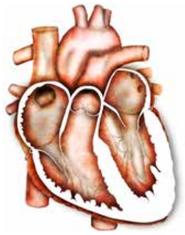
MYOCARDIAL AUGMENTATION FACILITY

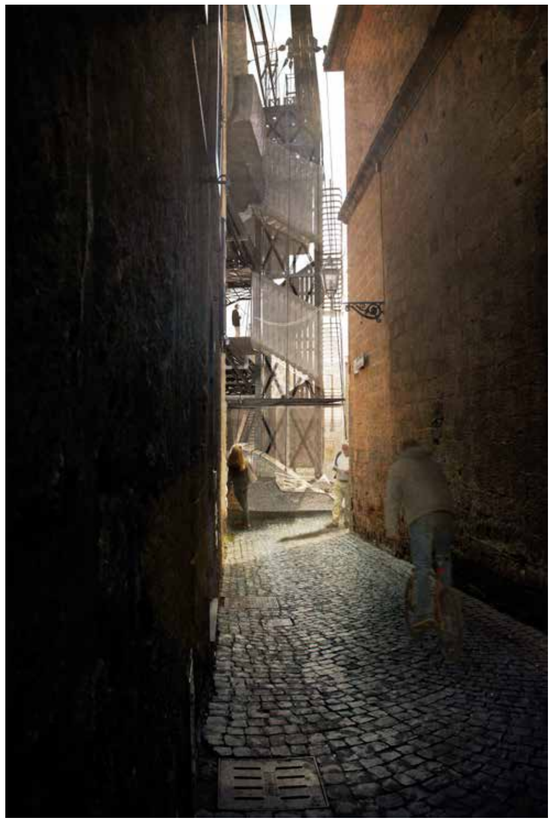
ORVIETO, ITALY

THOMAS BUSH



PROJECT DESCRIPTION

- The facility is for the treatment, mitigation and research of cardiological issues, based in the Italian hill top city of Orvieto.
- The project builds upon a scheme for cardio protection set out by the Commune of Orvieto, endeavouring to create a "cardiac protected city". This involves augmenting the population through medical, technological and architectural advancements.
- The facility is part of a network of health that modernises the emergency transport and response systems, through the employment of rapid transport networks and personal equipment given to the population.
- Integral to the design is the knowledge that the medical topology is an ever-shifting one; the design extends the longevity of the building through the use of a modular system of spaces that can be updated alongside medical advancements.
- The design uses principles from biomimicry alongside allegorical references to the human body, to construct the systems of spaces and structures that comprise the facility.



Anaesthetic tubing offset: light bathes the patient.

SOCIAL UNDERPINNING

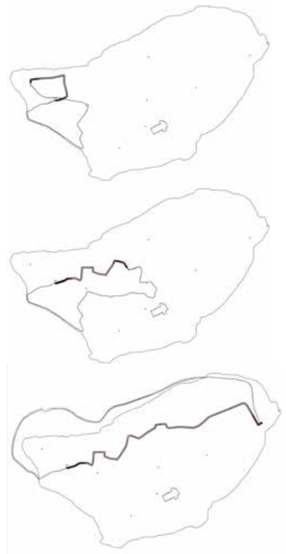
The hill top town of Orvieto in Italy is one of a few towns that is a is "Cardiac Protected City" it protects its population through education and training, along with the placement of 11 automated external defibrillators in the most public areas of the city, with many more placed in private premises such as shops and restaurants, this social policy promoted and moulded the generation of the brief/facility.

AMBULANCE JOURNEY TIMES

These are the journey times to certain defibrillator units, indicating the time it takes to go the point and back to the facility. The city's layout can impede the ability of ambulances getting to patients in need of treatment.

The first hour of treatment is the most critical, so by reducing the amount of time taken to recover the patient, and by decreasing the response time, the chances of recovery are increased, this is the reason for the implementation of the health network, monitoring and recovering the people of Orvieto should they require it.

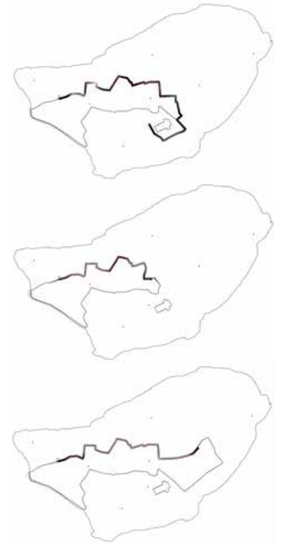
The time is the overall journey.



