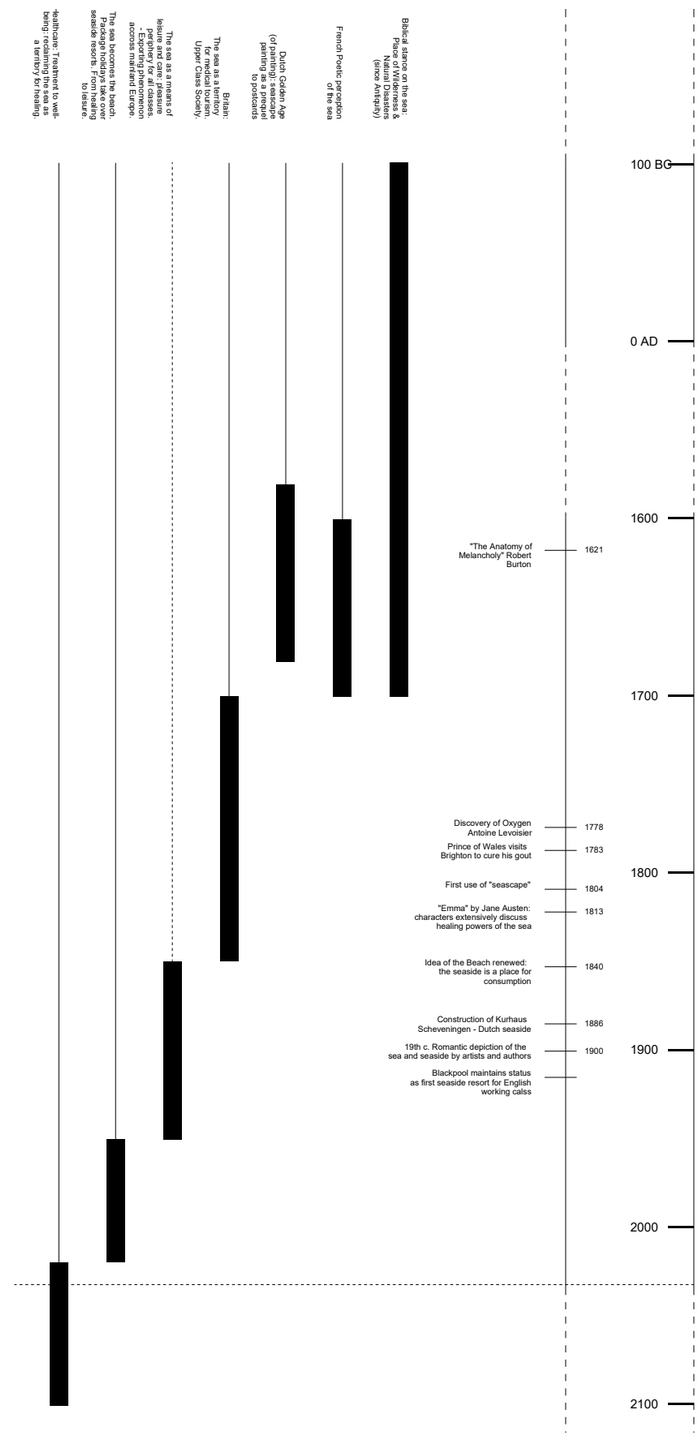
This eventually led to the full consumerisation of the coast and the commodification of the seaside as a place of repose and escape from cities growing along with the first wave of industrialisation.

The seaside was democratised as a place for vacationing and healing to the point where teh upper class, once exclusivley catered to in this environement, gave way to the working class citziens which had faster access to the sea thanks to the extension of railway lines.

Boiled down through decades and this threshold is still seen as a bastion of escapism - wether for medical or social needs. The former has invited for studies in the therapeutic values of the coast as methods of healing which are taken into consideration by this research.








**Occupation of the Coast**
Timeline

## Health & People

Since the late 18th century, the sea shifted from a place of external danger to one of open-air leisure. In warranting its beneficial treatment virtues, northern European cultures devised the typology of the solarium and the Grand Hotel by the sea – these enabled the sea shore to become a territory of leisure and healthcare. With society growing in number and economic output, this form of treatment has become a luxu-ry and hospitals, or patient centres are today confined to urban areas – albeit faster accessible and not including private clinics.

However sociological studies  have shown correlations between access to a natural view or a natural environment and faster patient recovery. This hereby attests to the neglect of the necessity of human interface with the natural environment.

These prompts call for new design responses addressing a broader view of health and its affiliated typologies and programmes.





**“On the beach at Trouville”**
1871
Claude Monnet

**Kurhaus Scheveningen: Grand Hotel & Solarium**
circa 1900

## Reasearch Framework

Research Methods
Analysis Methods

The project's research method is a context-led inquiry. Through qualitative, quantitative, historical, typological, topographic and territorial data, the heuristic technique of mapping is used to organise, process and discuss findings. In terms of organisation, the research is organised in a linear and horizontally conical manner. By using increasingly smaller frames, this allows to continuously refine the research.

The frame of reference at hand is enmeshed in the territorialisation and topographies of the greater North Sea region. In this light, the architectural research is set up on a territorial scale. Considering the breadth of the scale, the project illustrates the findings through exercises in mapping, programmatic diagrams and architectural drawings.

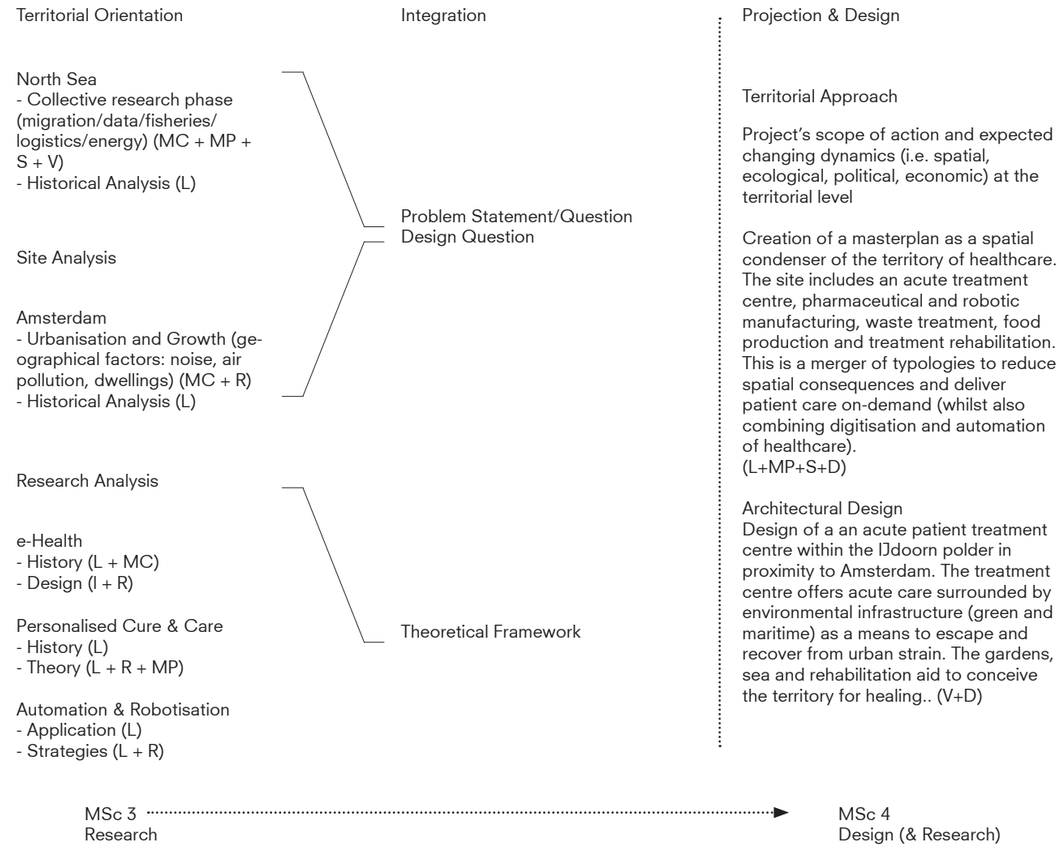
When considering the research's intention, the frame of intentionality(ies) is dual. On one hand, the un-weaving and deconstruction of territorial processes and elements is carried out, with analytical scrutiny, to understand the functioning of the e-Health's physical and socio-political systems relative to the North Sea territory. On the other hand, an assemblage of information layers (often widely differing) is exercised to find or confirm the relationships making up the very systems (people, urban health, data, migration trends, etc.).

Mapping is the first tool as it allows for multiple analytical strategies to be used under its helm: layering/addition, zooming/refining and exclusion (as a commentary)/subtraction. The other research methods include, research by designing (iterative), interviews (process-based inquiry), historical research and programme/typological studies to anchor the project within realistic projections.










L Literature Study - MC Mapping Current State - MP Mapping Projections - S Scenario Planning - R Reference Analysis - V Visit - I Interview - D Research by Design

# architecture

# Proposal

## Research Objectives

1. Increasing efficiency of health architectures and systems via technology (digitisation, automation & robotisation)

2. Equalising digital and natural infrastructure as treatment means via interdisciplinary programme

3. Reclaiming the sea side as a territory for health and treatment

In dismantling what appears as the core principles and spatial conditions of healthcare, the project will consider new cohesions, constructs, negotiations and encounters as means to answer the aforementioned problematics.

Territorial/Urban:

To alleviate the current territorial footprint of healthcare, the project proposes a reconfiguration and combination of programme. Instead of decentralized supply chains including hospitals, medical tool manufacturing, pharmaceutical manufactur-ing and delivery, medical waste processing, out and in-patient centres or off-site food production, amongst others, the project advocates for a merger of typologies to reduce spatial consequences and deliver care to patient on-demand. Therefore, a patient care centre may be more alike to a biotechnology campus than a singular clinic which must import all equipment(s) to function.

To alleviate urban-related illnesses and medical disorders, the project is situated in an entirely green area on the northern shores of the Ijmeer, in proximity to Amster-dam to allow for a fast commute. The immediate proximity to a natural and mari-time environment is done to reclaim the shore as a territory for healthcare.
The studio's philosophy sees the sea's territory and threshold as a central space and not a limit to the land, therefore, the project is placed within this space and is revis-ited through the lens of the land and adjacent sea.

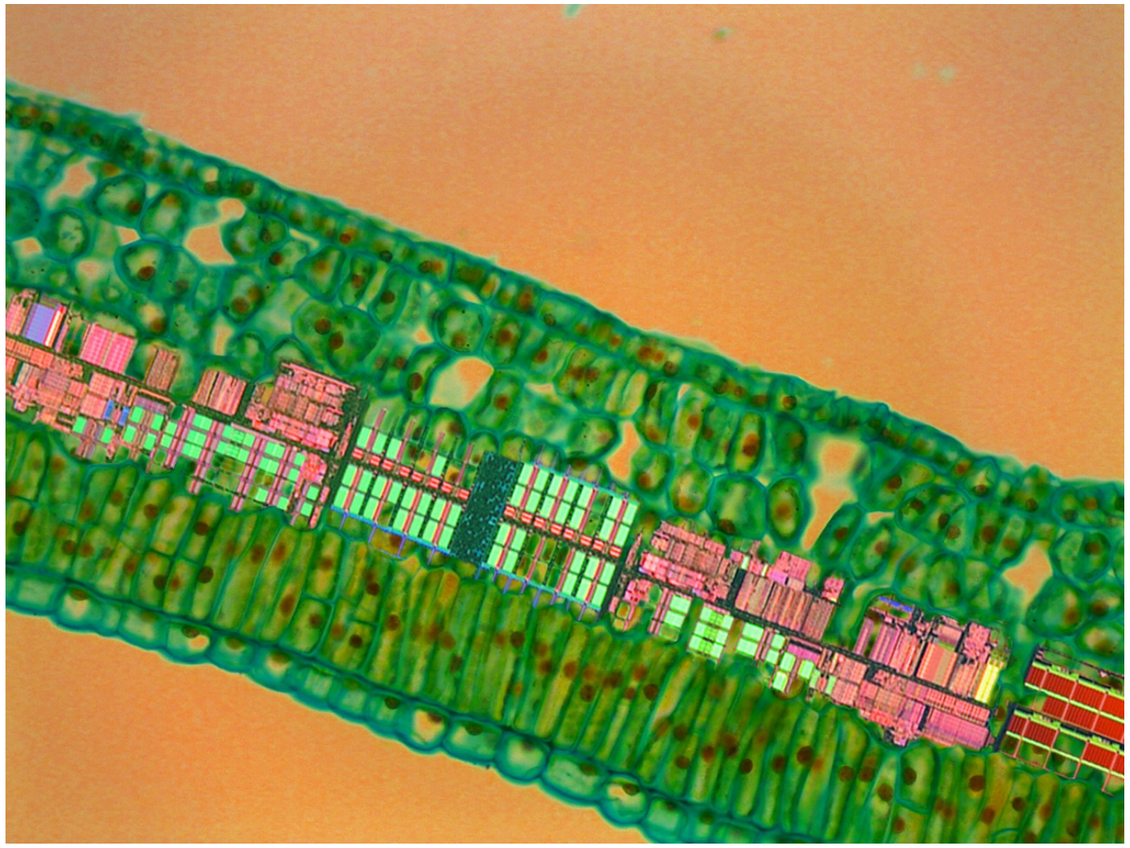
Architectural:

With the proliferation of data production and increase in importance of the digitiza-tion of processes in healthcare, associated programmes are radically changing in size.  The automation of processes in patient centres lead to faster patient recovery due to more contact time with medical staff and the collection of data and continu-ous monitoring via wearable technology means that less time is spent in hospitals. Data and automated logistics are therefore fuelling the advent of personalized care.

