

Convertible Studio in Johannesburg

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Site Plan of Highfield Campus



The brief focused on providing a creative space for students to learn and work productively at University. The project aimed to develop a two-person studio for Highfield Campus Southampton, set in Johannesburg, that was adaptable to maintain productivity whilst studying. In response, an interactive and contemporary studio was designed. It allows the user to be responsive to the environment.

The most notable feature is the pivot doors. These doors, when fully open, combine the outdoor serenity and indoor comforts to create a space where studying can be most effective. When you create an indoor/outdoor working space, you invest in the student's overall well-being. Recent building trends focus more on making the natural world

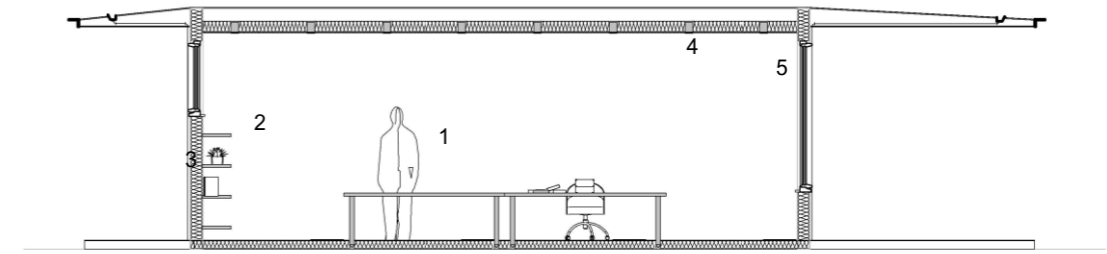
accessible, even in urban environments. Connecting the studio with its surrounding ultimately helps to expand the inside space, allowing the user to feel less confined to the surrounding walls. This will increase productivity, as a 'Global Impact of Biophilic Design in the Workplace' study showed that people who work in spaces with natural features and an open space reported 15% higher levels of overall wellbeing. Exterior design elements that embrace nature can also help to link the outdoors to the indoors. Therefore, it was essential to incorporate natural and earthy features into the design both on the interior and exterior.

In summary, the studio has two identical walls made entirely of 2m wide-pivot doors. This creates an immersive space inside the studio.

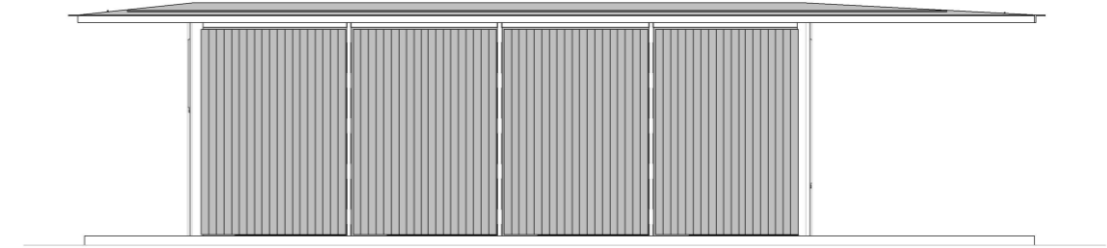
These pivot doors can be adjusted for comfort. For example, the doors can be fully open on hotter days, allowing a draft. During winter, the doors can be fully shut on cooler days, and an entrance is made from just one of these doors. The insulation shown in the *East Section Layout* (seen right) will provide a warm space to study. The large north-facing window will also allow a lot of daylight to fill the room, making it less confined during the winter. Privacy is also essential to some students when studying. Therefore, the doors can be open slightly on the east (the busy walkway), and open fully on the west to allow ventilation. Evidently, there are many possibilities to change the space to adapt to its environment and user's preferences.



