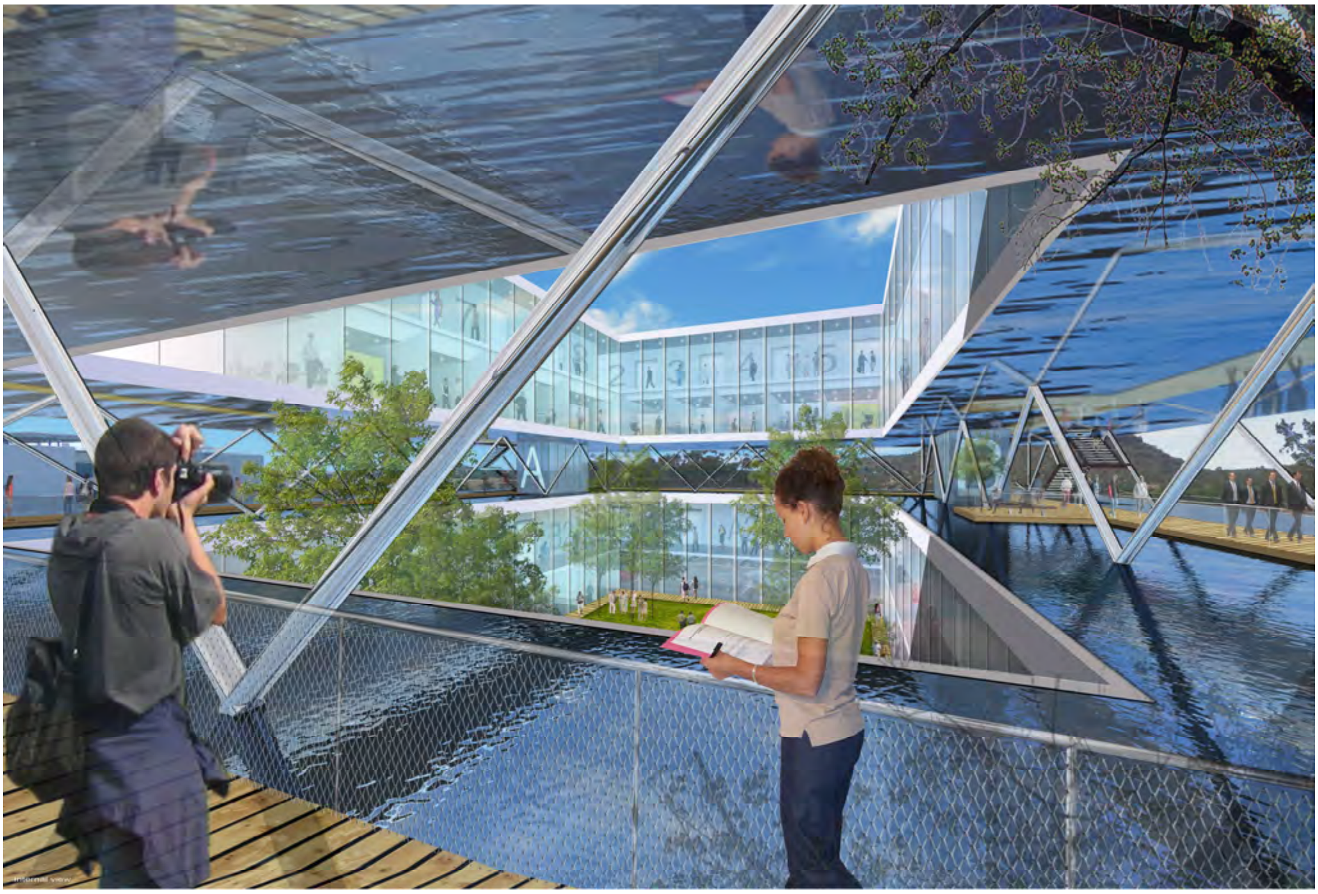
University of Cyprus

Architectural Competition for the Medical school Building facilities on Campus



Competition report – October 2015

Reference code : 30964

Context

The project takes advantage of the orographic context of the site and its descending slope in a North-South direction.

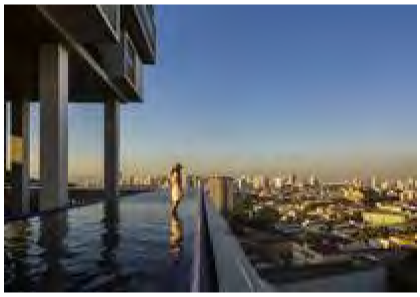
The main entrance is situated at the level of the main pedestrian axis running East-West that structures the campus, the solution thus allows all users to benefit from a panoramic view towards the "horizon" and the open country to the south as a green "scene background".