OVERALL TIME: 17
DISTANCE: 1.3MILES

OVERALL TIME:18
DISTANCE: 1.4 MILES

OVERALL TIME: 23
DISTANCE: 2.5 MILES



OVERALL TIME: 20
DISTANCE: 1.9 MILES

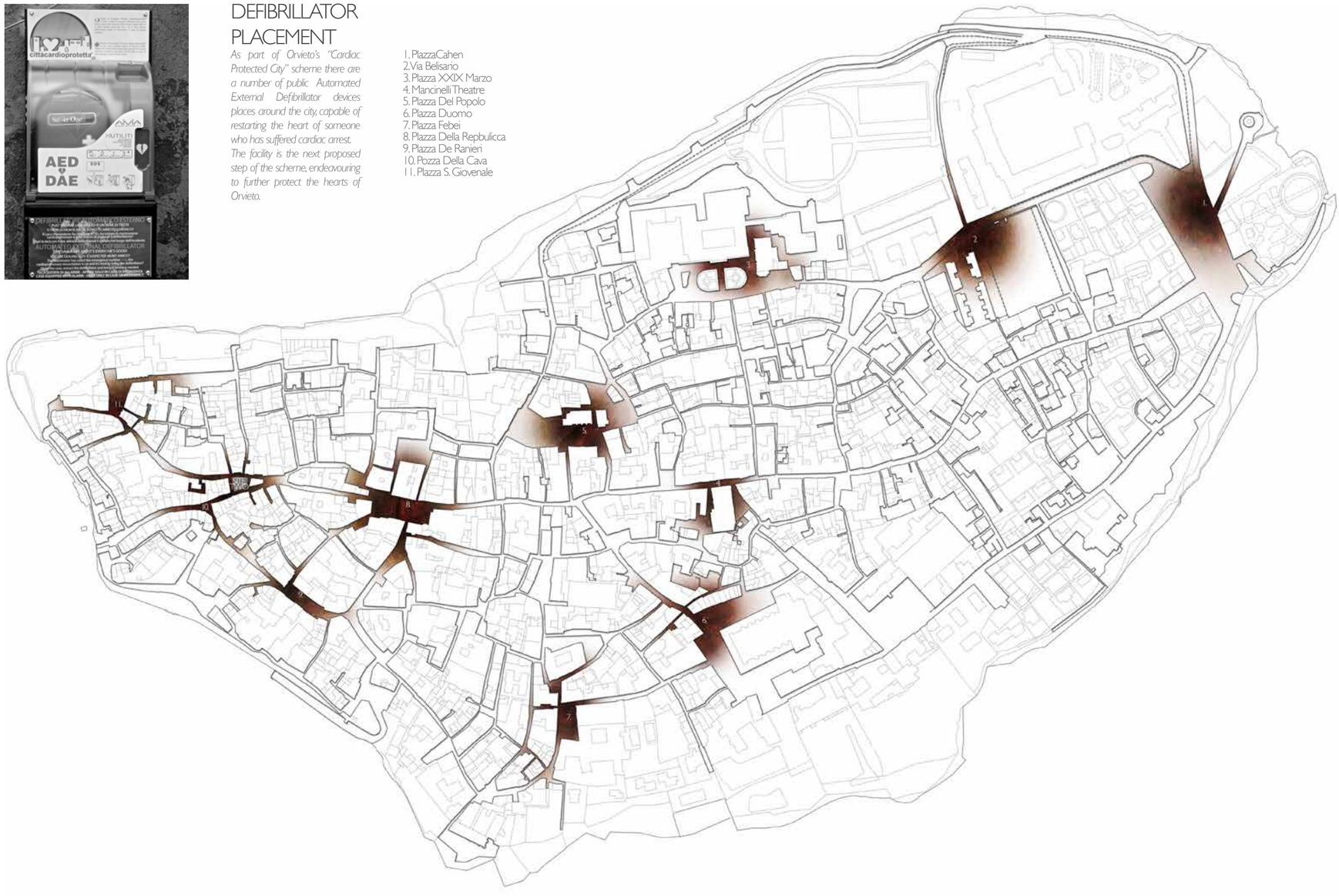
OVERALL TIME: 18
DISTANCE: 1.5 MILES

OVERALL TIME: 20
DISTANCE: 1.8 MILES

DEFIBRILLATOR PLACEMENT

As part of Orvieto's "Cardiac Protected City" scheme there are a number of public Automated External Defibrillator devices places around the city, capable of restarting the heart of someone who has suffered cardiac arrest.
The facility is the next proposed step of the scheme, endeavouring to further protect the hearts of Orvieto.

1. PiazzaCahen
2. Via Belisario
3. Piazza XXIX Marzo
4. Mancinelli Theatre
5. Piazza Del Popolo
6. Piazza Duomo
7. Piazza Febei
8. Piazza Della Repbulicca
9. Piazza De Ranieri
10. Pozza Della Cava
11. Piazza S. Giovenale



CONCEPTUAL UNDERPINNING:

The concept comes from the idea of medicine being a process of augmenting people, extending and increasing the quality of their life. It also comes from the way in which the population of Orvieto have augmented their city to suite their needs and requirements, this is through the creation of caves underneath their properties, to use as storage and shelter through times of siege and hardship.
This elevates the city from merely just a piece of rock to something that has been improved and moulded by the people of the city.

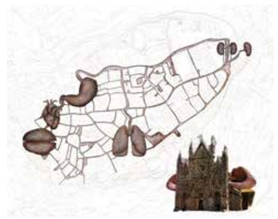
PRINCIPLES:

PEOPLE AUGMENT THE CITY

The people augmented the city by the creation of the caves. This elevates the city from merely just a piece of rock to something that has been improved, moulded by the people of the city.

§The caves allowed the people to store food and drink and offer them protection from outside dangers.

THE CITY IS A BODY



The city is a body, the buildings and spaces made up like organs. It is a complex system connected to a series of passageways that allow flow in both directions. The spaces of the city have different effects, they force the user to feel different things to perceive the spaces in different ways.

AUGMENTATION IS ACHIEVED THROUGH USING MACHINES AND TECHNOLOGIES

Augmentation is the strengthening, or improving, of an existing object. This could be through the use of machines or technology. Medicine would be an example of technology. An example of a machine would be something the user wears which improves them.

HUMANS RAISING MACHINES FROM OBJECTS TO INSTRUMENTS OF LIFE

If a person inhabits the machine then it changes the object, it elevates it to an instrument of life. It is a literal mind into the machine. The building itself could be seen as a machine, serving its purpose. It is made into something more by the human interaction it has.

ABSTRACTION:

MEDICINE

Medicine is a process of augmentation. Using chemicals, knowledge and treatment to improve the human body, be it improving the flaws that it was born with or flaws that have been gained through the years of use of the body.

AUGMENTATION

Augmentation is the process of improving an already constructed system, this system can be improved or strengthened by the renewal of parts, or the changing of the systems intent and use, or by the introduction of a device or system which takes control of this function or supplements this.

IMPROVEMENT

For a system to be improved then it needs to be accessed.
Within this assessment conclusions can be drawn about the augmentations available for the system and the best way to implement these new improved systems into the original.

TO PROTECT

The need to improve and develop is derived from the want and need to survive, it is to protect the system from loss, damage and destruction.

The natural evolutions of a system includes its own ability to help itself to survive and thrive in whatever way possible.

THE SYSTEM

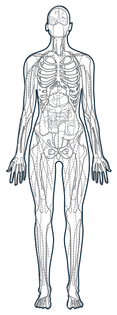
The system in question is the human body, a series of complex biological subsystems that work in a holistic manner to comprise the whole, where you can not alter one without impacting on others. In a process called Homeostasis.

AUGMENTED HUMAN

There will be a system of assessment put in place. It will monitor the human systems to assess points for augmentation. It will be worn by the individual and report data back to central unit which will process and analysis this data, making notes for augmentation.

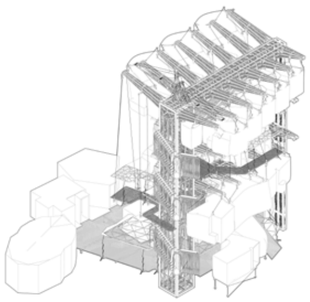
ALLEGORY:

Here shows the allegory employed in the design of the facility, it takes the essence of the thing its augmenting, the human body, mimicking the way the system within the body work together to form the organism as a whole the building also does the same.



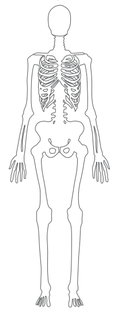
THE BODY/THE FACILITY

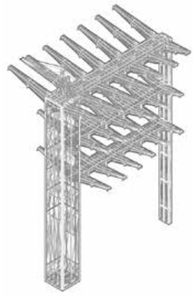
The whole, comprised of sub-systems that work symbiotically to create the overall entity. >



THE SKELETON/ THE STRUCTURAL FRAME

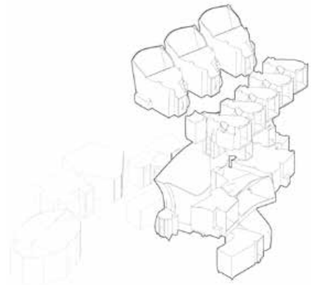
From which everything in body/facility hangs from. >





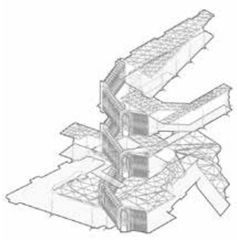
THE ORGANS/ THE MODULES

A self contained part of the body/facility, they perform specific functions >



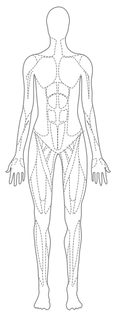
THE CIRCULATION

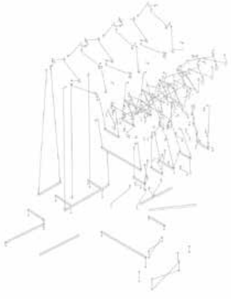
For the transportation of entities through the whole system, connecting all the system together. >