The collection of data such as genomics data or clinical data allows for the optimiza-tion of each individual's medical care. In considering the territorial scale, personal-ized health aims to process data to benefit the population at large by "identifying and tackling health risks at early stages and applying appropriate preventive and therapeutic measures" .







**Engineered Ecologies**
Source: Own collage adapted from microscopic section through plant leaf.

## Problem Statement

Urban: Amsterdam (Noord)

Being a logistic and data node in central northern Europe along with a leader in the digitization of processes in healthcare, Amsterdam remains at the centre of infor-mation flow and digital health innovation. The Dutch healthcare policies and tech-nocratic innovative stances have shaped the physicality and accessibility of caring facilities but have enabled a sprawling system of increasing costs and ageing decen-tralized infrastructure.

With the continued growth of the country's population (Over 18 million by 2060) , urban sprawl, inequalities in access to healthcare facilities and growths in chronic, environment-related injuries and mental health conditions due to societal strain will become issues.

**What kind of public health intervention (infrastructural and systemic) can contribute to innovation in the management of the Dutch healthcare system and alleviating its territorial footprint?**

Territorial/Urban

What infrastructural/typological reconfigurations should be carried out to increase the resiliency of medical facilities and alleviate the territorial footprint of healthcare?

How can the calculated displacement and reconfiguration of the decentralized model of healthcare facilities contribute to an alleviation of urban-related illnesses and medical disorders?

To what extent can the urban shore be reconfigured as a territory of healthcare?

Design Question

What kind of architectural intervention can amalgamate the tradition of the shore as a healing territory with the systemic reconfiguration of the decentralised Dutch healthcare model?

Sub-questions

Urban Health
How can the reconfiguration and de-localisation of a patient care facility contribute to an alleviation of urban-related illnesses and strains?

Seascape
To what extent can the site's maritime shore be reconfigured and occupied as a healing territory?

Data & Automation
To what extent can digitisation (process optimization, human-centric robotization, automation and health data harvesting) alter the scale and programme of acute care medical facilities and their processes of care?





**Satellite Image of the Randstad region**
Source: Zoom Earth

## Site

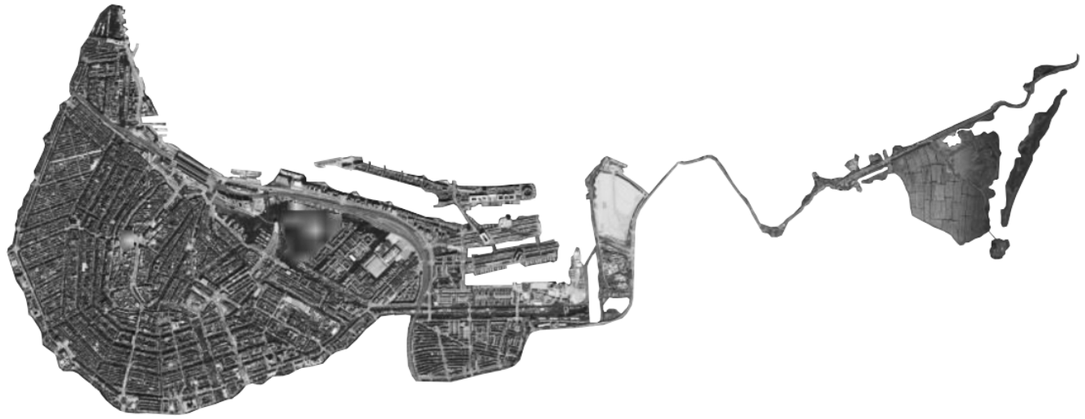
Purposefully situated out of Amsterdam's urban core, the selection of the Ijdoorn polder as a site is due to multiple reasons.

Firstly, it is geographically positioned as a peninsula within the Ijmeer and enjoy a low population density. This relationship to the sea and proximity to the coast means that it can offer a place of respite, contemplation and allow visitors to participate in the coast's therapeutic landscape.

Secondly, as it is still within the municipality of Amsterdam, granted the appropriate connections are included, the site can be a pace of medical and social repose easily accessible from the city. As it is a treatment facility for acute conditions, a calm environment is primordial, however, isolation would counter its geographical efficiency.







**Connection to Amsterdam's Fabric**
City to Local context

**Design Proposal**
System

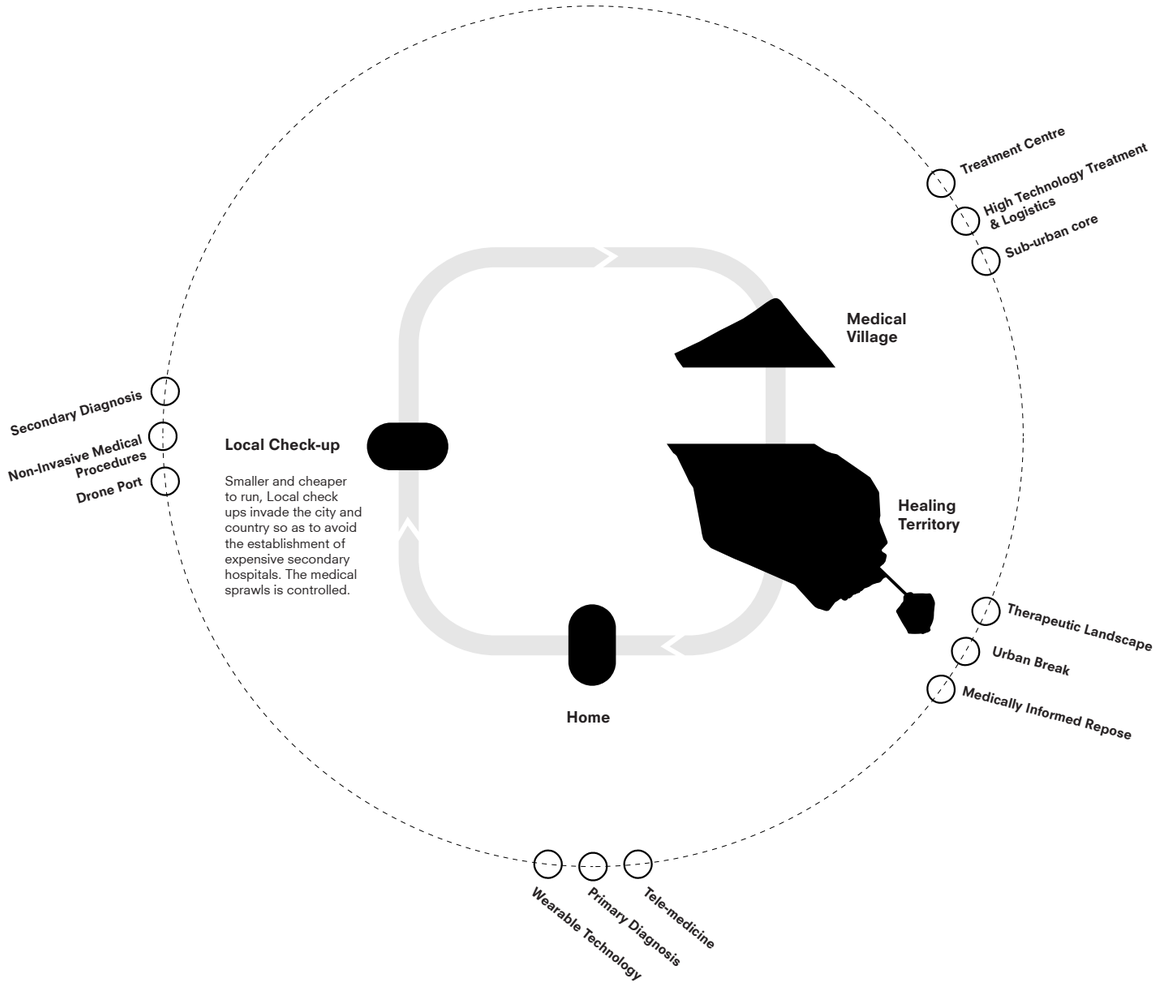
The architectural and territorial challenge aims to rearrange the healthcare space as a stage for radical natural-techno-human intervention. The project is committed to challenging the ramifications (cure and care) of health through the creation of a masterplan and architectural project.

“Healthcare in Transformation” enquires into the entangled processes and territorial occupation of the medical field in order to imagine alternative biotechnological, medical and ecological futures as means to alleviate sprawling facilities and urban strain.

Thus, the project uses a multi-dimensional approach to solve problematics in local and territorial scales and to increase efficiency in management of public health, via data, automation and the natural environement. The project proposes an acute treatment facility (medical village) nestled within a coastal territory for healing to harness its therapeutic conditions.








***Continuity of Care - Treatment becomes Well-being***

**Future Projection of Healthcare**
System

Architecture

Hospital Sprawl

Medical Facility
Decentralisation

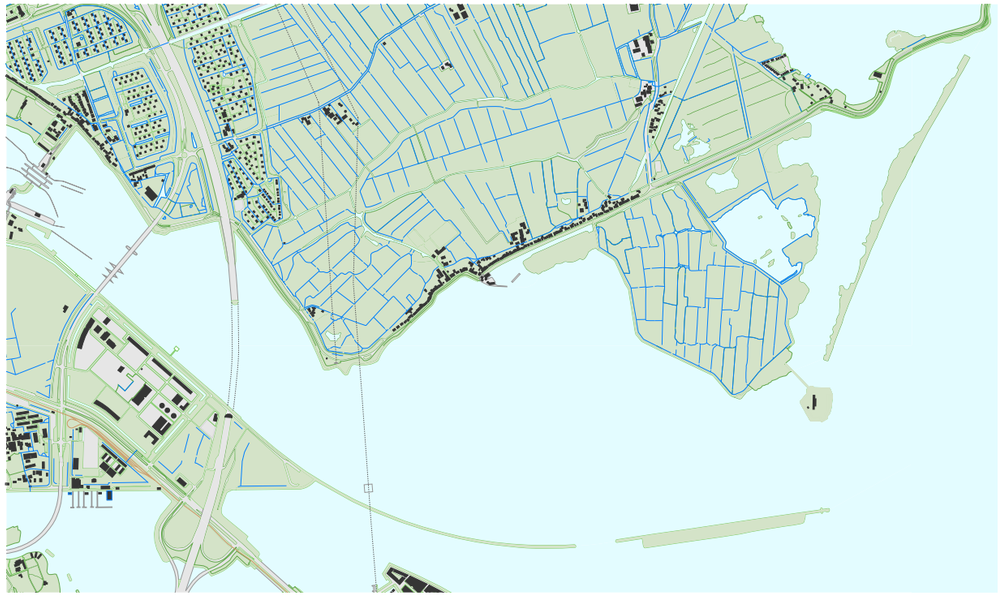


**Medical IoT**





Architecture



**Ijdoorn Polder**
Intervention Location

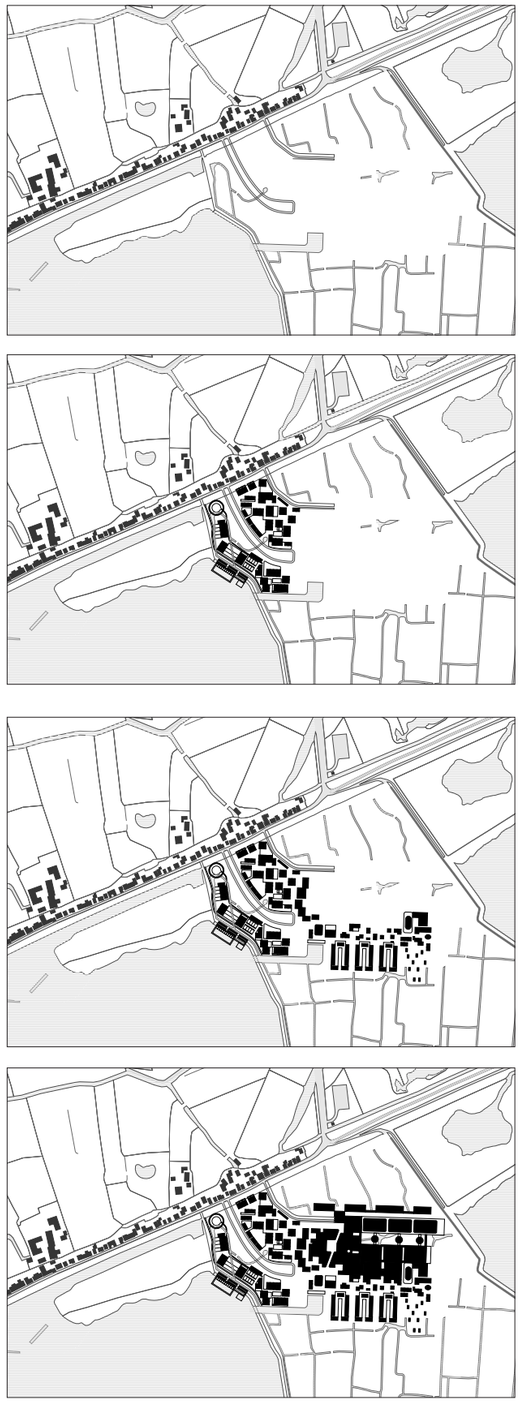
**Ijdoorn Polder Aerial Photography**
Siebe Swart, 2017