Concept

The idea is thus to conceive a building from an initial volume, a compact parallelepiped, which is carved out by "subtraction" of its central section so as to create a "cloister", a landscaped court which can be at the same time a space for meeting, for contemplation, for meditation, for study…

The volume is separated vertically by "division", into two blocks leaving a "covered open place" at street level representing the "heart" of the new building, open simultaneously to the external landscape and onto the inner garden below.





This covered intermediate space has a triple function:

- **architectural :** the space is conceived as a real « piece » of landscape implanted in the « heart » of the building. The place, treated as a water basin, transforms itself into a "magical" place where the play of reflections and shadows are multiplied by the presence of the polished stainless steel ceiling above.

  This « scenic device » allows us to bring natural light to the stairwells and internally to the -1 and -2 levels
- **functional** : as the guiding « heart » of the building, this space enables users to easily orientate themselves and to access the different departments of the Medical School through the use of wooden walkways and small public "squares".
- **technical** : the water for the basin, taking source partly from winter rainwater storage and partly from recycled greywater, is then fed onto the garden below and the system acts as water regulator for the site. (The greywater will obtained with Bio-Membrane-Technology which is the safest water treatment method and will comply with British Standard BS8525-1:2010 as well as European bathing regulations)

  Thus during the hottest months, the evaporating water contributes to creating a refreshing microclimate not only for the entrance areas but also to the floors below which also benefit from optimal thermal inertia by being partly set underground.

Our response to the brief

The choice to develop the project on four concentric floors served by an intermediate entrance "place" offers the following advantages:

- it gives an optimal distribution of the different components of the brief with clearly identified areas that favors good orientation for the users
- it allows for reduced functional connections between the different departments

In addition, by adopting a compact and introverted « cloister » typology, we optimize glazed facade areas with obvious economic benefits in respect of the overall budget.



The structural system proposed, with clear spans between facades allows us to design open platforms free of internal columns thus allowing for maximum internal flexibility.

Similarly, the stairs and lifts as set out allows for flexibility and the possibility of a variety of configurations of circulation distribution and a variety of teaching and laboratory spaces on each floor that can be reconfigured in time when required:

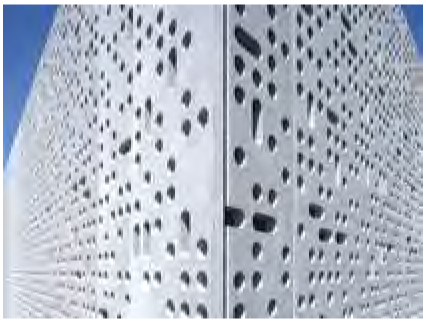
- teaching spaces facing the "inner garden" on the -2 level for maximum natural light where required

- circulation spaces running around the “inner garden” on the -1 and +2 levels thus freeing up the space for deep laboratory and teaching spaces
- a central corridor on the +1 level to optimize the distribution of the smaller size administration offices

Image

The external “skin” of the building is made of a “network” made from ultra-high performance white concrete (UHPC) Ductal® panels acting as sun screen and thermal regulators.



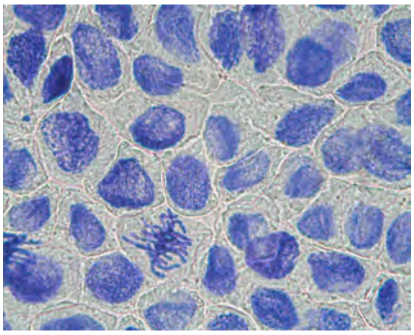
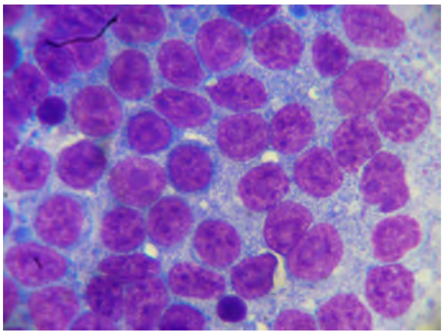


Behind this perforated screen, an external membrane envelops entirely the outer facades, alternating opaque panels with double-glazed elements.