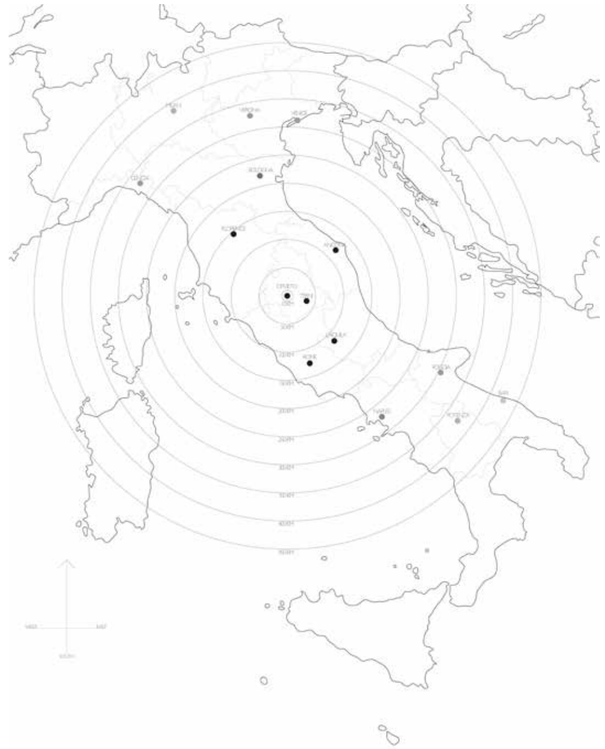


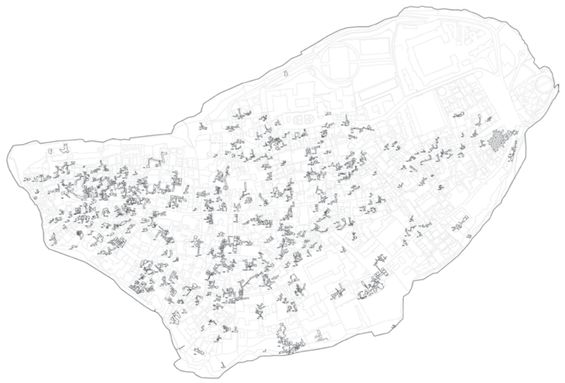
THE MUSCLES & LIGAMENTS

For the structural jointing, holding all the units of the system in place. >









CAVE NETWORK

There are a substantial number of caves that have been hollowed out by thousands of years' worth of inhabitants.They date back the Etruscan era, they have been integral to the architectural language of Orvieto, they have been used as stores, churches, olive oil presses and as places of shelter during periods of attack. It seemed only logical into integrate them into the design of the facility.

TOPOGRAPHY

The area of Umbria that Orvieto is located in was formed tens of thousands of years ago by volcanic activity, the resulting landscape is one of extreme verticality, it creates an area of isolation for Orvieto, which in the past protected it from siege and invasion, but now presents issues for the access to healthcare by its inhabitants.

PLACE

Orvieto is located in the heart of Italy, one of only four provinces in Italy that is not bordered by the sea.
Italy located in the centre of Europe is know for its rich cultural history with its Roman heritage, that is evident through nearly all of its architecture.

PLACE AND CONTEXT

CONTEXT

The city of Orvieto acts as a architectural palimpsests, with space being a commodity in the city, buildings were rebuilt and remodelled across the years creating a rich articulation in the architectural grammar of the city, that spans from the commanding Duomo, to the smaller more delicate churches from the Etruscan period, to the adorned palazzos that over looks spacious piazzas.

1 Recovery Area
Where patients recover after undergoing minor treatments or operations.

2 Treatment and Consultation
Where consultations with medical professionals take place, along with some assessment procedures.

3 Population Monitoring Booth
Where the data from the cardiac devices is analysed as part of the early warning system protecting the population of Chiasso.

4 Computer Server
Where the raw data from the cardiac devices are collated and storage primary database, to then be verified by users of the monitoring rooms.

5 Laboratory
Where the tests required by doctors are carried out to diagnose problems, and where cardiac research takes place.

6 Surgical Preparation
Where patients are prepped before undergoing operations.

7 Operating Theatre
Where all the surgical procedures happen within the facility.

8 Toilet
A disabled toilet.

9 Catheterization Laboratory
One of the newest of cardiac assessment available at the facility.

SECTION AA

3RD FLOOR PLAN- TREATMENT AND RECOVERY AREA.

1: TREATMENT/CONSULATION AREA
2: RECOVERY ROOM
3: TOILET
4: LIFT

VIEW 1

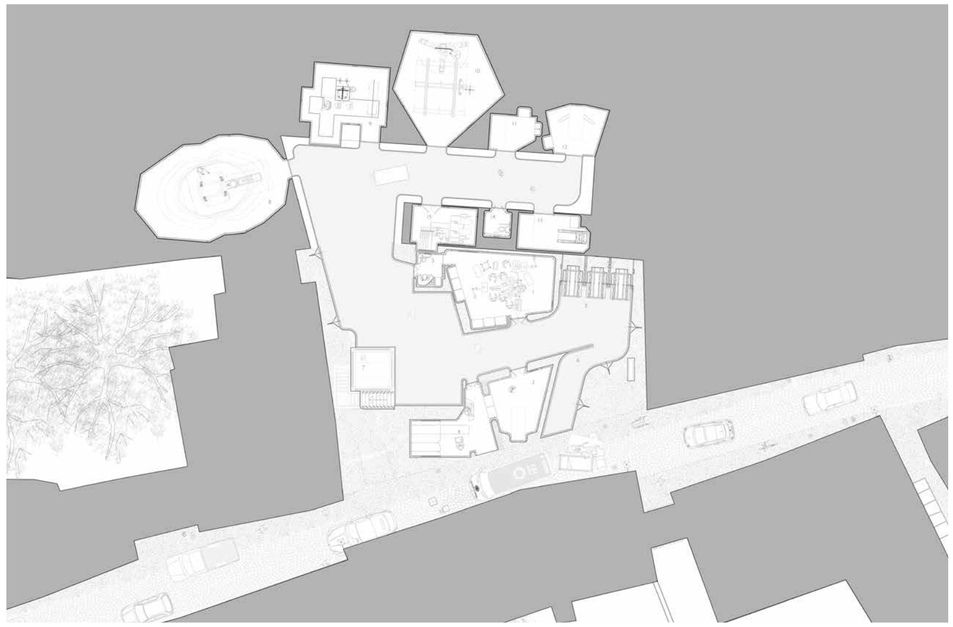
View 1. The recovery space.