**Site Plan**
Project's relationship to its surroundings



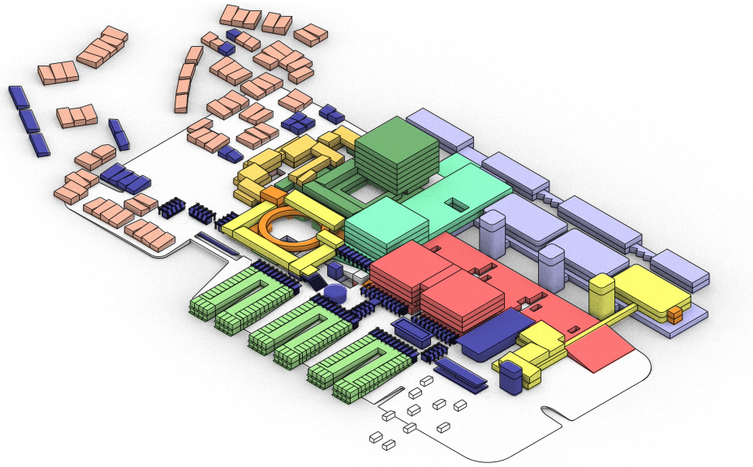




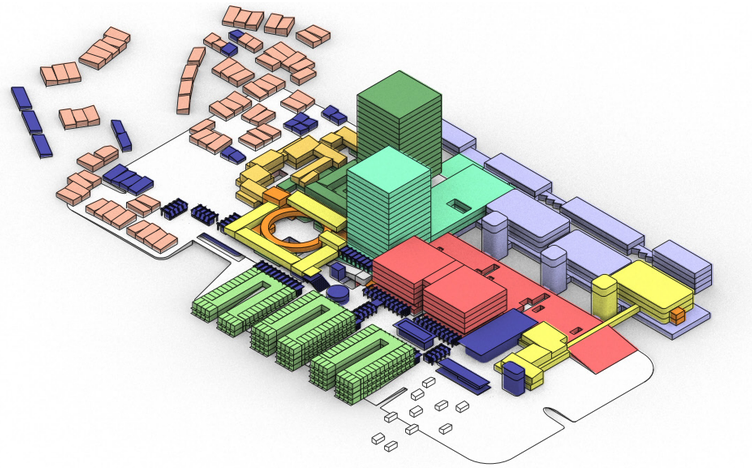


**Extending the Existing Village**
Spatial Local Scheme

## Medical Village Programme

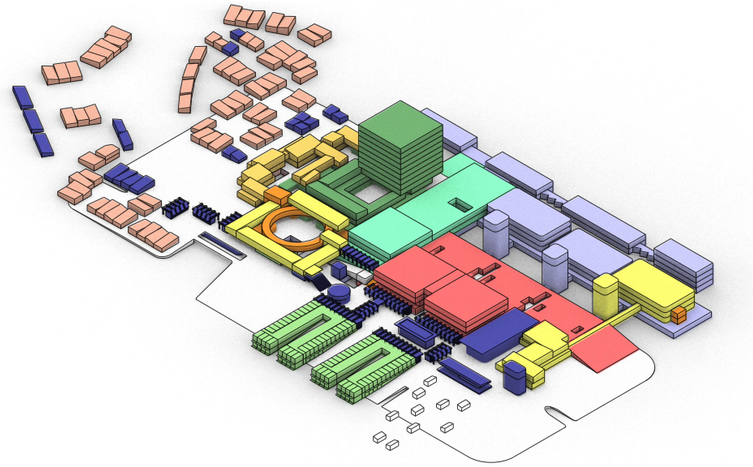


**Medical Plinth**
Programme



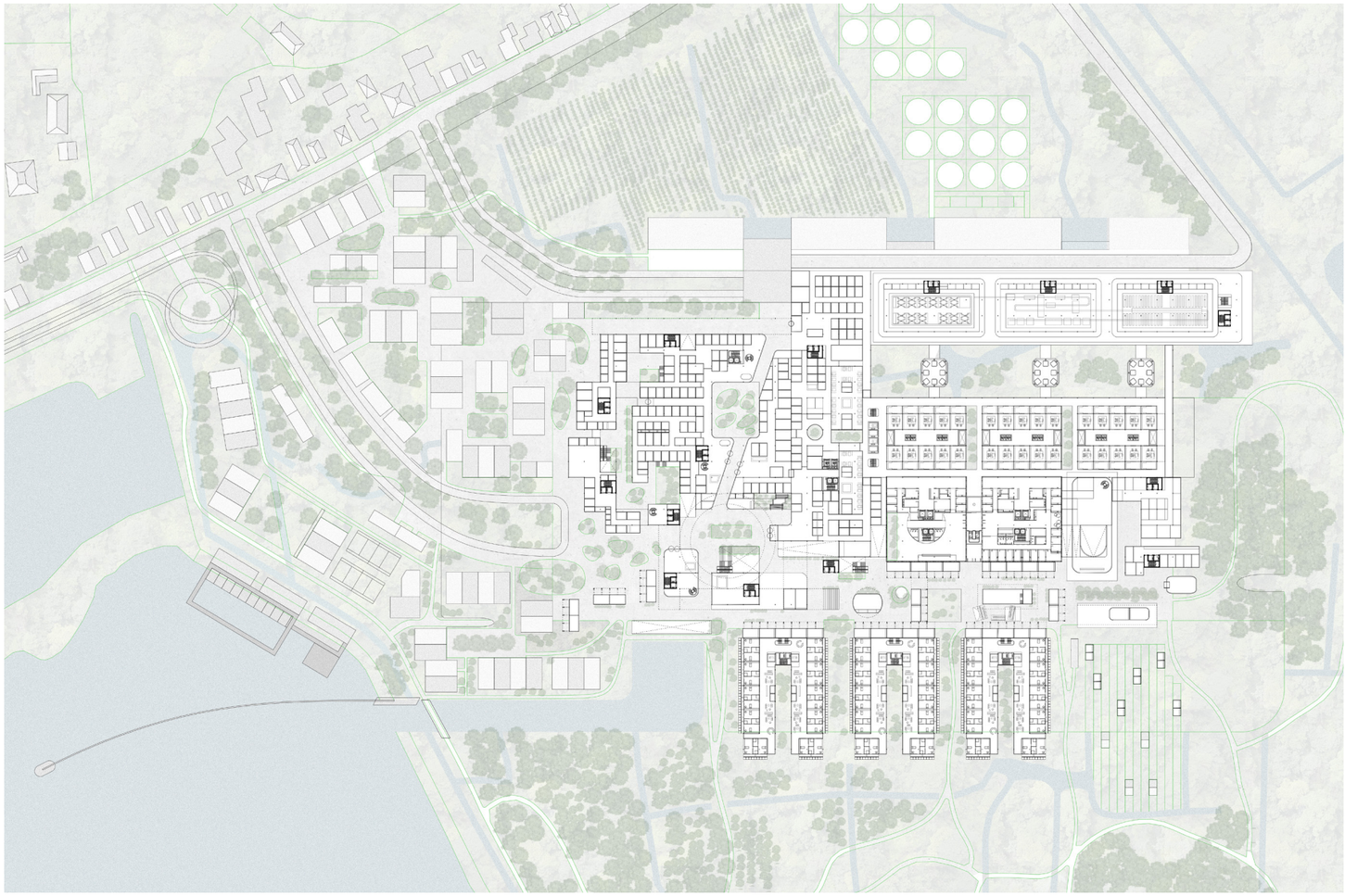
**Medical Village 2030**
Programme





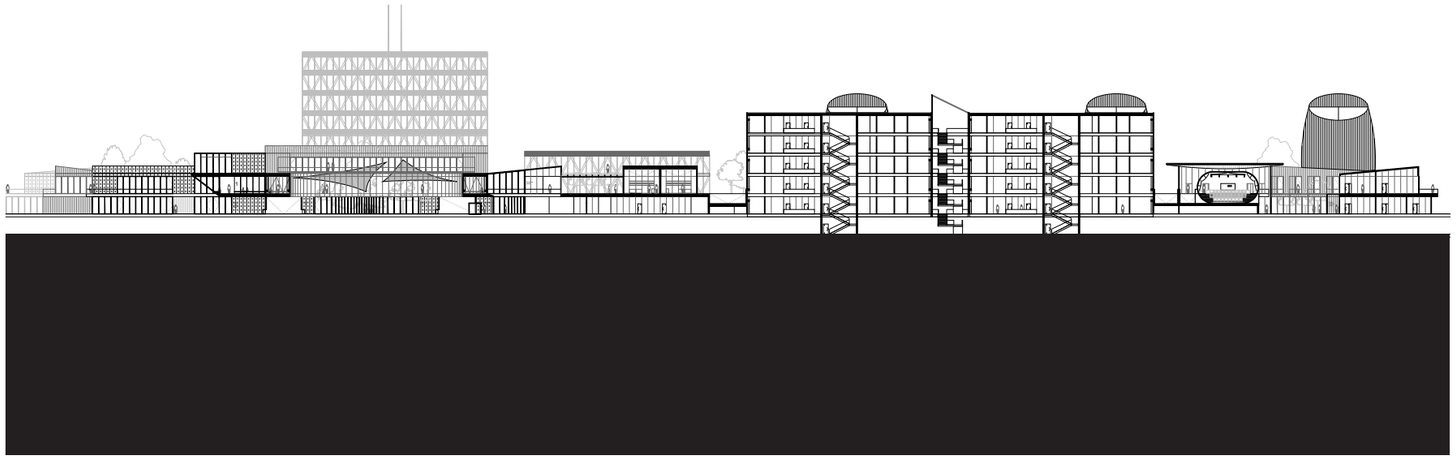
**Medical Village 2035**
Programme

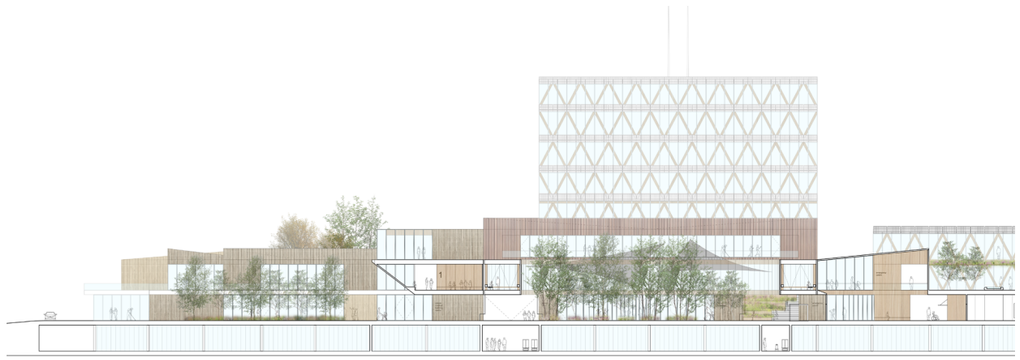
- In-Patient Wards
- Out-Patient Clinic
- Emergency Centre
- Automated Units
- Facilities Management
- Public Programme
- Parking
- Housing
- Medical Units/Machine
- Circulation/Cores
- Offices/Staff
- Research Centre/Labs