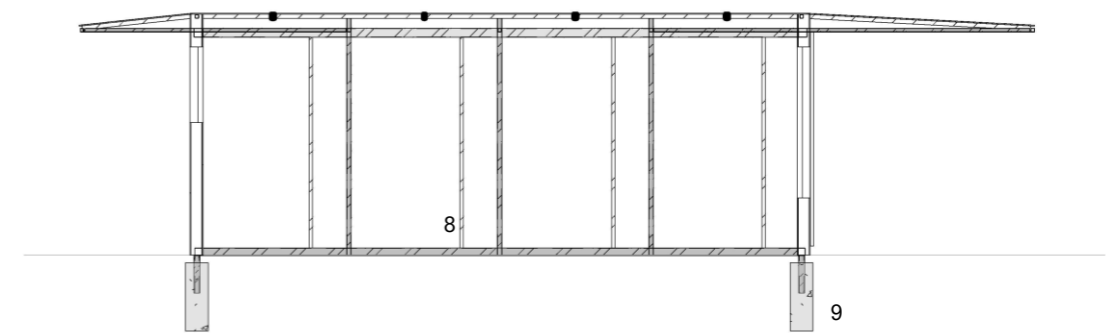
East Section – Layout



East Elevation - Architectural



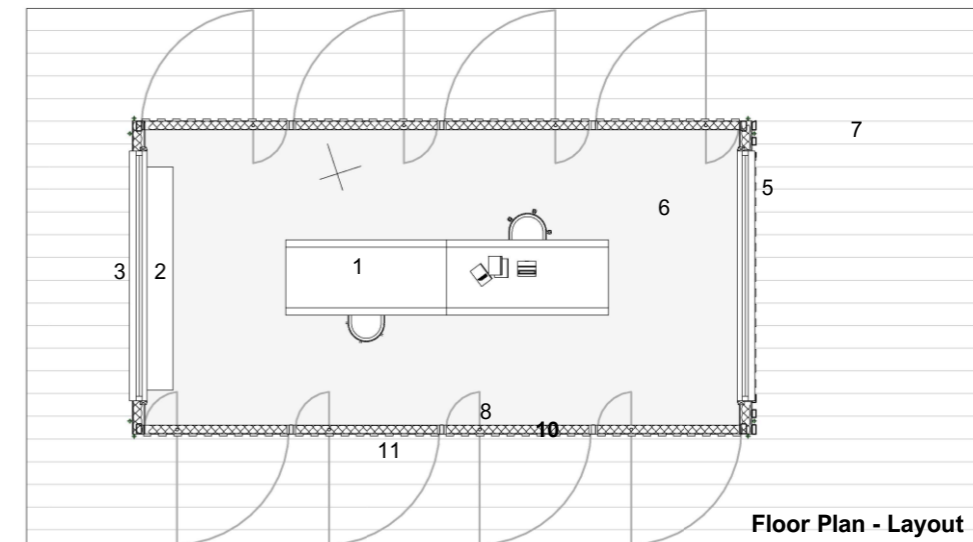
East Section – Structural (For more detail see page 8)



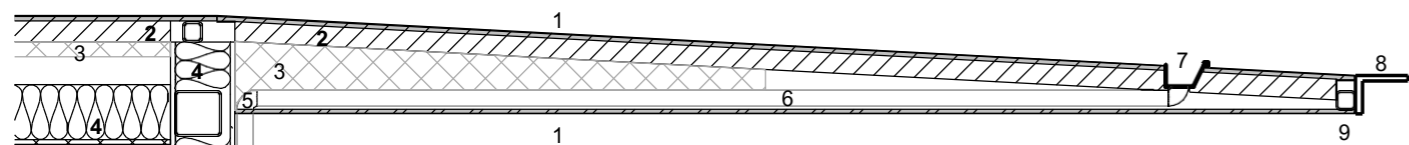
Site Plan – Highfield Campus
scale 1:5000
Sections . Elevation . Floor Plan
scale 1:100

- 1 Double desk with chairs
- 2 Shelving
- 3 South Wall with 145 mm insulation

- 4 Ceiling with 145 mm insulation
- 5 North Wall with 145 mm insulation
- 6 Pine Flooring with 105 mm insulation
- 7 Pine Decking
- 8 Pivot Support
- 9 Pier Foundation
- 10 Pivot Door
- 11 20 mm rough sawn pine cladding