These are conceived as real “incisions” whose variable densities and dimensions allow at the same time for maximum internal flexibility in internal layouts, good quality natural lighting where required and controlled views out onto the surrounding landscape.

The perforated skin also wraps over the roof area providing shading but most importantly screening all technical plant. Below the screen, the roof integrates some glazed sections so as to bring in controlled light to circulation and meeting areas.

The idea is to translate on the skin of the “Medical School” the image of a living cellular organism such as can be perceived under the microscope.


This “network” has a double function:

- by acting as a sun screen that reduces the effects of heat reverberation in front of the opaque parts
- by acting as *“brise-soleil”* that controls sunlight and diffracts light in front of the glazed sections for optimal comfort

Structural engineering philosophy

Overview

The proposed building is rectangular on plan and measures approximately 48m x 60m. A central rectangular opening measuring approx. 20m x 32m runs through levels -1 to roof, leaving an approx. 14m wide floor plate around the opening. Ground level at the Northern end of the building is at level 0 (the 3rd floor). The ground slopes away down the valley such that ground level at the Southern end is level -2 (the bottom floor of the building). A retaining structure retains the earth between levels -2 and 0 at the Northern end of the building.

Superstructure

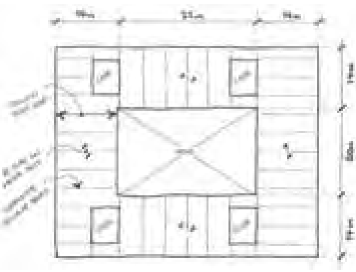
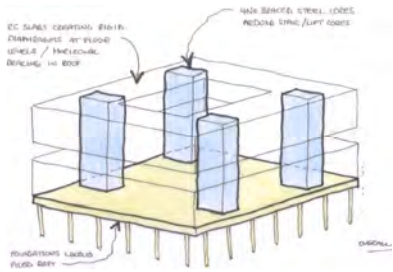
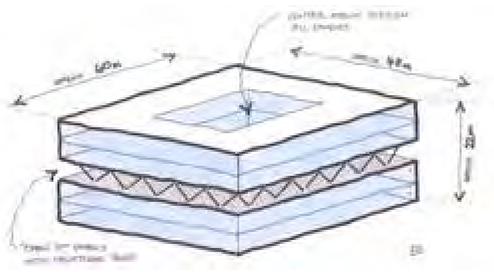
The superstructure is formed from a braced steel frame. Generally the columns are on a grid of approx. 4.3m along the shorter East-West elevation and approx. 4.7m along the longer North-South elevation. The steel beams span approx. 14m from the internal perimeter columns to the columns on the external perimeter, accommodating the requirement for column-free spaces. Typically cellular beams will be utilised with regular openings in the web to allow for the dense service distribution within the structural zone of the floor build-up.

Alternatively, trusses could be considered as an option for the main floor beams. The floors comprise reinforced concrete (RC) slabs cast onto profiled metal decking. The metal decking will minimise the requirement for temporary formwork when casting the slabs. The RC slab will act compositely with the steel beams at levels -1, 0, +2, helping to minimise deflections and vibrations and giving thermal inertia. At level +1 the beams will cantilever negating the advantages of composite action. The base slab construction (level -2) will comprise an RC slab, the form of which will be determined by the adopted foundation solution, as developed further below.

The roof could take a similar construction to the floors with an RC slab on profiled metal decking for optimal thermal inertia. Serviceability requirements such as deflection and vibration criteria will need to be established by the client / architect during detailed design (see section below for the criteria assumed at this stage).

Stability

Four braced steel cores will provide stability to the steel frame. The cores are located around the stair / lift areas and are positioned fairly symmetrically within the building geometry. Lateral loads will be transferred from the facade to the main structural frame and then via the rigid floor plates to the braced steel cores. The cores will then transfer the lateral loads to the foundations via diagonal bracing. A more detailed review of the applicable lateral loads will be required with regards to local wind loading and seismicity.

Foundations

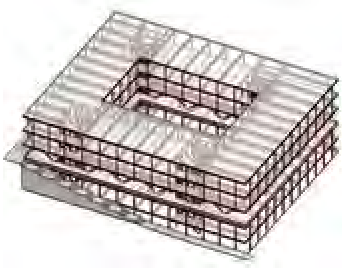
Further site investigation will be required to determine the most suitable foundation option; likely solutions are a ground bearing RC raft or a piled option. Geotechnical engineers will need to be consulted, particularly with regards to local seismic behavior.