**Site Plan**
First Floor/Concourse

**Isolated Long Section**

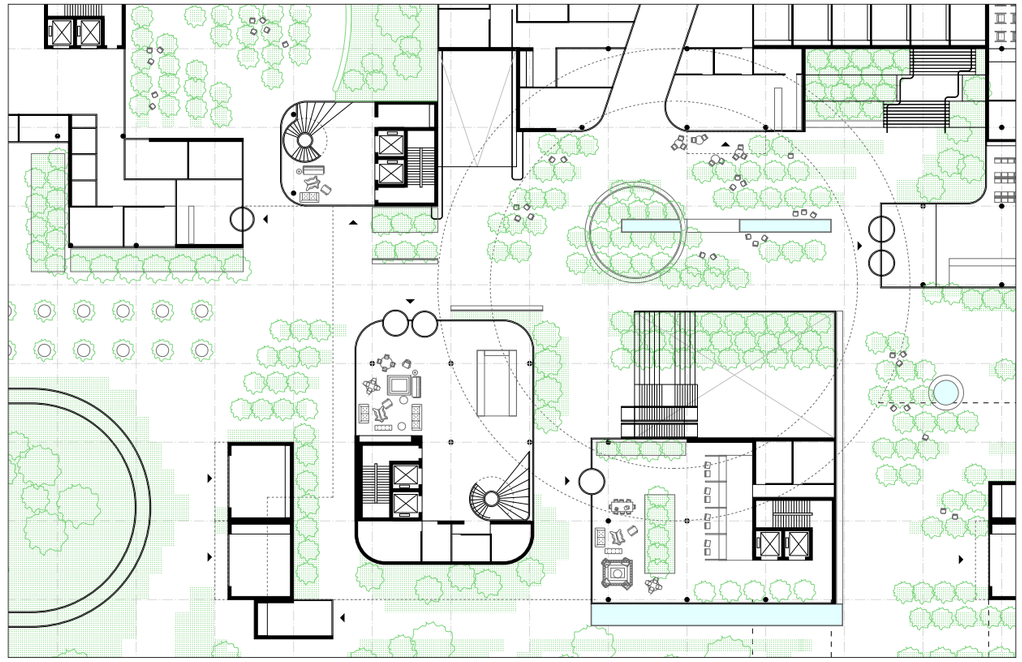




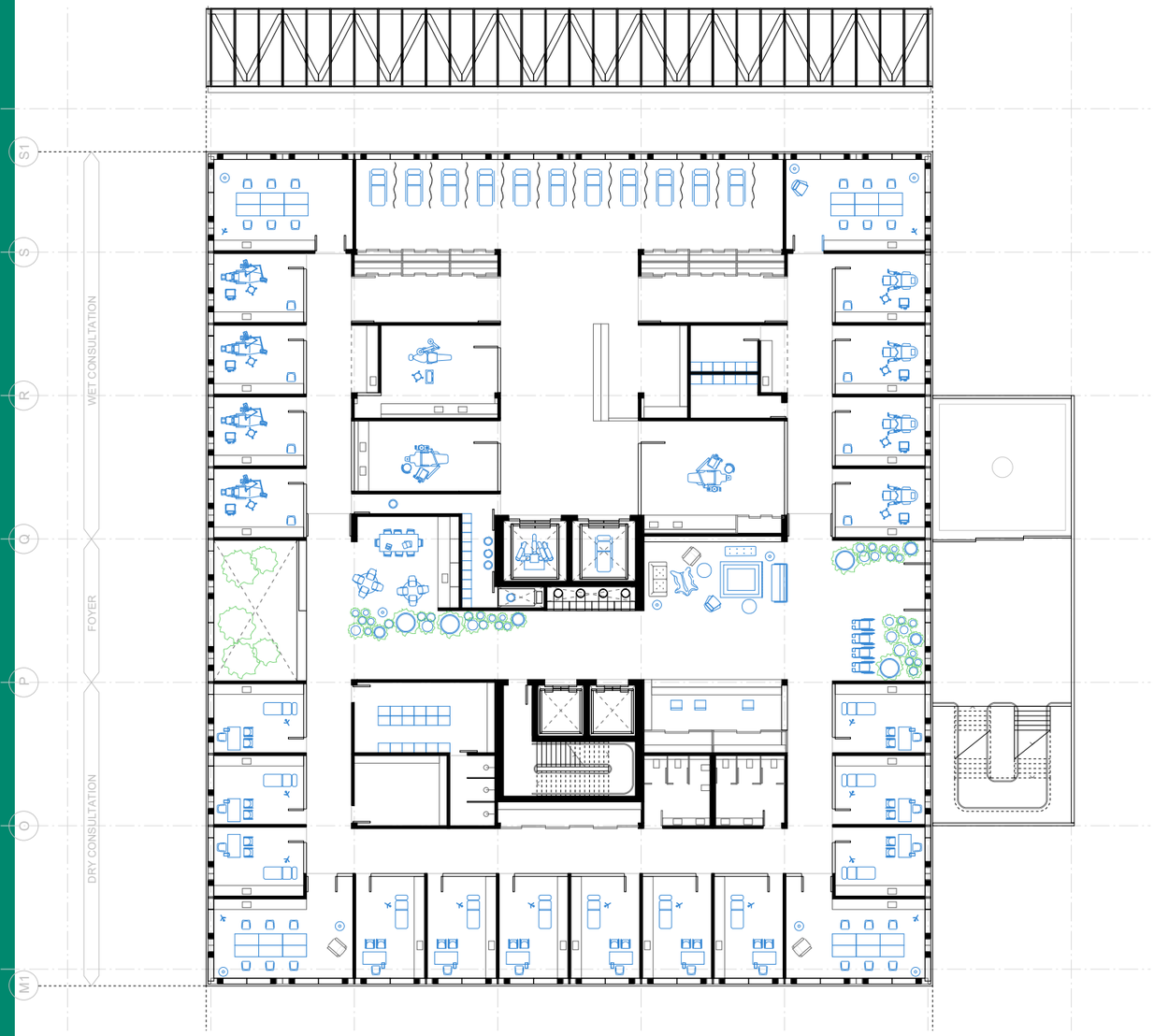
**Medical Village**
Civic Centre Section
1 : 500







**Medical Village**
Civic Centre Plan
1 : 500




**Medical Machine Unit**
Plan & Elevation
1 : 200

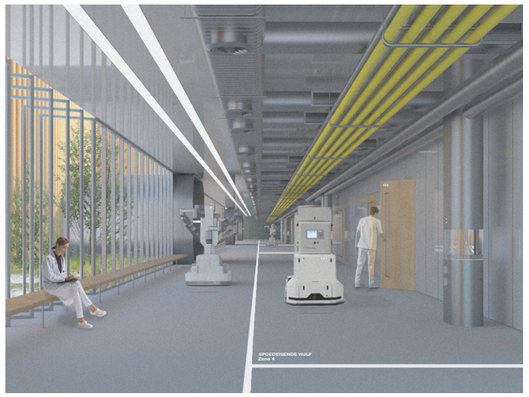





**Medical Machine Unit**
Section
1 : 250

## Illustrations

Medical Village

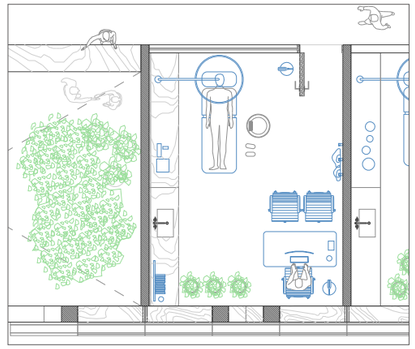


Robotic Slab

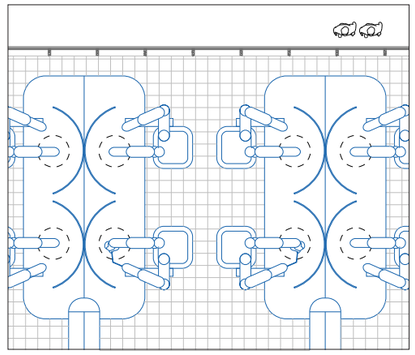
Civic Square



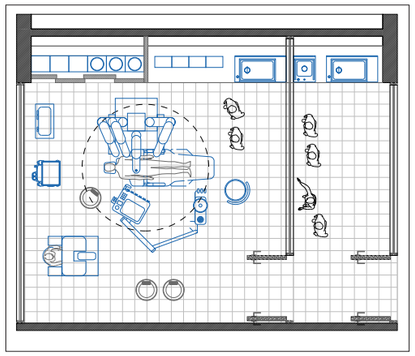




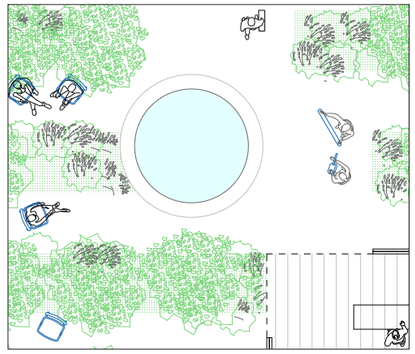
**Consultation & AR Visualisation of Procedure**
Out-Patient Clinic



**3D Bio-printing of Required Tissue**
3D Printing Centre - Facilities Management



**Robotised Minimally Invasive Medical Procedure**
Out-Patient Clinic



**Patient Recovery**
Piazza in Medical Village

**Out-Patient Journey**
1 : 50 Drawings

## Territory for Healing

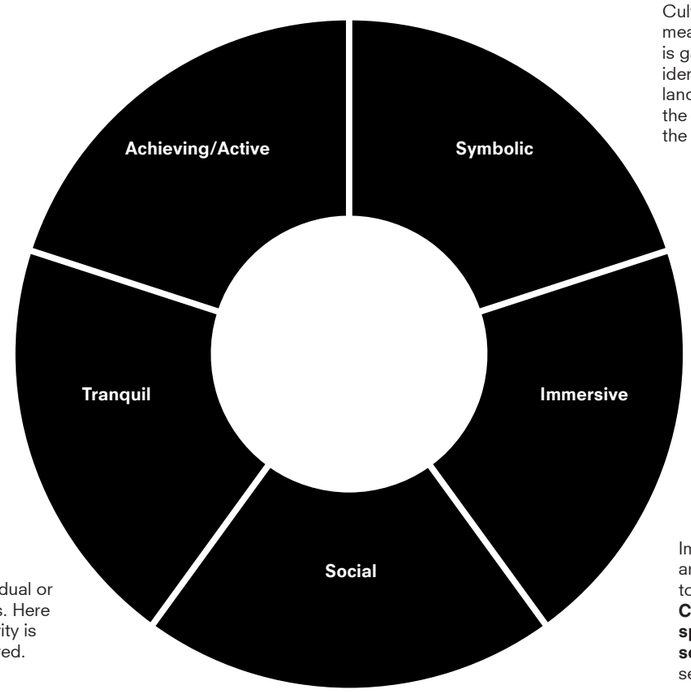
**Territorial Site Plan**



Supportive and challenging infrastructure which cater to long-term achievements and immediate gratification.

- **long term**
- rehabilitation
- personal goals
- sporting
-
- **immediate**
- exercise trail
- sporting trails

Relaxing spaces for individual or calm restorative purposes. Here contemplation as an activity is encouraged and engineered.




Cultural/Personal places of meaning. The sense of place is gathered through belonging, identity and attachement to the landscape. The romantic idea of the coast as a healing medium is the narrative.

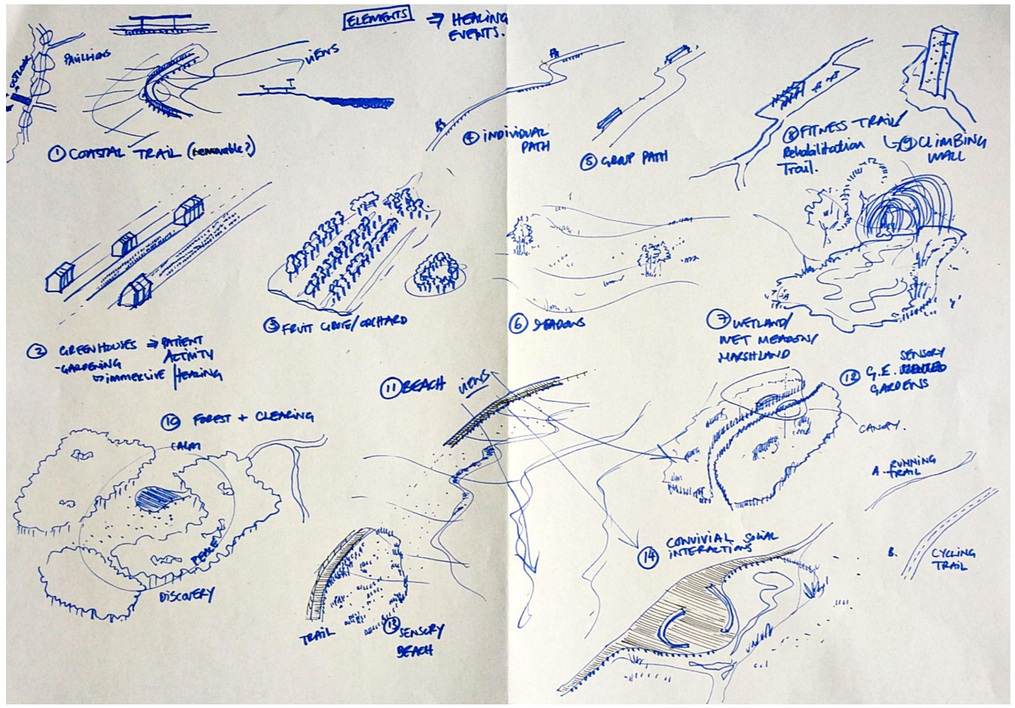
In creating places for encounters, convivial and social interaction can be engaged in. Leisure, conversation and a shared sense of well-being contribute to communal healing. **These spaces can be beaches, promenades, plazas and sporting facilities.**

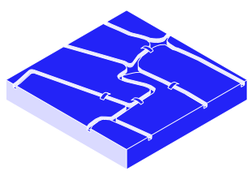
Immersive insipring experiences are created through opportunities to explore the landscape. **Captivating and multi-sensory spaces like coastal paths or sensory gardens** activate the sense of discovery.

- microclimates
- views
- sensory gardens

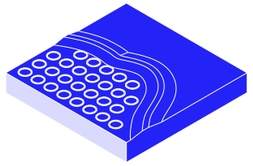
**Multi-Landsacpe**

## Healing Events

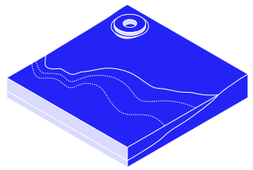


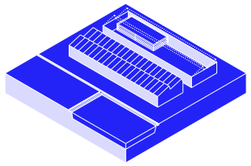
PATIENT REHABILITATION
HEALING GARDENS



WASTE MANAGEMENT:
AEROBIC TREATMENT CENTRE



SOLARIUM
SEASIDE AS A HEALING
TERRITORY



FOOD PRODUCTION:
ON-SITE FARMING

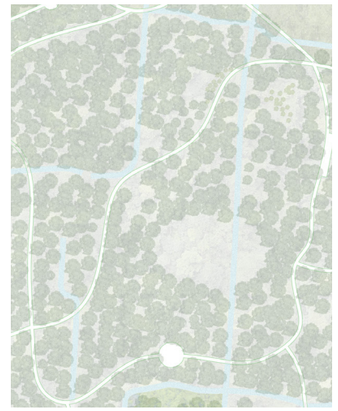
**Territorial Healing Events**
Illustrations





**Coastal Trail**
**Sensory Forest**
**Sporting Trails**

**Fruit Orchard**
**Garden Café**
**Dry Meadows**
**Water-Retention Ponds**



**Immersive Buffer Forest**
**Solitary Paths**
**Contenplative Events**

**Wetland**
**Minimally Invasive Paths**

**Social Paths**
**Beach**
**Sporting Trails**
**Sea Pavilion**

**Island**
**Sea Views**
**Therapeutic Coast**

**Healing Events**
Territory for Healing

**Forest**
Heaving Event illustration






**Organic function of healing & technocratic system**
Engineered Nature

# building technology

## Research Questions

**Natural Infrastructure**
How can the flora/fauna contribute to the patients' healing?

**Technical Infrastructure/Systems**
How can we climatise/create different zones in the hospital according to varying medical, technical, environmental and personal conditions?