Floor Plan - Layout



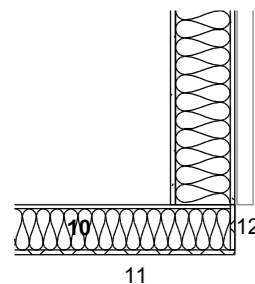
Cantilever and North Wall Build Up
scale 1:20

- | | |
|---------------------------------------------------------------------------|----------------------------------------|
| 1 12 mm plywood sheet with 'Firestone RubberCover' EPDM Membrane – 1.52mm | 5 Pipe Elbow |
| 2 100x47 timber rafters | 6 Pipe |
| 3 Roof Insulation | 7 Gutter |
| 4 145 mm Knauf-Earthwool with 47 x 75 timber battens | 8 Metal Roof Fascia |
| | 9 S355 SHS 50x50x7.1 |
| | 10 110 mm Kauf-Earthwool |
| | 11 Sile Plate with EPDM Membrane Cover |
| | 12 Band Joist |

Data from 'Weatherspark' shows that Johannesburg has the wind from the north for 1.7 months, from 3 March to 24 April and for 7.4 months, from 30 June to 10 February, with a peak percentage of 35% on 27 March. In response to this data, the studio was placed to allow the shutters to direct the wind from the north into the studio on hotter days (as shown to the right). Johannesburg has an average of 8 hours of sunshine in the summer, where temperatures reach up to an average of 26°C in January. Therefore, this natural ventilation method is vital in maintaining a calm working environment whilst reducing the energy consumption of the building.

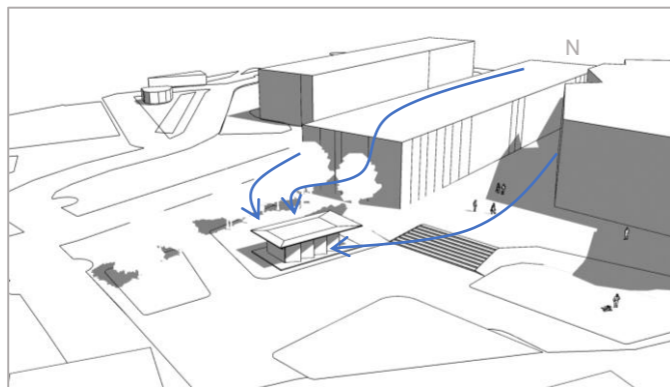
The sun path diagram below shows that the sun rises from the east to the west, with a yearly solar angle ranging from 40° to 64°. The 3m cantilever effectively shades the 2 x 3 m window facing the north. This is vital as direct solar radiation will heat up a room significantly, raising the internal temperatures to uncomfortable levels in warmer climates like Johannesburg. In addition, the reduction of direct sunlight will prevent screen glare in the studio. Finally, the flow of students is shown below. The solid path represents the routes taken more often by students (by observation and analysis). The studio was

placed parallel to the sites access side. This positioning still allowed access to the green space around it, with the pivot doors on the west opening to the grass. Johannesburg can have up to 130mm of rainfall per month. Thus, the roof was designed with an efficient and hidden drainage system that doesn't take away from the apparel of the design (See detail above).

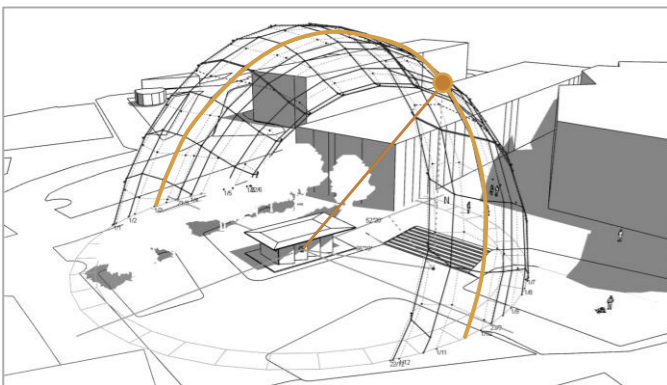


- Student flow from:**
- 1 Interchange
 - 2 Building 67/32
 - 3 Building 85
 - 4 Students arriving from dense student accommodation
 - 5 Building 13 or surrounding
 - 6 Hartley Library