An RC raft would be designed to spread the vertical loads transferred to the ground bearing slab below the footprint of the building. The level of the ground water would need to be confidently established and considered when determining the allowable bearing pressure of the founding strata. The volume change potential of the founding and underlying soils would also need to be confirmed as compatible with a raft solution. If required, piles could be utilised in the highly loaded areas to create a piled raft that would transfer the vertical loads to stronger underlying layers. If a raft solution is not deemed suitable by geotechnical engineers, a suspended slab spanning between piles could be adopted. RC ground beams could be utilised to break up the span of the suspended slab and to support the facade of the building, transferring the load to the piles. The piles would extend to a suitable depth advised by a geotechnical engineer in coordination with the pile designer.

Transfers

The open 3rd storey of the building (between levels 0 and +1) comprises two storey-high truss elements forming a rectangle on plan. The inner truss wraps around the central opening, approximately 2.6m outbound from the column grid.

The outer truss runs parallel to this, approximately 2.6m inset from the building perimeter. The diagonal truss elements support the beams from the floor above. As the trusses are inset from the main column grid, the floor beams above this level will cantilever to support the columns and facade. The floor beams below this level will act as transfer beams transferring the loads from the truss elements back out to the main column grid below.

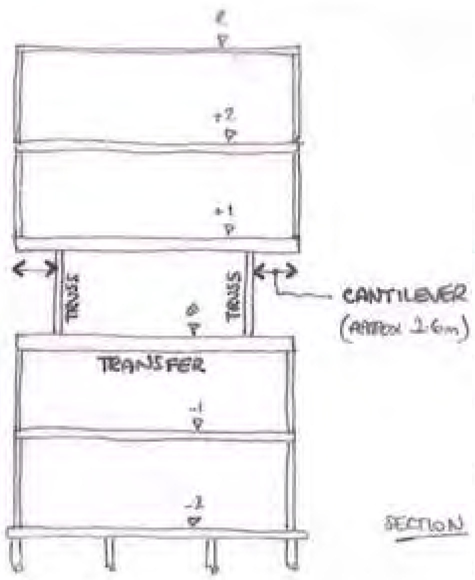

Retaining walls

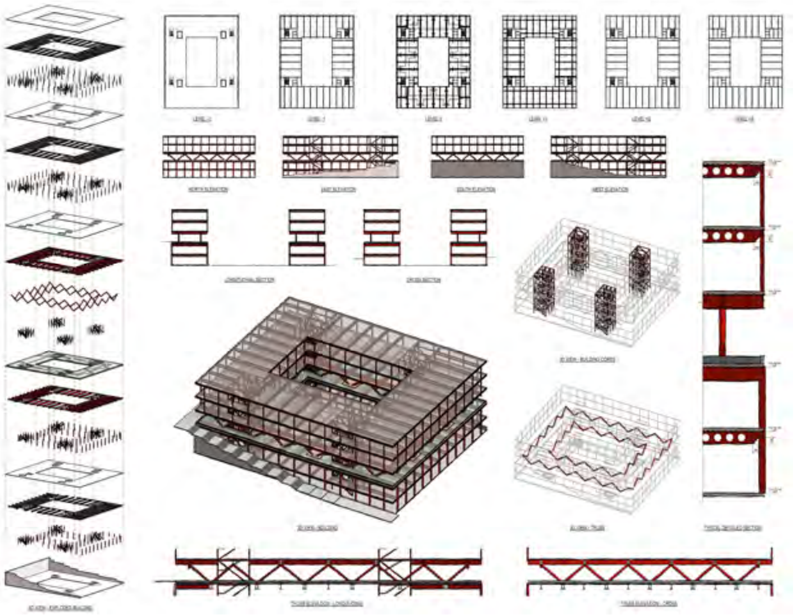
At the Northern end of the building the external ground is level with level 0 of the building. A two-storey retaining structure is therefore required between levels -2 and 0. The design of the retaining wall will need to consider the lateral loads from the retained soil, water and possible surcharge loading from the nearby road above. The retaining wall would likely comprise of a contiguous or secant piled wall with an RC liner wall to the inner face. The RC construction would create a primary barrier to water ingress, a secondary barrier such as a cavity wall construction, would need to be adopted in coordination with the architect.