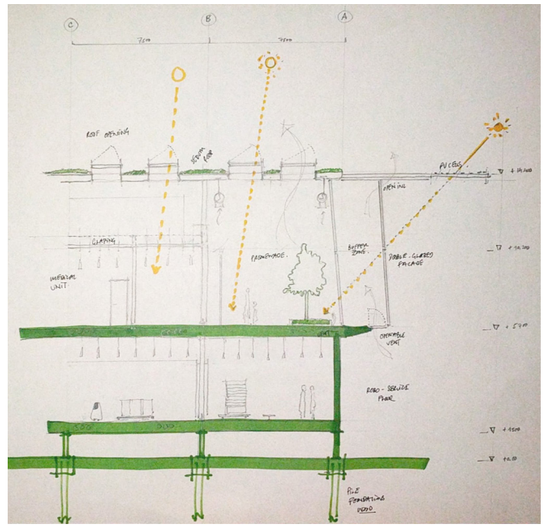
**Structure**
In the context of the project's modular approach, which structural tools can contribute to/enable the structure's flexibility & adaptability?

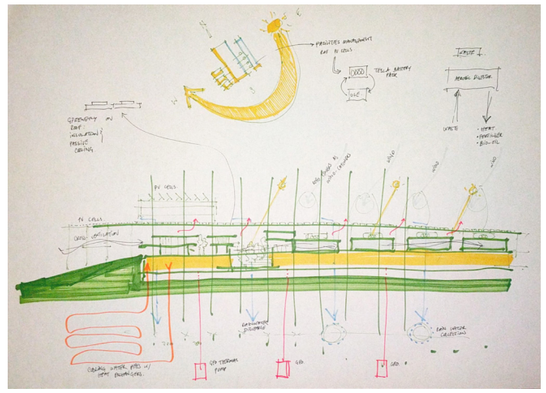
**Sustainability**
How does the logistical network promote sustainability in energy, waste flows, materiality & mobility?

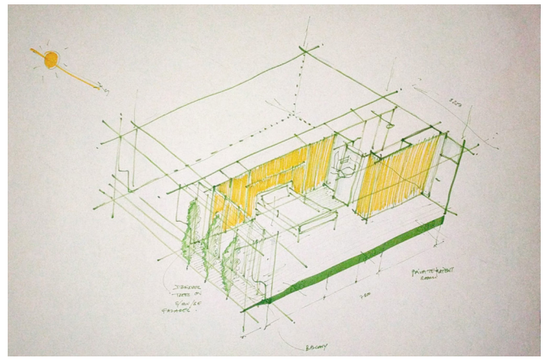
**Territory**
What are the territorial management tools which allow for its resiliency?











**Preliminary Sketches**
Building Technology

## Application

Natural Infrastructure

How can the flora/fauna contribute to the patients' healing?

- Green Territory
- Territory for healing
- Healing gardens: scented, walking route, plants, views, sea shore

Technical Infrastructure/Systems

How can we climatise/create different zones in the hospital according to varying medical, technical, environmental and personal conditions?

- Medical conditions: medical rooms, surgery rooms, avoiding contamination, high-tech spaces
- User-oriented conditions: hospital rooms, low-tech spaces
- Flexibility: Allow flexibility in the building's climatisation of zones by decentralising systems which allows for easier change

Structure

In the context of the project's modular approach, which structural tools can contribute to/enable the structure's flexibility & adaptability?

- Time-oriented structure
- Flexibility and malleability of the medical infrastructure
- The machine section is extend-able and shrinkable
- Pile foundations to anchor the building into the soil - possibility to use open soil system along pile foundations as a combination of uses





| **Systems** | People | Structure | Natural Infrastucture | Technical Infrastructure |
|---|---|---|---|---|
| **Goals** | User Comfort | Modularity<br>Adaptability | Territorial<br>Management | Logistical Efficiency |
| **Layers** | | | | |
| Use & Occupation | User experience: Patients, Guests, Staff, Visitors, Students. **Patient First:** the single occupancy patient rooms designed for patient confidence & security accommodate interdisciplinary examination + treatment medical teams. The clinitians come to the patients to allow undisturbed consultation. Patient participation & wellbeing. | The project is part modular & part permanent. The modular section (machine) has a flexsible structure, modulable cells, modulable facades. | Territory for healing: healing gardens, interaction and integration with nature. How can the flora and fauna contribute to the patient's recovery? | Patient rooms designed so that medical equipement doesn't dominate - supported by technical support spaces, private hygiene rooms and contamination-free logistical solutions. |
| | | **Modularity of everything:** Each ward should have its own roof so as to be self-contained. The module can then be "pluged- | | |
| | | | | |
| Network | Flow of individuals: Mobility in/out and within the medical campus | | | Flow of goods in/out and within the medical campus |
| | Enhance interaction between care, research & education. Thus, the compact structure ensures proximity bwtween different funcatoins & interdisciplinary working | | | Supplies cand be efficiently transported using pneumatic tube system and remote-controlled logistical robot carts which have a |
| | Specialist clinitians are now part of thematic diagnostic care and treatment units - full range of specialist healthcare professionals. Nursing stations: Small + decentralised. | | | |
| Territory (Biotic) | Nature as part of healing | | On-site flora, fauna and water | |

| Materials | Climate | Energy | Waste |
|---|---|---|---|
| Circularity | Flexibility Malleability | Renewable Energy<br>Energy Safety | Circularity<br>Recycling<br>Upcyling |
| | | | |
| Materials to lighten the atmosphere: Natural stone, light wood, durable granite floors, white concrete elements. **Art** as a healing medium/material - | Positive impact of daylight and natural materials, views and spaces for patient wellbeing. **Considerations**: Daylight, air movement, air quality, accoustics, temperature, humidity. | Reduced energy consumption as compared to equivalent hospitals. Renewable sources with low CO2 emissions: **District heating, remote cooling, separate geothermal plant & recycles** | |
| Consider materials as part of climate strategy. | **Modularity of everything:** Climatisation of different wards/modules should be decentralised to allow for flexiblity and change. Plug-into building. | | |
| Use of standardised elements or printing of standardised elements to create flexible | | | |
| Circularity in material use, transport, disposal and re- | Division of patient, public and service areas to minimise germ transmission. | | |
| Material Passport | | | |

Dutch Layer Approach & Hospitals Systems Matrix

**Energy Management Scheme**

On-site energy demands are fulfilled using wind power, solar power and the general mains to ensure sustainability and resiliency in the event of an input shortage.

Energy Centre

- Storage Batteries
- Substation & Distributor
- Wind Farm Link
- Solar Roofs Link

Wind Farm on isolated island
- 2x on-shore wind turbines
- 2MW of electricity generation

- Hospital Size: 80,000 m2
- MWh Useage Per m2, Per year: 0.27
- Hospital MWh Useage per year: 21,600

**Wind Power Calculations**

Wind Turbine Capacity of average on shore turbine: 2-3 MW

Energy output: 6000 Mwh/ year

**Solar Power Calculations**

Solar panels capacity KWh/m2/year: 170

Roof surface for solar panels: 20,000 m2 (or 10,500 panels of 1.7m2)

Energy output MWh/year: 2000

**2 Wind turbines theoretically produce 12,000 MWh/year. 10,500 solar panels produce 2000 MWh/year. These provide 2/3 of the hospital's energy needs With only 7,600 MWh required from the grid.**

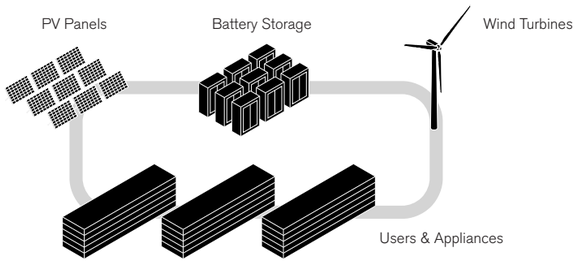
Sources:
https://www.vattenfall.nl/



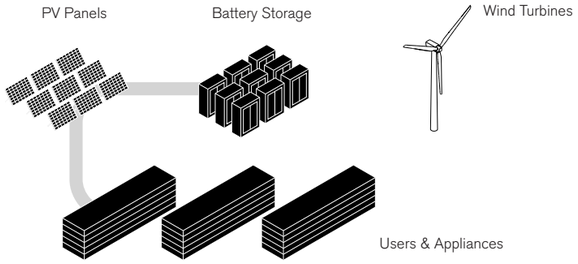


## Energy Management Scheme

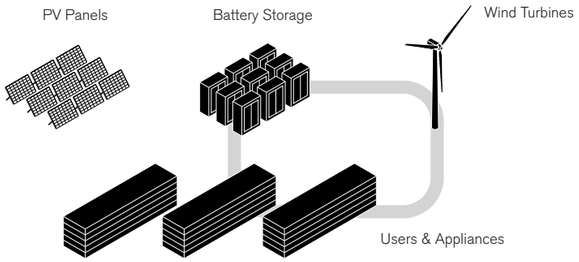
Windy & Sunny DAY




Windless DAY




Cloudy DAY/NIGHT



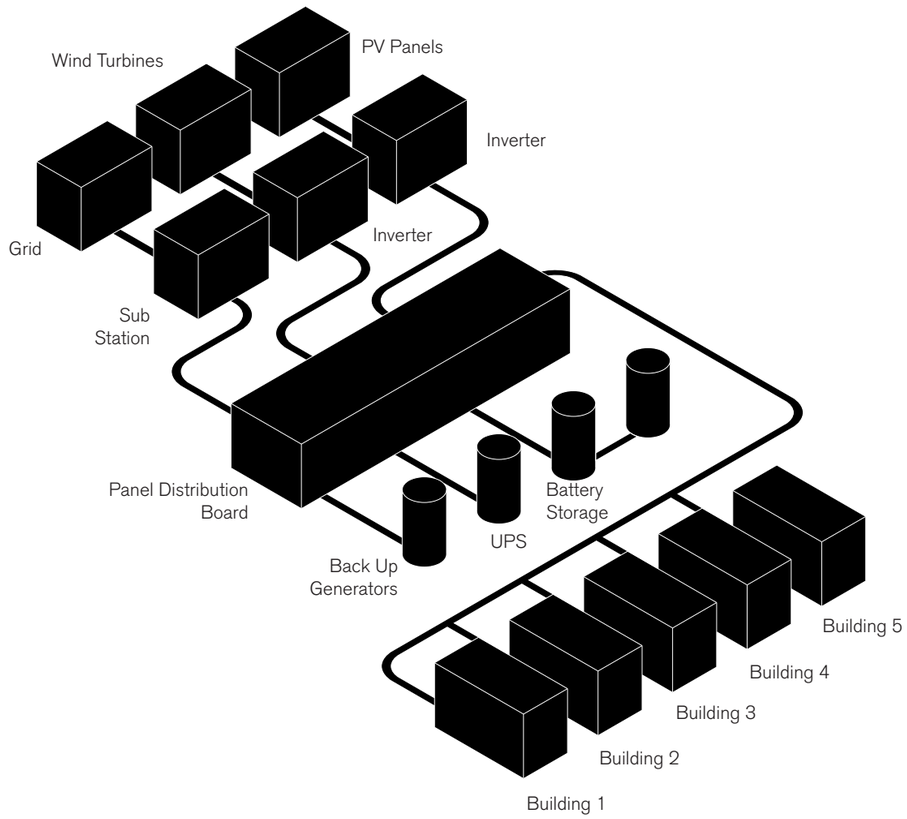

**Wind**
- minimal audible sound
- no physiological effects on human health
- placed away from protected area to avoid bird interaction

**Solar**
- PV panels accross all semi-permanent roofs
- PV cells within glazed canopies
- PV panel shading facade on S & W facade of out-patient tower

**Storage Batteries**
- integrated DC storage device
- connected to WKO for cooling
- micro grid supplementing main grid
- emergency backup
- scalable infrastructure








**Wind and Solar are intermittent energy sources and can't be used as base-load energy sources but as supplements.**

## Waste Management Scheme

Waste management is primordial within a treatment centre's typology due to the different streams of waste created.

Additionally, as the centre is situated in a rural area, special attention is to be given to avoid the contamination of the surroundings.

Small Scale Aerobic Digester
- Tiered filtering of biological wastes
- Bio-Oil and Ferlitiser resulting from chemical process can be used on the agricultural plots and for building.
- Waste heat from the chemical process sent to central heating facility

Medical Gas Tower - Logistics Hub
- Arrival & Docking Infrastructure
- Medical Air Compressor
- O2 Evaporator Tanks

## Process

Created Waste
-
-
Filtering of waste flow in robotic slab
-
-
Medical waste sent to external treatment plant for incineration.
-
-
Biological non-medical waste sent to Aerobic Digester
-
-
Recycled non-toxic water is filtered ans used in building white bio-oil and fertiliser are used on site.