2ND FLOOR PLAN - POPULATION MONITORING SYSTEMS

1:COMPUTER CORE
2: MONITORING STATION
3: LIFT

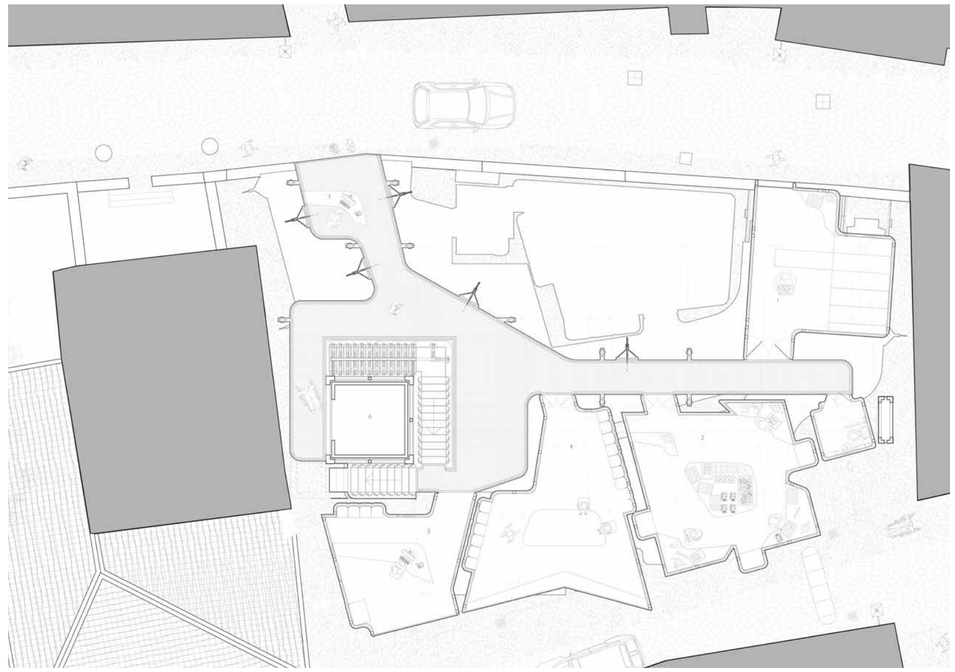
GROUND FLOOR PLAN - SURGICAL AND ASSESSMENT AREAS.

1: OPERATINGTHEATRE
2: SURGICAL PREP
3: SCRUB ROOM
4: MEDICAL STORE
5: TRANSPORT TUBETERMINUS
6: AMBULANCE DROP OFF
7: LIFT
8: MRI
9: X-RAY
10: CATH LAB
11: ECG
12: PHLEBOTOMY CLINIC
13: MONITORED EXERCISE
14:TOILET



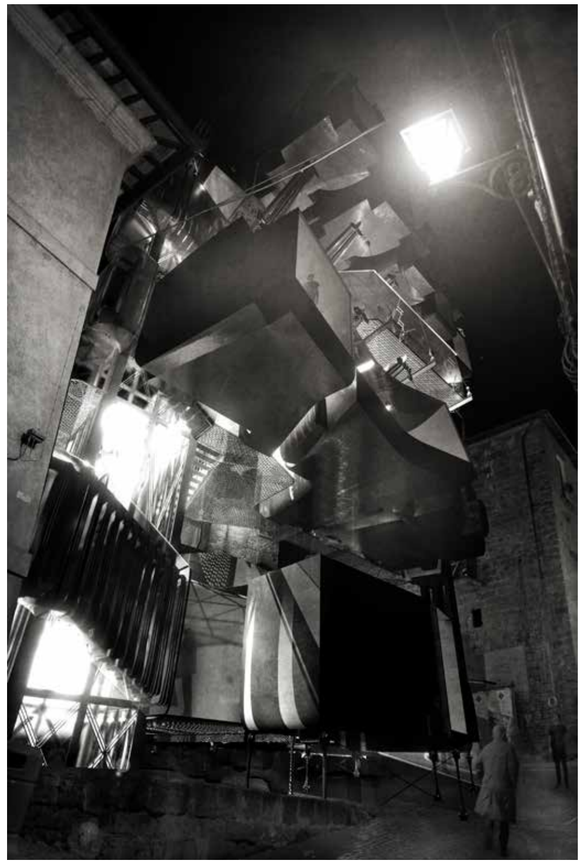
1ST FLOOR PLAN- LABORATORY AND CLERICAL AREAS

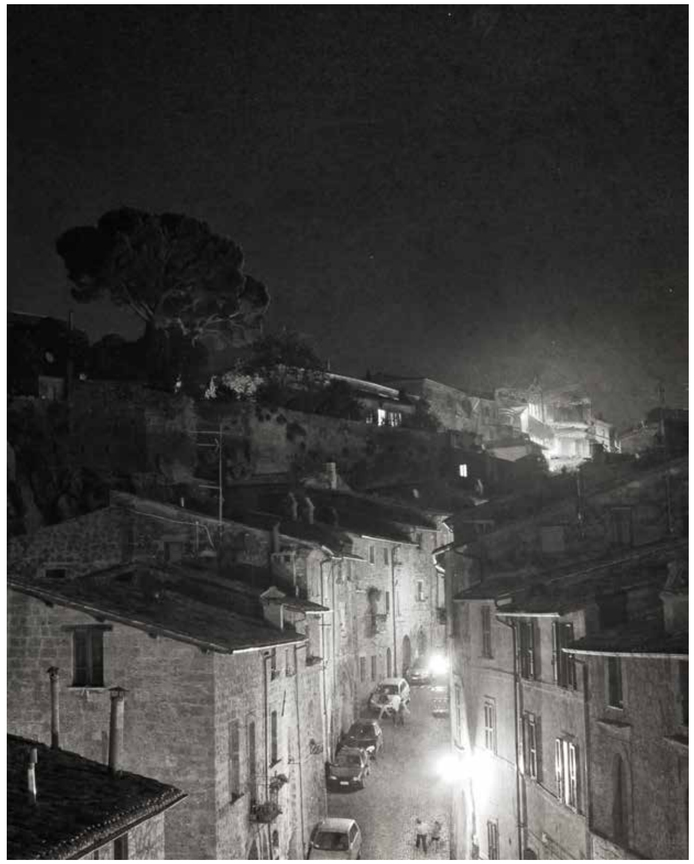
1: STORAGE AND DELIVERY BAY
2: LABORATORY
3: RECEPTION
4: STAFF ROOM
5: OFFICES
6: LIFT



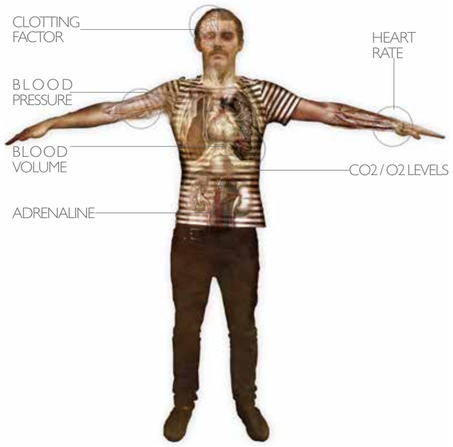
THE FACILITY AT NIGHT

The building acts as a becon to the surrounding area, it shows the community of Orvieto that they are protected, the building is augmenting the cities ability to care for it ocupants.