Seismic behaviour

The local seismic behaviour has been considered in line with BS EN 1998: Eurocode 8: Design of structures for earthquake resistance (EC8) and the Cypriot National Annex CYS NA EN 1998. Based on these codes the site can be identified in Seismic Zone 2 which equates to an area considered to have a very low seismicity. In cases of very low seismicity, EC8 states that the provisions of earthquake resistance need not be observed in the design.

The local ground conditions and seismicity will need to be confidently established, and the extent of seismic design reviewed further during subsequent design stages.





Vibration
Any areas that contain vibration sensitive equipment will need to be identified and particular design criteria for vibration and response of the floor structure will need to be established. Similarly, any equipment that may induce floor vibrations will need to be considered, along with vibrations caused by normal walking and transient forces. The current proposal utilises deep cellular beams acting compositely with an RC slab to achieve large floor spans. This system is ideally suited for limiting deflections over large spans and reducing the dynamic response of the floor. Whilst also providing flexibility to achieve more stringent serviceability requirements where required. These options are to be explored during the detailed design stage.
For the purpose of the initial scheme design the natural frequency of the floor structure has been limited to a minimum of 5.0Hz, which is generally considered acceptable for office and educational use. As mentioned above, to reduce the dynamic response in more sensitive areas a higher natural frequency limit may be required and criteria should be established during subsequent design.

Fire strategy
The following information is based on the requirements of Approved Document B ‐ Fire Safety (England); the requirements of the relevant local codes will need to be considered in subsequent design. Areas with special uses, such as plant rooms, may be required to have increased fire ratings. The fire ratings of all areas are to be coordinated and confirmed by the Architect and Fire Consultant. At this stage, a fire resistance of 60-90 minutes has been assumed for all structural elements supporting the basement levels and floors above ground.
Columns formed from concrete filled hollow sections would significantly delay temperature rise within the steel. This strategy would have the added benefit of increasing the structural capacity of the columns with the potential to utilise more slender sections.

Disproportionate collapse
The following information is based on the requirements of Approved Document A ‐ Structure (England); the requirements of the relevant local codes will need to be considered in subsequent design. Considering the building as Educational, this equates to a Class 2B building in accordance with this document. The structure would therefore need to consider provision of effective horizontal and vertical ties in accordance with this classification. Checks for the effect of notional removal of elements and the design of supporting elements as key elements may be required where effective vertical tying is not possible. All connections should be detailed to sustain a minimum 75kN tie force.

<u>Engineering Services Design and Bioclimatic approach</u>
The design of the Building and Engineering Services will be integrated to deliver a functional low energy design solution. The functionality of the spaces must comply with both statutory legislation but also provide a comfortable environment for all of the user groups. The following are key elements of the engineering services design.

Energy and Sustainability
Our engineering team will work with the architect and the design team to achieve the desired building form. To minimise heat gain within the space we are looking to design a precast perforated sunscreen which combined with a quality glazing system will minimise the heat gain to the space. It is proposed to use insulated precast concrete panels which will provide thermal mass to the building again to help reduce heat gain to the space.

With regard to engineering systems and plant the design would look to minimise energy by the specification of high efficiency plant combined with heat recovery where appropriate. An early geothermal survey will assess if the benefits of ground source heat pumps for the scheme which would provide a low carbon heating and cooling solution for the School. With the direction of orientation of the building we will examine the best location to install solar PV as a further carbon reduction measure.

Laboratory and Clean room design
The energy consumed and carbon emitted by a research and education facilities can be enormous. Adopting the correct holistic sustainable design strategy is critical to the success of the design. Our approach is to build a mathematical model of the building at a very early stage, which can be used throughout the design process to analyse the energy cost/carbon performance of each of the various technologies and design solutions put forward.

For the laboratory areas we would develop a process energy model that allows individual systems, for example a chemistry laboratory ventilation scheme, to be examined in great detail. We can explore energy/carbon savings associated with items such as:

- reduced sash face velocities/sash control techniques
- varying fume stack sizes to reduce bleed air volumes during night set back
- reduced supply and extract ductwork velocities to reduce fan energy
- fume extract heat recovery, polypropylene or alternative
- maximising extent of mixed mode ventilation to write up and non-lab areas
- exploring temperature limit relaxation in peak summer conditions
- diversity of use across fume hoods and other central functions

The design and delivery of the clean room facilities will comply with the performance requirements of EN ISO 14644. In the development of the design the selection of the appropriate terminal filtration device and positioning of the associated exhaust air terminals are all critical. If required computational fluid dynamic software to model and investigate air flow patterns to aid design and confirm that laminar flow can be achieved where required will be used.