## Rain & Grey Water Management Scheme

Considering the site's geographic location as a peninsula, water management is of primary importance.

Water has to be managed at multiple scales, from the risks of storm surges and flooding to grey water and filtering facilities.

### Surges & Flooding

- Water Retention Ponds - fitted within the territory, they act as as basins during surges.
- Drainage Basins and
- Wetland Flooding Plains act as overflow management in the event of floods

### Rainwater Collection

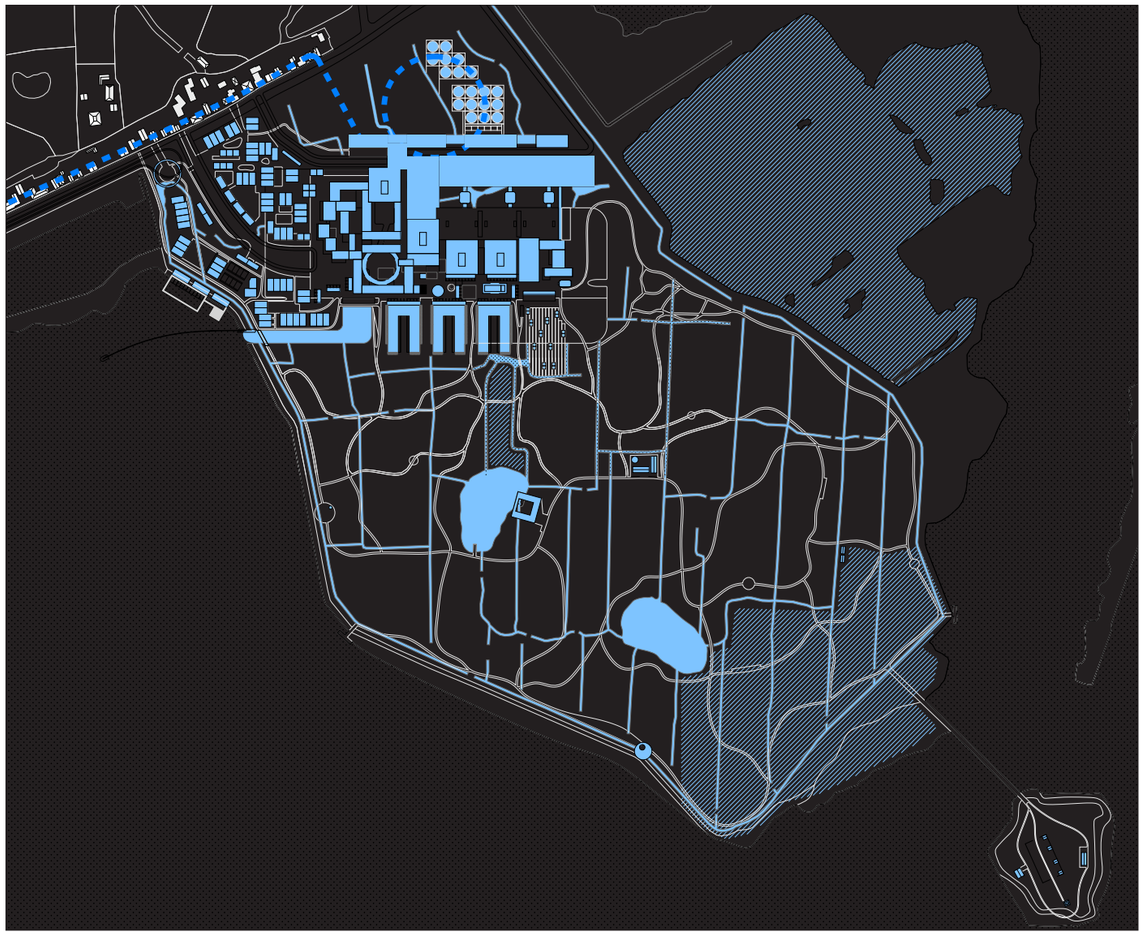
- Rainwater is collected on all of the village's buildings' roofs. This amounts to approx. 60,000 m2 of available collection surface.
- This is used for irrigation and cleaning necessities
- The collected excess rainwater is filtered and sent to the surrounding homes via shared infrastructure.

### Waste Water

- The Aerobic Digester is used to filter grey water which is re-purposed for non-sterilised uses.
- Black water is sent to external treatment plant







## Heating & Cooling Scheeme

On-site energy demands relative to heating and cooling are fulfilled using both an electric PV system supporting an open soil energy system.

In an effort is integrate the building in its surrounding and build resiliency, all local buildings are liked to a shred WKO system in a neighbourhood ring connected to a central heating hub.

### WKO System

- Open soil energy system using two different sources: a hot and cold.
- Using ground water's constant temperature at 10-15°C as an energy buffer throughout the seasons by pumping water in and out of the sources.
- The system requires good process control and consistent management - energy management station at hospital to provide performance analyses.
- By using the heat pumps and passive cooling, we can save up to 60% in heating energy and 80% in cooling energy with a thermal storage system.

### Heating and Cooling Capacity

- 1 set of dual bore holes is required/9000 m2 of a building.
- The medical village's size is 80,000 m2 meaning that 9 doublet are to be envisioned.
- 9 doublets of 18 bore holes will be bored accompanied with a series of heat pumps.
- There is a requirement for about 100 m3/hour of volume flow per source.
- There needs to be between 50 - 100 m between the infiltration and extraction tubes - the large territory can cater to this.

- **Benefits**

- Lower energy costs over time
- High degree of controllability
- Reduction in maintenance
- The system can cater to variations in the energy demands (heating and cooling).

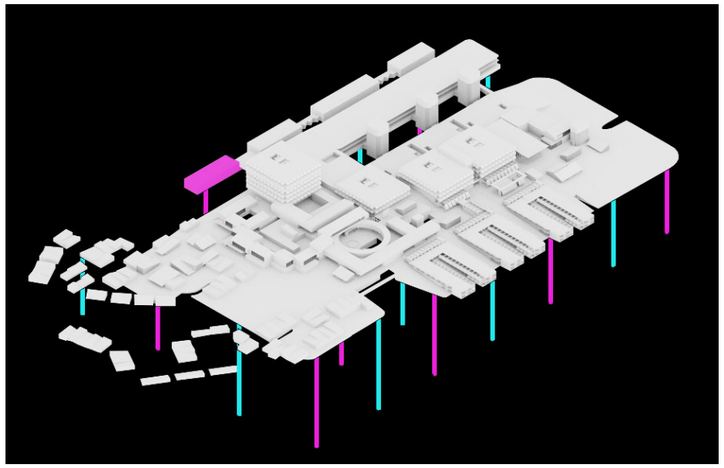
Amenities

Central Heating Hub
Management Station
- Electrode boilers
- Heat recovery from servers
- Heat recovery from Aerobic Digester
- Heat recovery from wind turbines

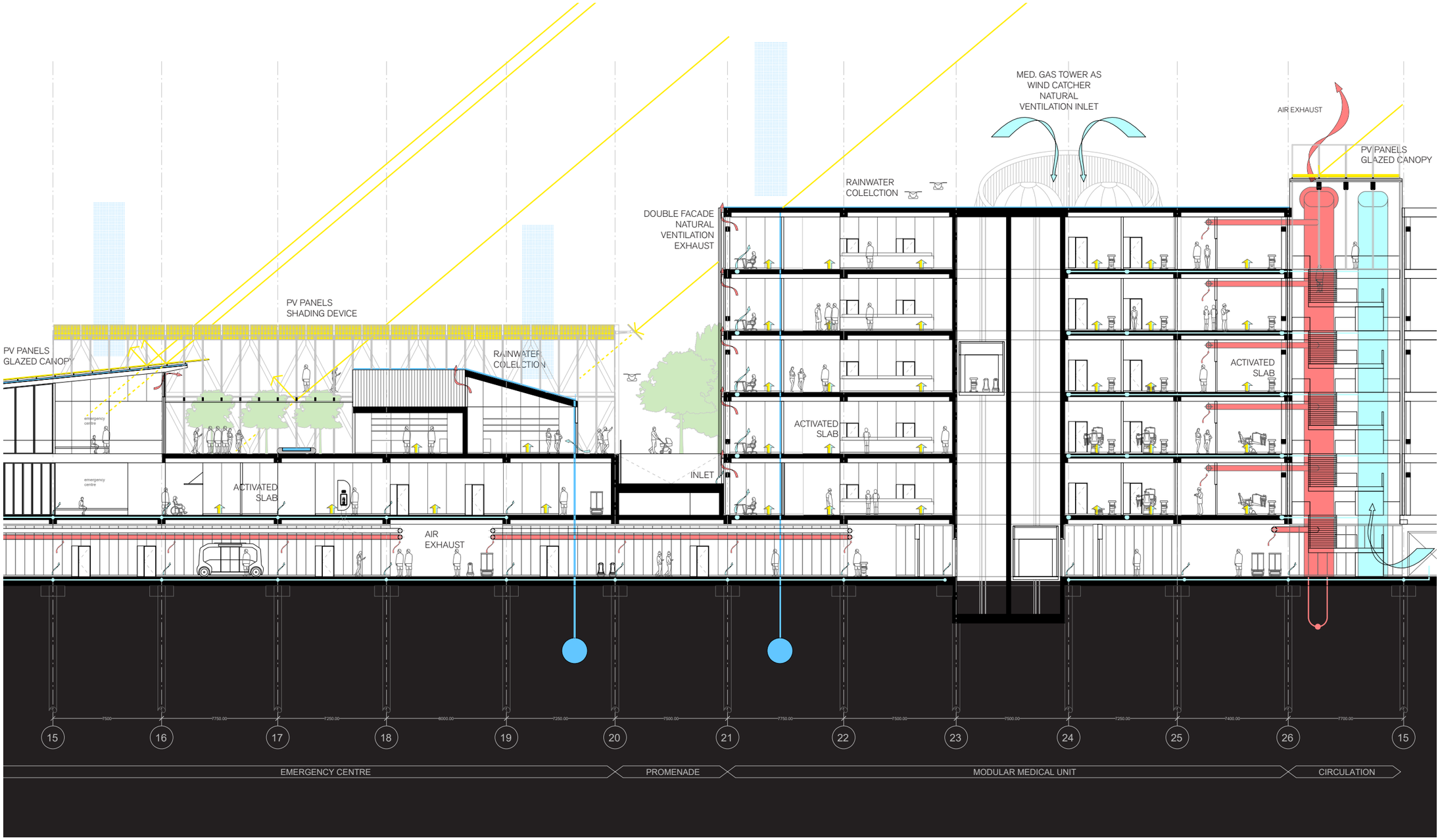
Sources:
https://expertisecentrumwarmte.nl
https://www.dgem.nl