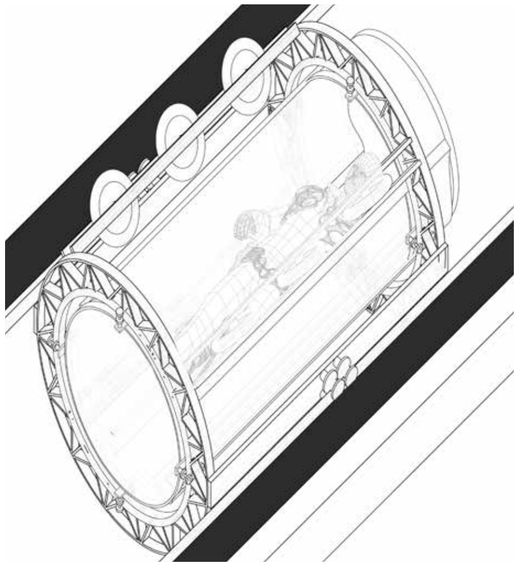




AUGMENTING THE POPULATION OF ORVIETO

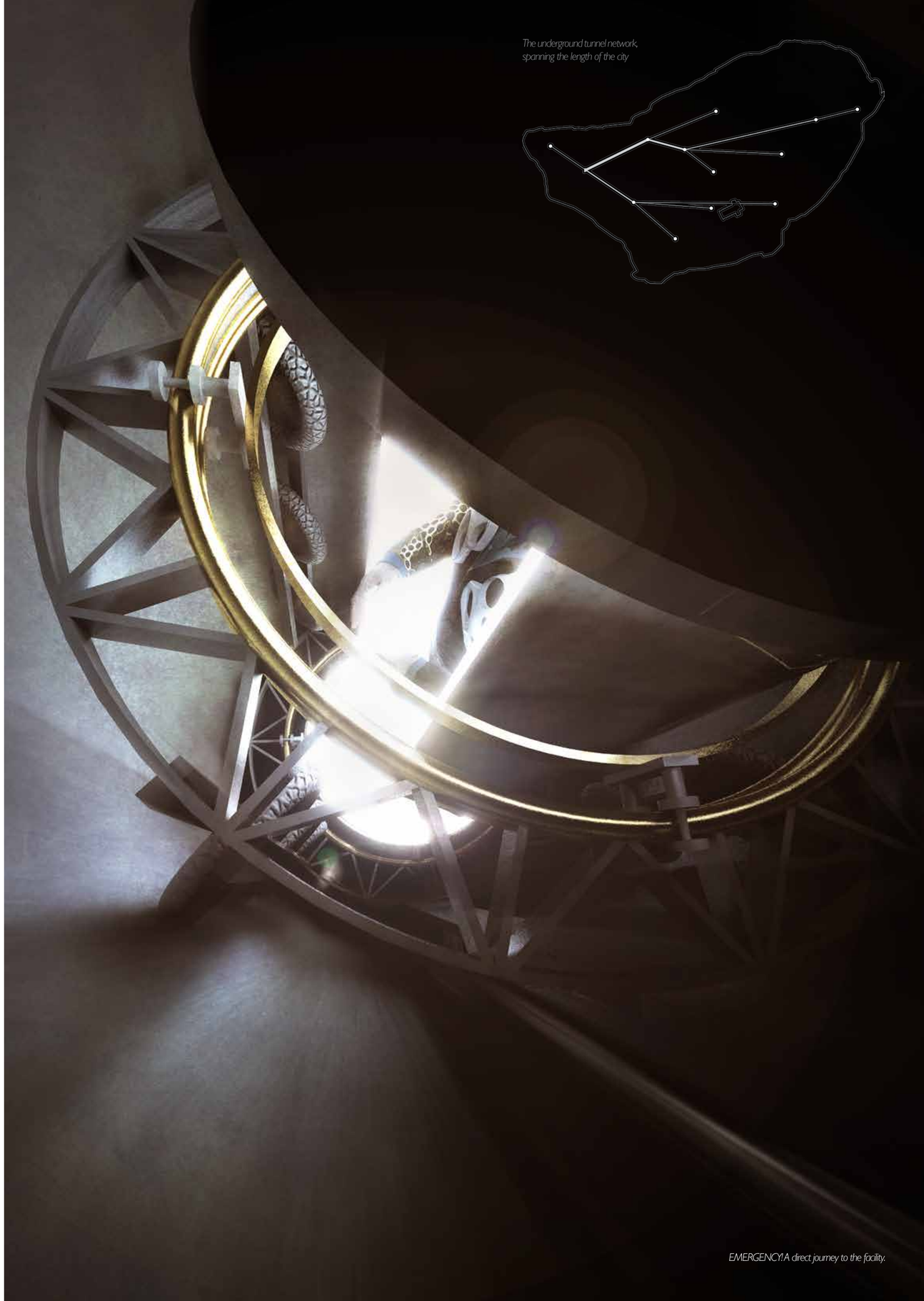


The population of Orvieto are directly augmented by the facility by wearing these bands, they are able to be constantly monitored for any cardiac related issues, and should any issue arise they are rushed to the facility.



The augmented ambulance, an exoskeleton, augments the patient if they become ill, it is able to run them to a tunnel network point to allow quick transportation to the facility to create the most positive survival rates.

Here shows a rescue scenario for a member of the population of Orvieto. They start to have a heart attack, the augmented device fitted to the wrist detects this. This information is relayed back to the facility and it sends the nearest ambulance unit to intercept. The ambulance picks up the individual by contorting itself around the body and acting as an exoskeleton it propels the user to the nearest entry point for the underground rescue tunnels. Whilst en route it is able to perform mitigating medicine such as to reduce the user's stress levels through sedation, to give anticoagulated medication and supplement with more blood.



The underground tunnel network, spanning the length of the city

EMERGENCY! A direct journey to the facility.

MEDICAL DEVELOPMENT TIME LINE

This shows the rate at which the field of medical science progresses, showing how quickly medical practise changes and augments itself.

TOPOLOGY SHIFTS

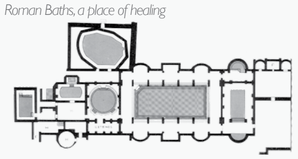
MEDICAL/ SCIENTIFIC ADVANCES

CULTURAL EVENTS

TIME

420 BC Asclepeion, Healing Temple

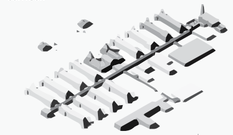
4 Century
Roman Bath's, a place of healing



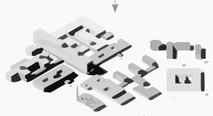
1671 L'Hôtel national des Invalides

1902 Germany introduces hospital train

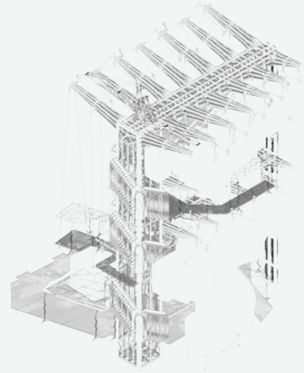
Pre 1945 - hospital centralised around a central corridor.



1965 Le Corbusier, The Venice Hospital



2000 a return to a centralised corridor



Myocardial Augmentation Facility

1500 BC - Egyptian medical text, the oldest known surgical treatise

510 BC - First scientific anatomic dissections

420 BC – Hippocrates of Cos maintains that diseases have natural causes and puts forth the Hippocratic Oath. Origin of rational medicine.
400 BC – Discovery of veins and arteries

280 BC – Discovery of the nervous system
250 BC – Discovery and differentiation of the brain, heart and eyes, and in the vascular, nervous, respiratory and reproductive systems.