Our engineering team will deliver mechanical and electrical engineering systems that will conform to the required protocols. The experience extends to supporting the client and validation teams with the testing stream of the industry recognised V-Model standard that is undertaken on completion of the system design qualification (DQ) process.

Our engineering team involvement can be tailored to suit the project and client needs and can include acting as witnessing signatory for Operational Qualification (OQ) to demonstrate that all facets of the services design and equipment are operating correctly.

Teaching Spaces
With the ever evolving teaching methods flexibility will be incorporated into our design. The use of a raised floor has the benefit for services including drainage to be easily reconfigured. A regular array of drainage stacks will provide this flexibility. Power and ICT can be redistributed more easily.

For the lecture theatres the preferred solution would be to adopt a displacement ventilation solution to maximise user comfort and energy efficiency – particularly when coupled with variable air volume control.

Working with our acoustics group in conjunction with the architect, our engineering team will deliver both a quality acoustic solution within the space with minimal MEP noise intrusion.

Daylighting/Lighting
The team recognise that where possible, most users would chose to work in natural daylight, wherever possible, the use of daylight will be optimised. We recognise however that the majority of larger science and research facilities will incorporate significant areas where users will have to rely on the use of artificial lighting.

Our engineering design team will develop the lighting designs for these areas are:

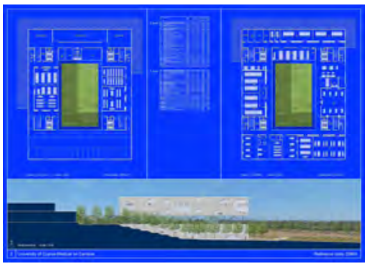
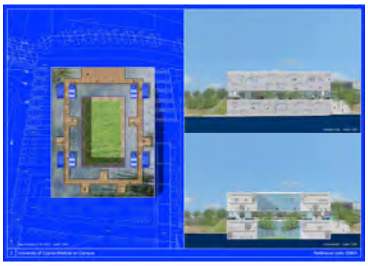
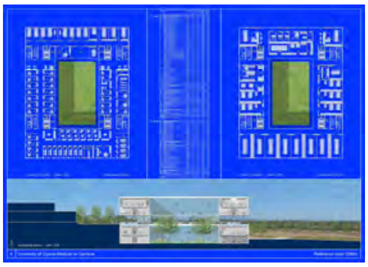
- flexible/adaptable
- controllable
- high aesthetic quality
- maintainable

As lighting schemes can contribute up to 10% of the total energy consumed by research facilities, it offers significant scope for clever design, particularly in the laboratory, write up and shared central areas.

<u>Landscape Design</u>
The planting will follow the Master Plan Review landscape strategy favoring a predominantly ‘urban’ landscape. The watering system will be conceived in combination with the main entrance level aquatic basin described above and with the aim to be well below the 1,5m^3/sqm irrigation target set for 2020.

The planting and exteriors will be carefully designed so as to be environmentally friendly, thus special attention will be given to the following elements:

- use of plants adapted to the Mediterranean Nicosia climate
- measures taken to avoid losing water due to evaporation and run-off (mulching, rainwater retention...),
- reducing the presence of impermeable surfaces
- reducing irrigation needs by using a maximum number of drought tolerant species and using resistant varieties of local shrubs and vegetation
- all planting beds are covered with wood mulch in order to slow down evaporation

ARCHITECTURAL PROPOSAL LIST AND CONTENT OF PRESENTATION PANELS		
• **Panel 1**	**Masterplan Layout Drawing** - scale 1:500 **Concept and functional layouts** – NTS	
• **Panel 2**	**-2 level plan** - scale 1 :200 **-1 level plan** - scale 1 :200 **West elevation** - scale 1 :200	
• **Panel 3**	**Main entrance level plan** - scale 1 :200 **South Elevation** - scale 1 :200 **Cross Section** - scale 1 :200	
• **Panel 4**	**+1 level plan** - scale 1 :200 **+2 level plans** - scale 1 :200 **Longitudinal Section** - scale 1 :200	
• **Panel 5**	**Four perspective views :** **Context view from the South-West** - NTS **External view from the East** - NTS **Internal view from the South** - NTS **Internal** space view- NTS	
• **Panel 6**	**View from main entrance level** - NTS