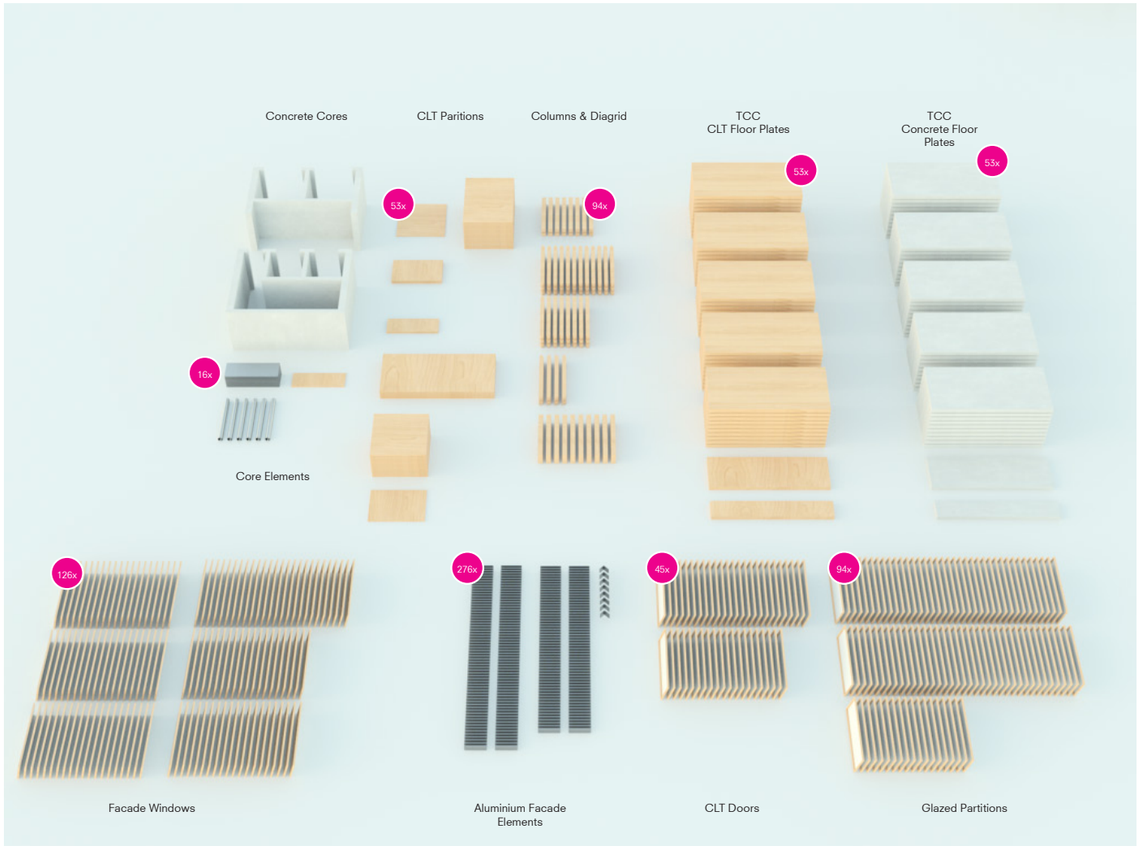




## Climate Scheme



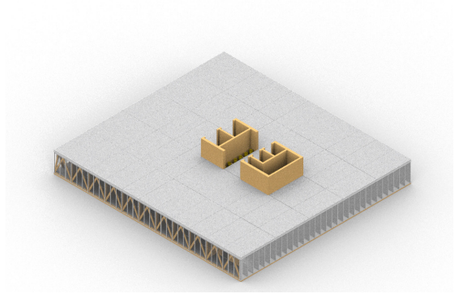
## Structural Buildability

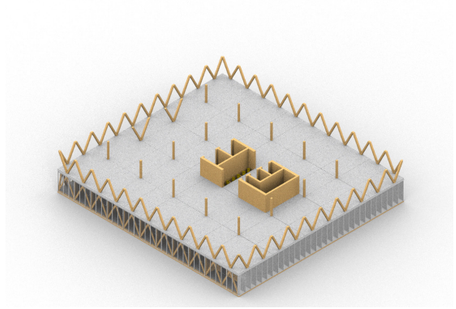


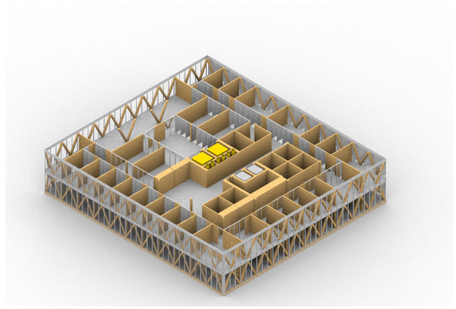

**Tower Floor Catalogue of Elements**



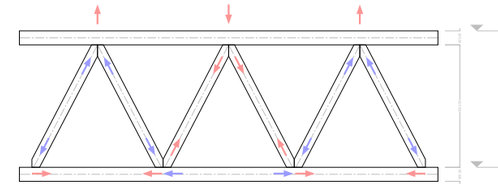




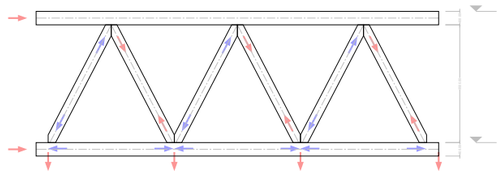




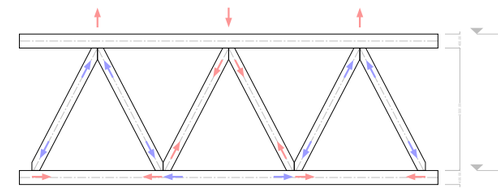
**Medical Unit Dry Construction Process**
Diagrid Structural Assembly



GRAVITY LOAD



LATERAL/SHEER LOAD



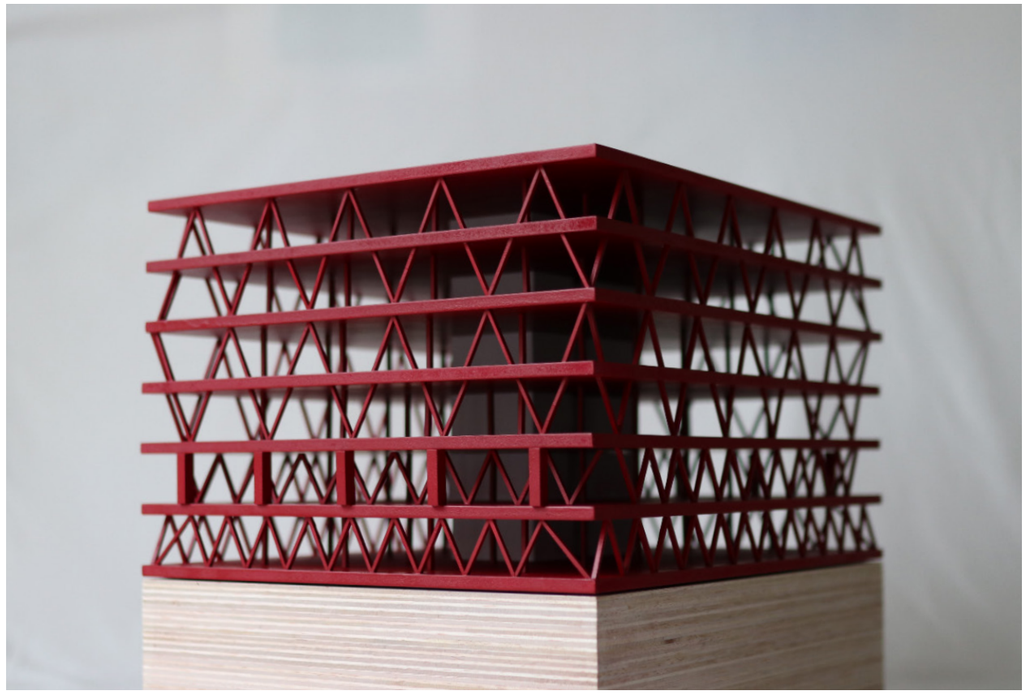
OVERTURNING MOMENT

**Load Forces Diagrams**
Diagrid Structural Assembly

## Physical Model Images







## Facade Elevation, Plan and Section 1:20

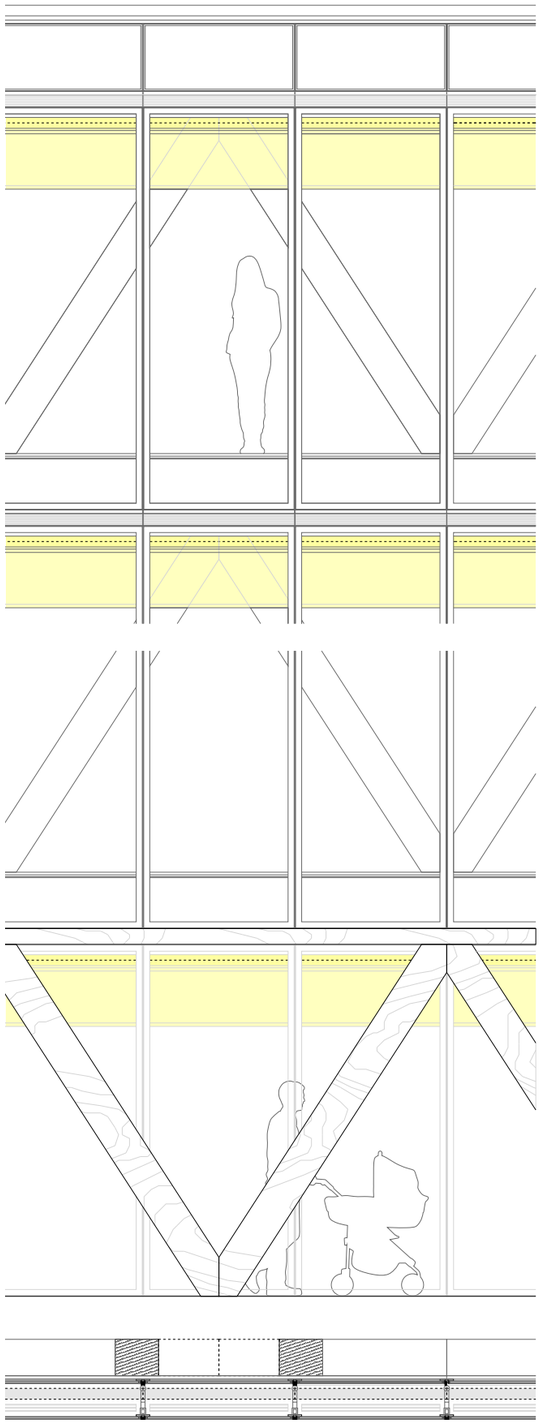
In order to embrace the necessity for modularity and flexibility, the patient wards (rooms) along with the medical machines (extend-able and shrinkable towers) are designed in modular elements which ensure the posibility of their reprogramming according to timely needs.

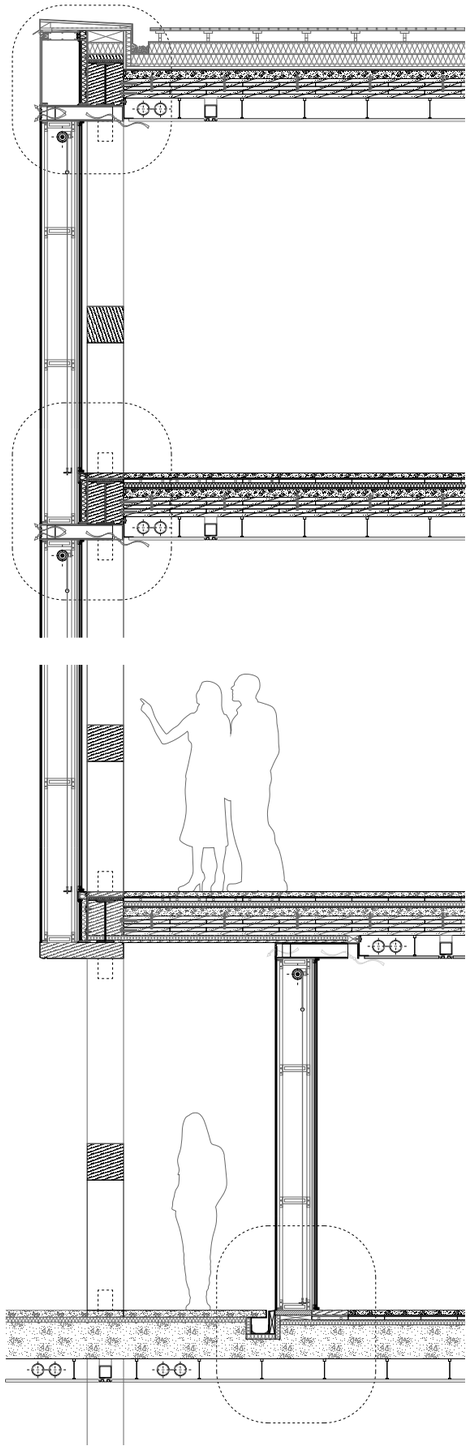
Built using Timber-Concrete Composite Floors and Ceilings (with 5-sheet CLT) and dray construction, the buildings are fully mountable and dismountable without the need for glueing joints.

This ensures a rapid building process along with the possibility to extend the use of the materials byond the building's life.









**Facade - Roof Detail**
1 : 5

Legend

1 Single Glazed Fixed Outer Skin (Reflective Coating), Cast Aluminium Mullions; 80mm Cavity

2 Double-Glazing (Inner Glass panes/weather line)
3 Schüco Ventilation System Ventotherm (Decentralised Facade Ventilation)
4 3mm Aluminium Parapet Capping with Metal Flashing, Air Cavity, Air, Water & Vapour Barrier

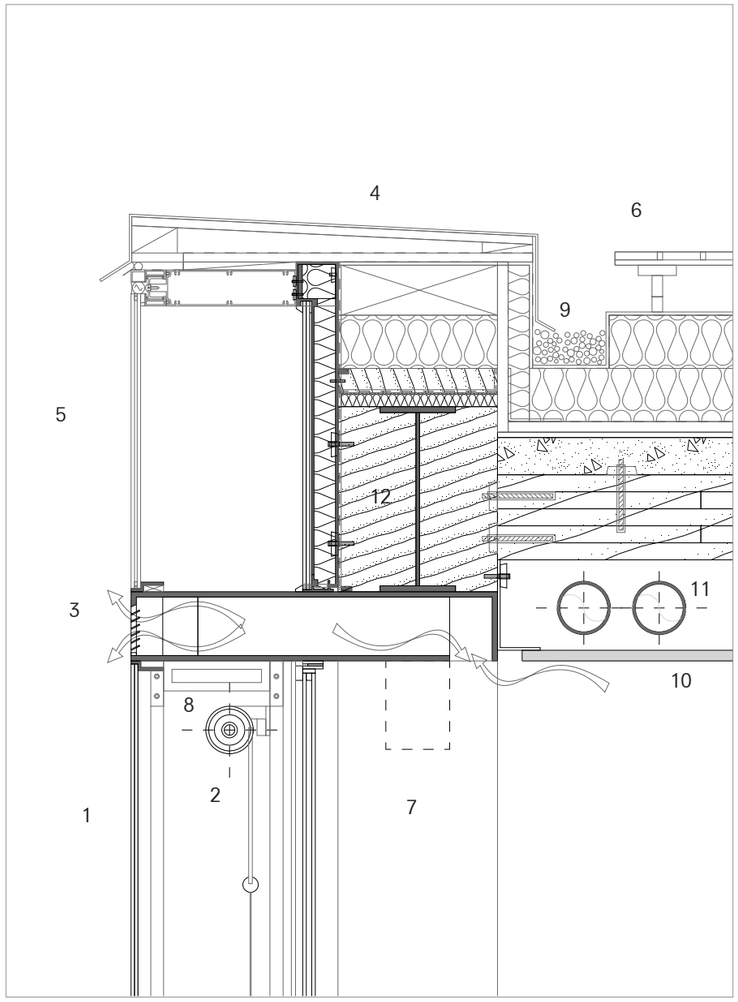
5 Single Glazed Fixed Outer Skin (Reflective Coating); 100mm Ventilation Gap; Aluminium Panel Cladding; Gypsum Board, 50mm Fibre Glass Insulation; Air, Water & Vapour Barrier; Rigid Insulation