400 - The first hospital in Latin Christendom was founded in Rome

1242 - Discovery of pulmonary & coronary circulation

1439 - Printing Press Invented

1500 - Century pioneers the use of chemicals and minerals in medicine.
1511 - Da Vinci documents the anatomy
1518 - Royal College of Physicians of London Founded
1546 - Proposal that epidemic diseases are caused by transferable seed like entities
1553 - The circulation of blood through the lungs is documented.
1556 - The use of values in veins is documented

1674 – Bacteria Discovered

1736 - First successful appendectomy
1744 - First surgical periodical
1747 - Discovery that citrus fruits prevent scurvy
1758 - Electricity discovered
1774 - The discovery of nitrous oxide and oxygen
1796 - Small pox vaccination method discovered
1799 - Anesthetic properties of nitrous oxide discovered

1816 - Stethoscope invented
1818 - First successful human blood transfusion
1827 - Anti-septic surgery technique developed
1842 - First surgical operation using anesthesia
1858 - Gray's Anatomy First Published
1876 - Telephone Invented
1879 - First vaccine for cholera
1879 - Light bulb invented
1881 - An anthrax vaccine developed
1882 - Rabies vaccine developed
1892 - Viruses discovered

1900 - First motorised ambulance
1901 - Different human blood types discovered
1903 - Electrocardiography (ECG/EKG) created
1921 - Insulin discovered
1921 - Epidural anaesthesia developed
1923 - First vaccine for Diphtheria
1926 - First vaccine for Pertussis
1927 - First vaccine for Tuberculosis
1927 - First vaccine for Tetanus
1928 - Penicillin discovered
1943 - Dialysis machine invented
1943 - First Electric Computer
1944 - Disposable Catheter invented
1946 - Chemotherapy developed
1947 - Defibrillator invented
1952 - Cloning developed
1953 - Heart-Lung Machine invented
1953 - Medical Ultrasonography invented
1954 - First human kidney transplant
1958 - Pacemaker invented
1959 - In Vitro Fertilization developed
1960 - Invention of Cardiopulmonary resuscitation (CPR)
1963 - Artificial Heart invented
1963 - First human liver transplant
1963 - First human lung transplant
1965 - First portable defibrillator installed
1967 - First human heart transplant
1968 - Powered Prothesis created
1969 - Internet created
1969 - Balloon Catheter invented
1970 - First effective immunosuppressive drug
1971 - Magnetic Resonance Imaging (MRI) invented
1971 - Computed Tomography (CT or CAT Scan) invented
1981 - First human heart-lung combined transplant
1985 - Surgical Robot invented
1988 - Intravascular Stent developed
1989 - Pre-implantation Genetic Diagnosis (PGD) developed
1998 - Stem Cell Therapy developed

2000 - Human Genome draft completed
2001 - Artificial liver created
2007 - Visual prosthetic (bionic eye) created

2013 - First baby cured of HIV
2013 - First kidney grown in vitro
2013 - First liver grown from stem cells

2015 - Aids cure available for all
2020 - Cure for cancer discovered
2025 - Hand Held MRI Scanners invented
2030 - 3D printed organs become common place
2035 - First human successfully cloned
2040 - Genetically modified humans are researched
2045 - Fusion power is used to power the national grid
2050 - Mechanically/genetically augmented humans become common
2055 - Artificial intelligence is invented
2056 - Biological building invented
2060 - Mars Colony settled
2065 - Genetic coding for agelessness is discovered
2070 - Robotic doctors invented
2075 - Cybernetic human interface created
2080 - Space colony created

753 BC
Rome is founded

430 BC
Plague of Athens

0 AD
Birth of Jesus

1340
The Black Plague

1492
The Americas discovered

1914 First World War

1939 Second World War

1945 Atomic Bomb Dropped on Japan

1947 Cold War

1969 First man on the moon

2020 - First War for water

2040 - Clone riots

2050 - Fossil fuels run out

2060 - The robot riots of Brixton

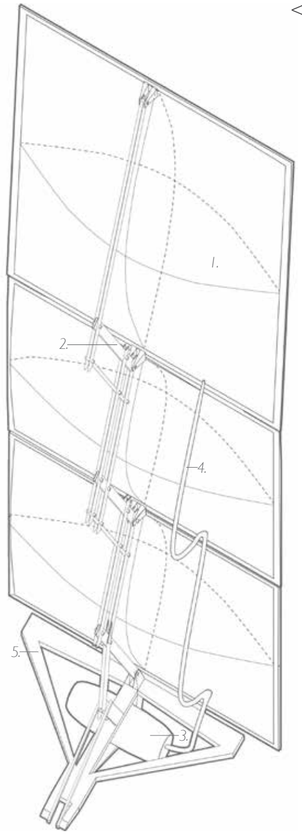
2062 - The world population reaches 10 billion

1500 BC | 500 BC | 400 BC | 200 BC | 0 AD | 400 | 1200 | 1400 | 1500 | 1600 | 1700 | 1800 | 1900 | 2000 | 2013 The Future

Coming round from a general antithetic, the Italian sun starts the recovery process

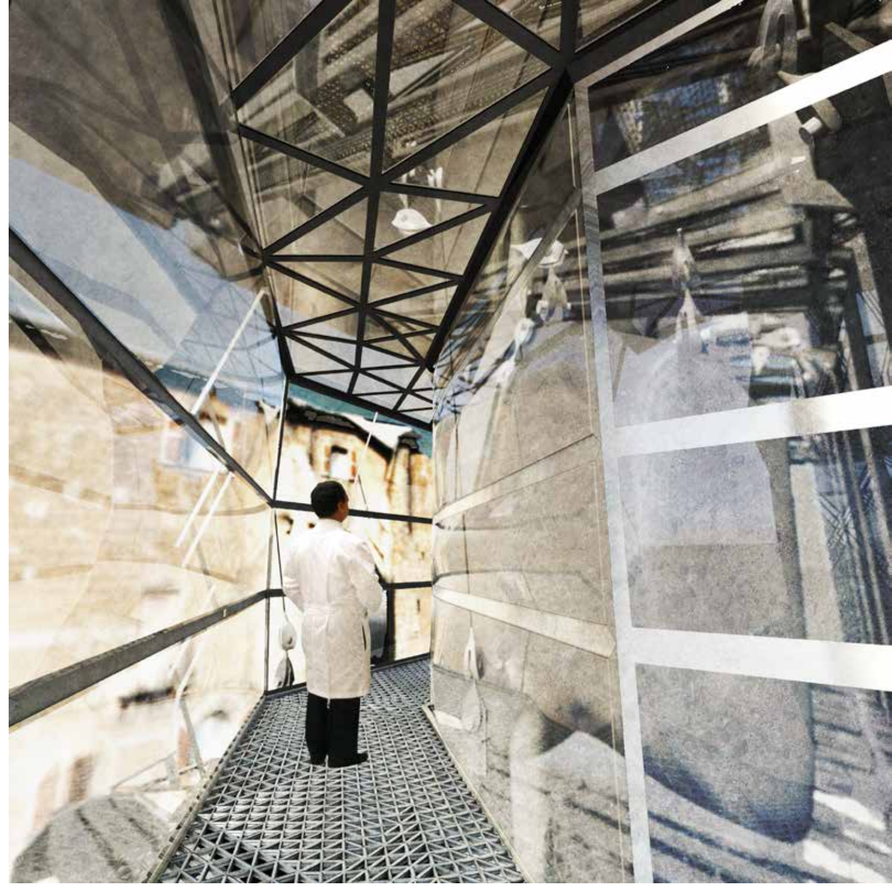
DYNAMIC SKIN AUGMENTING THE CIRCULATION

The skin of the building is much like the human skin, an adaptable surface, changing the internal conditions of the entity, striving to create the most favourable temperature condition.

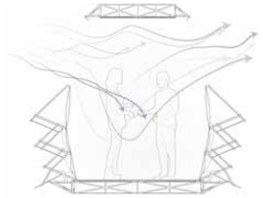


<A detail showing how the canopy mechanism is comprised.

1. ETFE Pillow
2. Mechanical Arm
3. Air Compression Unit
4. Air Tube
5. Fixture Unit

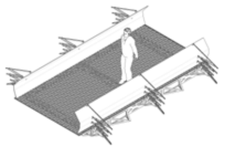


A series of diagrams showing the canopy augmenting the internal environment of the building by adapting for the most favourable condition for the user. V

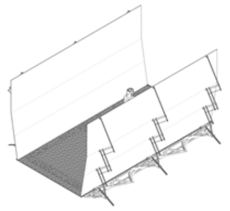


<The canopy opens to allow for passive cooling of the building.

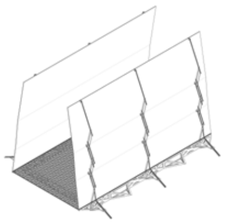
V *Open position*



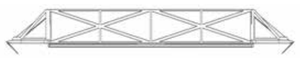
V *Mid-deployment*

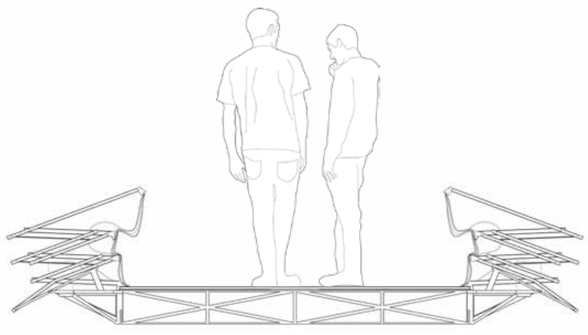


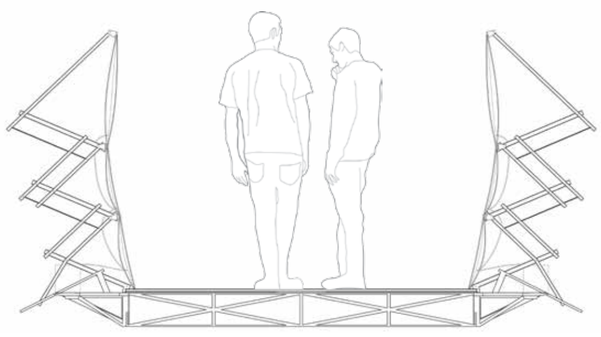
V *Closed Position*

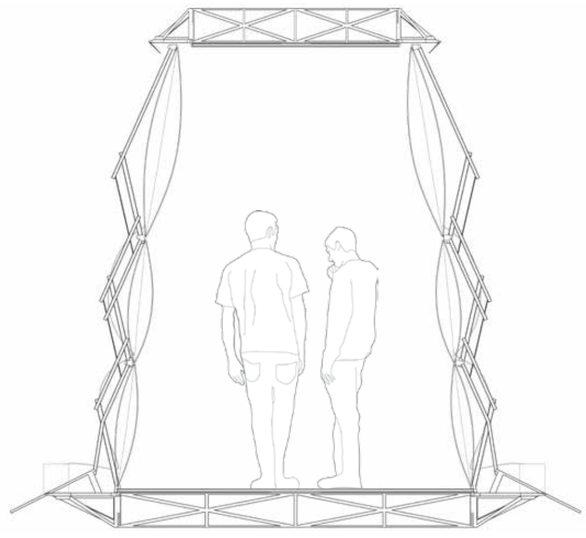


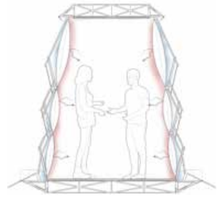
<The canopy has reflected fritting, to reduce the amount of solar gain.





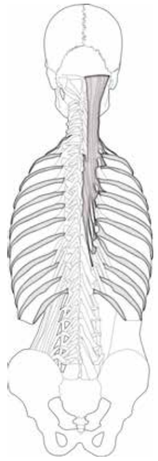






<The ETFE pillows create a insulating barrier allowing for heat retention when required.

TECHNICAL DETAILING

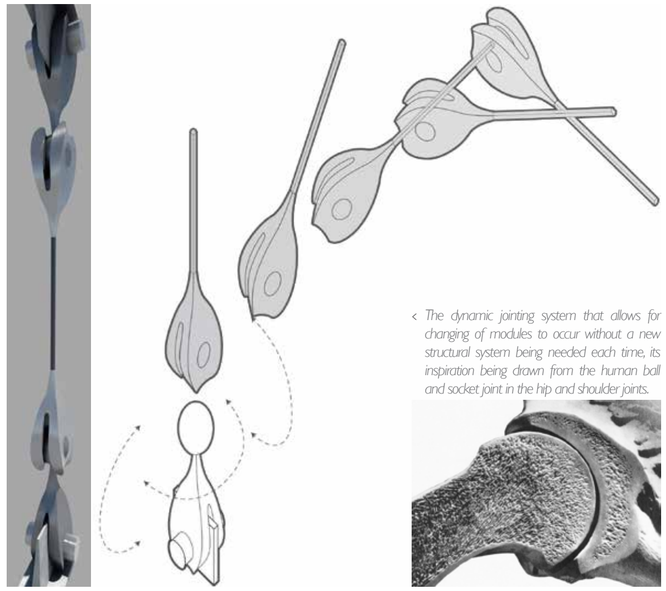


The inspiration behind the design for the structure of the building comes from studying the structure of the human body.The skeleton is the structural frame of body, from it everything else hangs. The skeleton has adopted to be the most structurally efficient it can be with the least material.

So, from this the design has attempted to do something similar, with a steel skeleton as the main structural element of the building, comprised of a central spine and ribs that allow for the modules to be suspended.

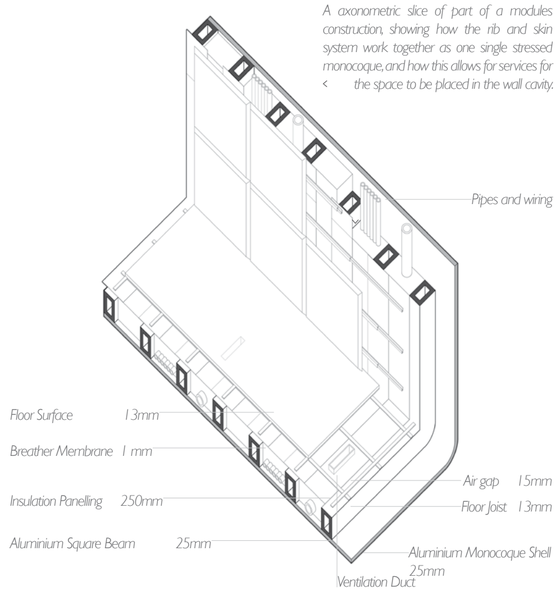
The structure of bones gives rise to the structure of the modules. They are structurally efficient, using a stressed outer surface of dense material working in combination with internal structure of less dense material it forms what can be described as a monocoque. Which uses the least amount of material it can, and still, performs is structural function.This gives the inspiration to make the modules of the building out of single sided monocoque. Making it light and structurally efficient.