6 Steel Roof Grating; RIgid insulation; Air, Water & Vapour Barrier; 2x 100m Fiberglass Insulation, Gypsum Board, Timber-Concrete Composite Floor (Concrete slab bolted into 5-layer CLT panel)

7 300mm Glue Lam Beam
8 Motorised Roller Blinds (Manual override) on tension rods
9 Gravel & Filter Fabric
10 Suspended Ceiling
11 Utilities Gap/Tolerance/Deflection Zone
12 Steel beam encased in Glue Lam Wood







**Facade - Floor Detail**
1 : 5

Legend

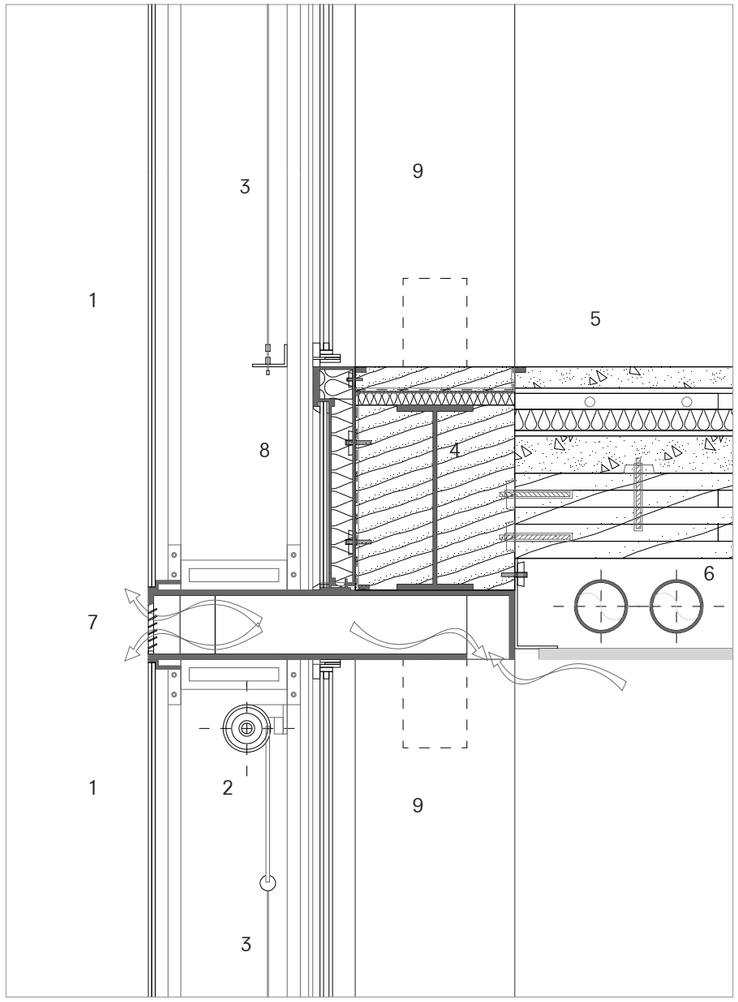
1 Single Glazed Fixed Outer Skin (Reflective Coating), Cast Aluminium Mullions; 80mm Cavity

2 Motorised Roller Blinds (Manual override) on tension rods
3 Double-Glazing (Inner Glass panes/weather line)
4 Steel beam encased in Glue Lam Wood
5 Concrete Flooring Screed; Heat Diffusion Foil; Modular Underfloor Heating Panels /10mm coils); 40mm rigid insulation; Timber-Concrete Composite Floor
6 Utilities Gap/Tolerance/Deflection Zone
7 Schüco Ventilation System Ventotherm (Decentralised Facade Ventilation)
8 Single Glazed Fixed Outer Skin (Reflective Coating); Aluminium Panel Cladding; Gypsum Board, 50mm Fibre Glass Insulation; Air, Water & Vapour Barrier; Rigid Insulation

9 300mm Glue Lam Beam







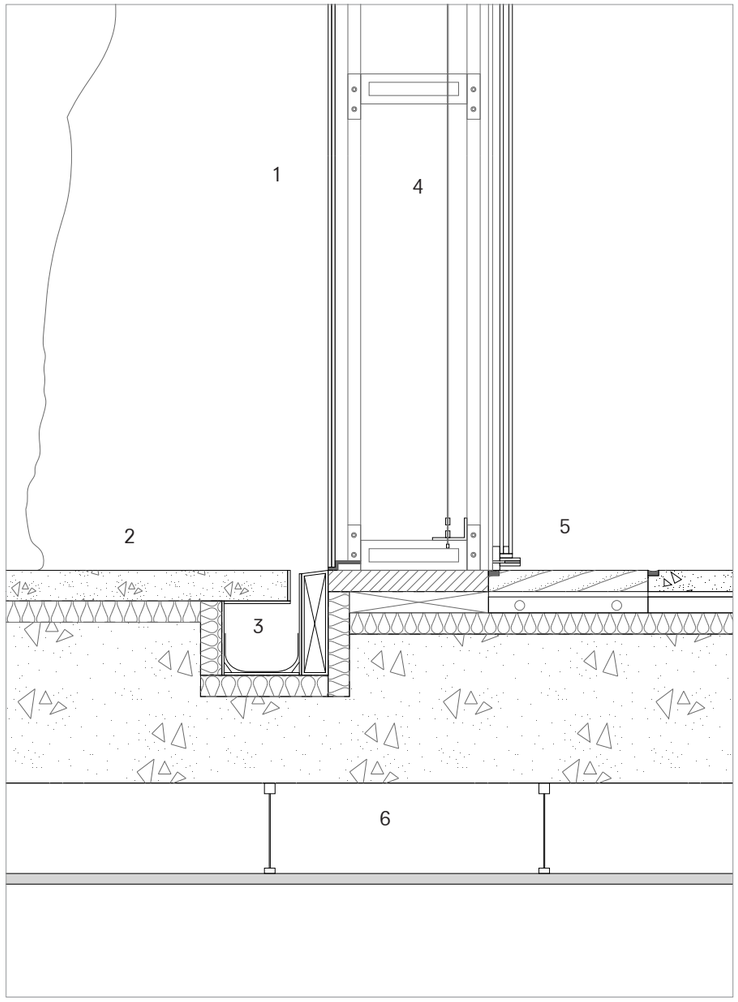
**Facade - Ground Detail**
1 : 5

1 Single Glazed Fixed Outer Skin (Reflective Coating), Cast Aluminium Mullions; 80mm Cavity

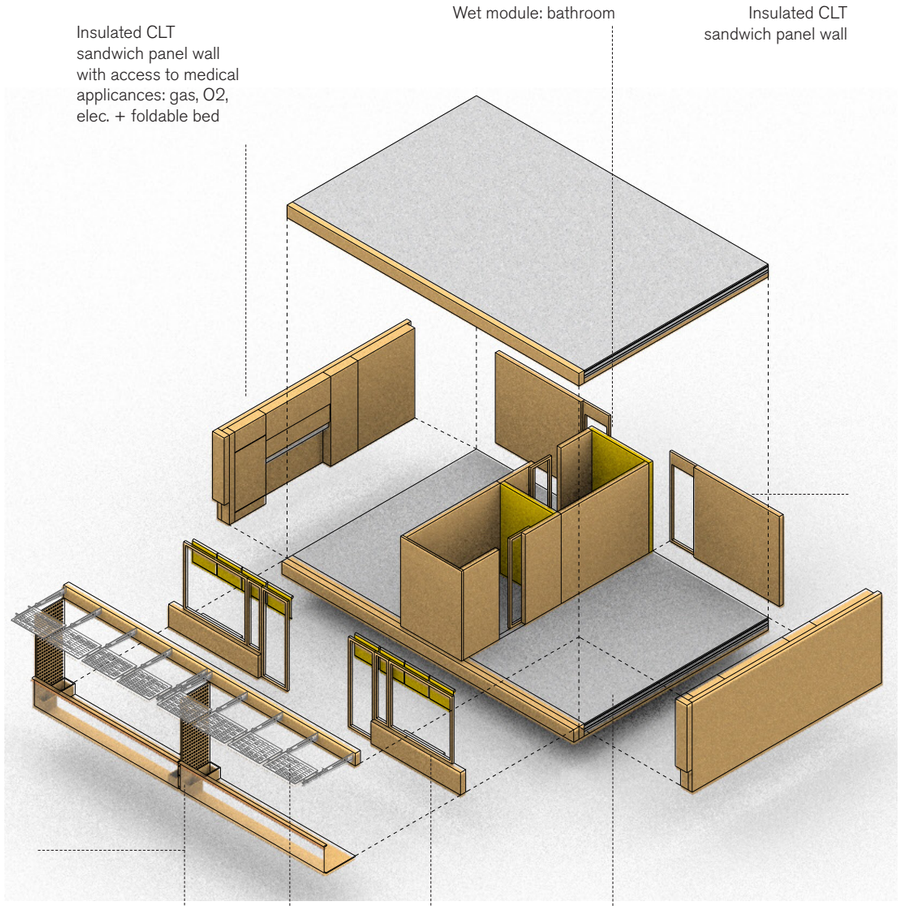
2 60mm Polished Concrete Floor Exterior Slab; Air, Vapour & Water Barrier; 40mm Rigid Insulation; 200mm Concrete Floor Slab
3 Hidden Drainage Gutter: Continuous Metal Gutter & Counterflashing supported on frame; 40mm rigid insulation
4 Double-Glazing (Inner Glass panes/weather line)
5 Concrete Flooring Screed; Heat Diffusion Foil; Modular Underfloor Heating Panels /10mm coils); 40mm rigid insulation; 200mm Concrete Floor Slab
6 Utilities Gap/Tolerance/Deflection Zone within Robotics Corridor







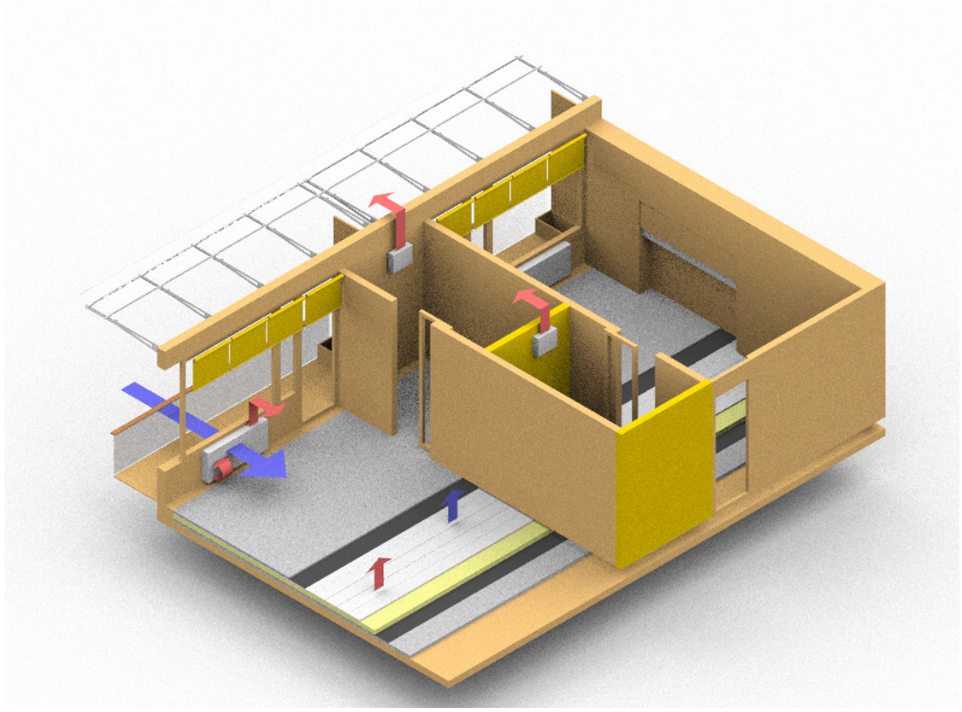
**Patient Wards Dry Construction Process**
Assembly Strategy








**Room Module**
Ventilation, Heating & Cooling



**Room Module (10.75 x 7.5 m)**

- Prefabricated unit including:

1. an activated assembled timber-concrete composite floor with disconnected elements (acts as roof as well) with modular underfloor heating panels
2. Insulated CLT sandwich walls
3. a wet unit (bathroom) with humidity sensor + extractor
4. prefabricated facade with mechanised shutters
5. attached balcony with visual + acoustic screen, planting unit, automate shading shutters and PV cell-incorporated glazed canopy

- Dry Construction
- Fast assembly

**Room Module**
1: 20 Section & Elevation


This elevation and section shows the guiding principle of modularity extended to the patient wards. In embracing CLT , concrete and Glue Lam as principle materials, the efficiency of the construction does not compromise the feeling of intimacy and warmth provided by the abundance of wood.






**Buildability**
Proof of Concept

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# Healthcare in Transition

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