The jointing system can be seen like the ligament or muscle system that by using tension keeps the modules in place.

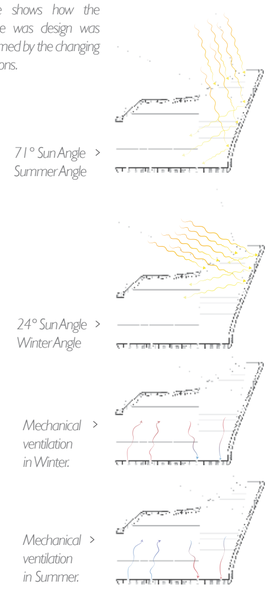


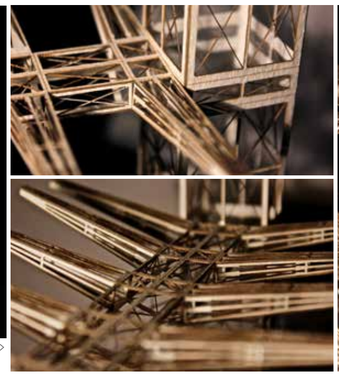
< The dynamic jointing system that allows for changing of modules to occur without a new structural system being needed each time, its inspiration being drawn from the human ball and socket joint in the hip and shoulder joints.

A axonometric slice of part of a modules construction, showing how the rib and skin system work together as one single stressed monocoque, and how this allows for services for the space to be placed in the wall cavity. >

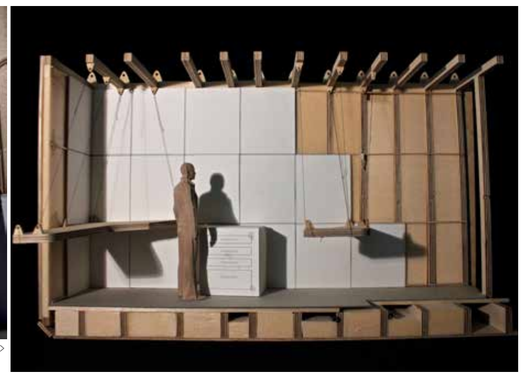


Here shows how the space was design was informed by the changing seasons.





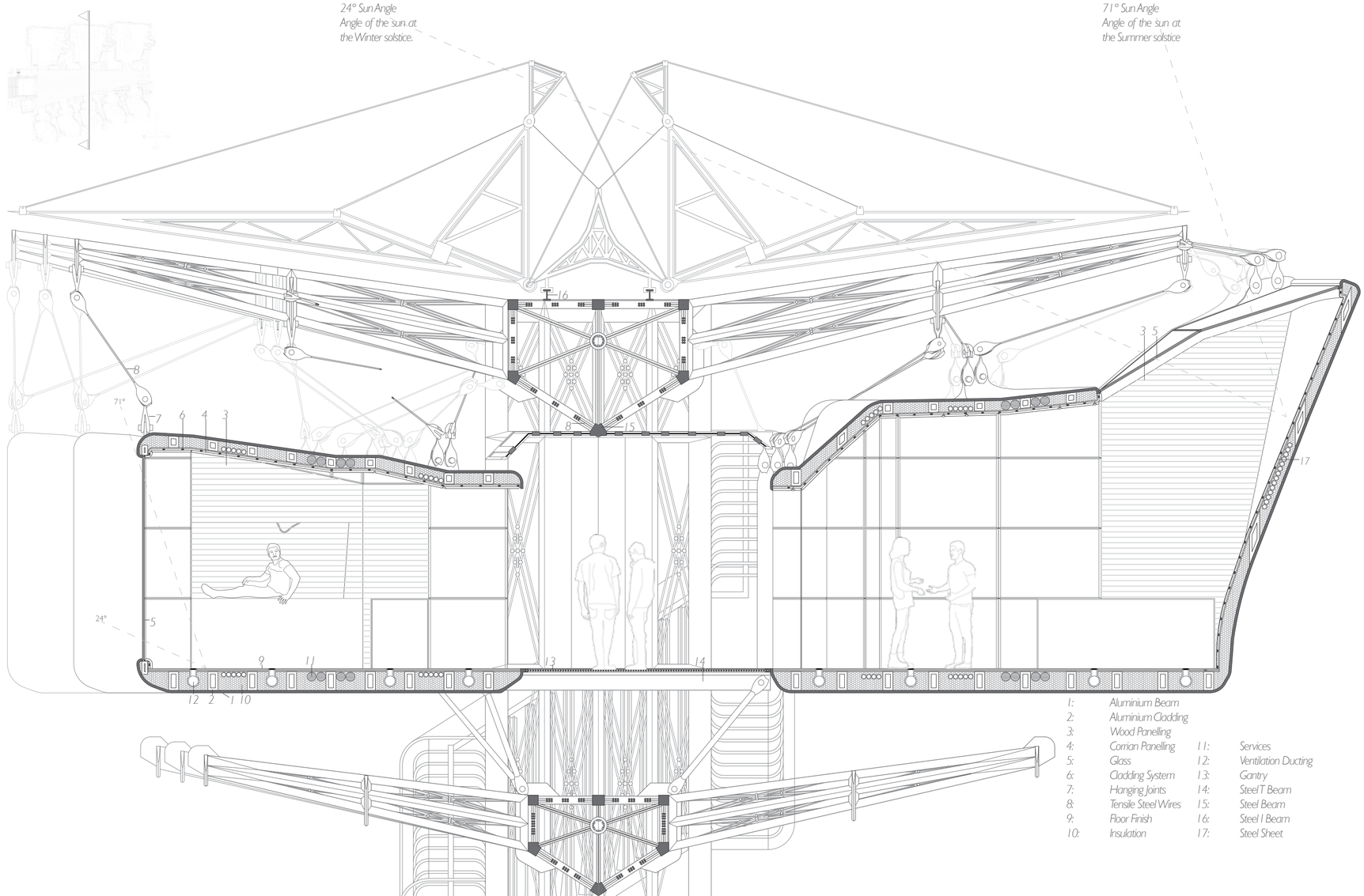
1:100 Model of the primary structure of the facility >



1:10 Model of the Laboratory module, > showing the monocoque design.

24° Sun Angle
Angle of the sun at the Winter solstice.

71° Sun Angle
Angle of the sun at the Summer solstice



1:	Aluminium Beam		
2:	Aluminium Cladding		
3:	Wood Panelling		
4:	Corrian Panelling	11:	Services
5:	Glass	12:	Ventilation Ducting
6:	Cladding System	13:	Gantry
7:	Hanging Joints	14:	Steel T Beam
8:	Tensile Steel Wires	15:	Steel Beam
9:	Floor Finish	16:	Steel I Beam
10:	Insulation	17:	Steel Sheet

1:50 SCALE MODEL

Here shows the building scheme in the context of Orvieto at a scale of 1:50. The canopy has been omitted from the model to allow for clear commutation of the internal walkway spaces.