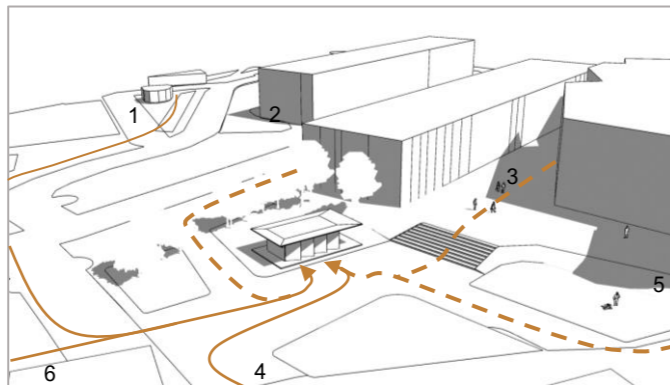
Wind analysis



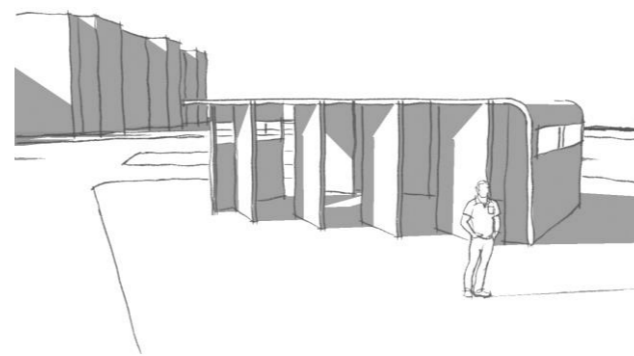
Sun Path Analysis



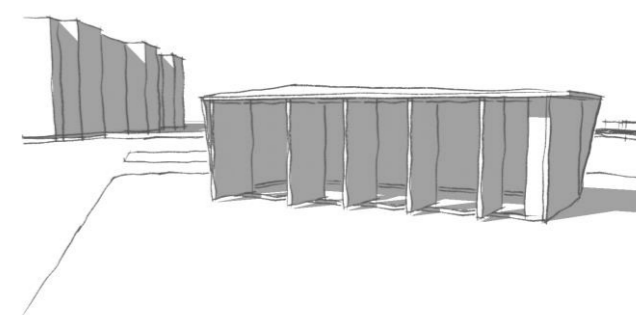
Entry Point



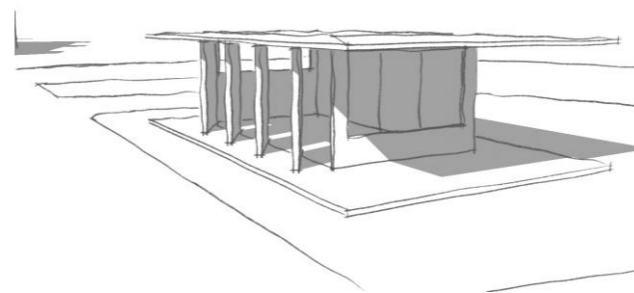
Development 1



Development 2



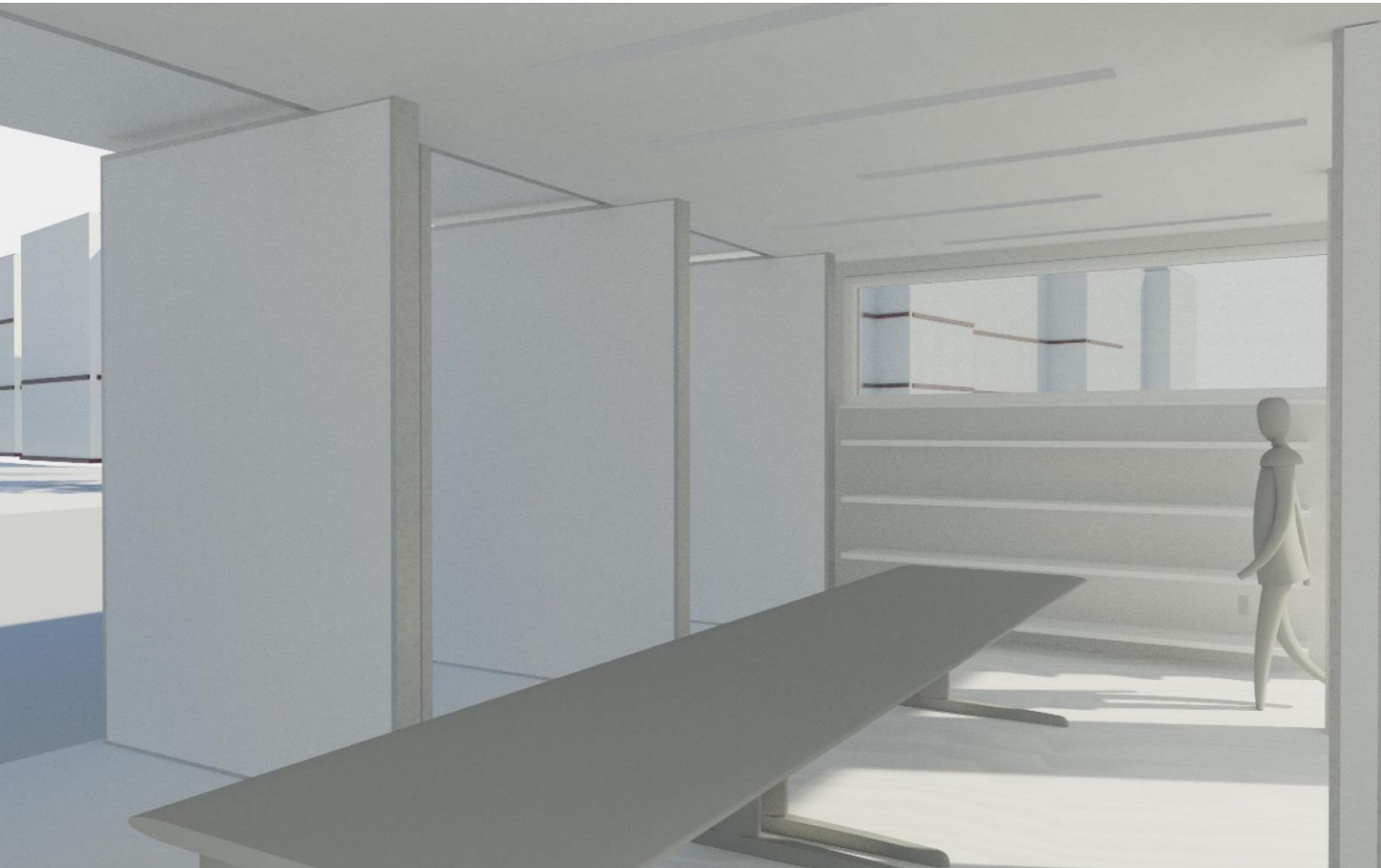
Final Development 3



The design for the pivot door studio has developed over ten weeks. This involved scrutinizing each architectural and structural decision to produce the most effective design that aligns closely with the brief and the design principles (discussed on the next page). From *development 1* with curves and elements that are harder to construct, to *development 2* with a roof that had little function. The final *development 3* implemented all ideas into a minimalistic design that focused on its elegant roof. The roof could ultimately hide a gutter whilst remaining slender enough to show off its impressive cantilever. The striking north window lights up the room with morning, afternoon and evening light, giving the room a bright and cheerful space. The window height is placed so seated students can enjoy the studio's greenery. Overall, the pivot doors, warm amber lighting (see below), and tall 3m roof space create a relaxing working environment for morning and evening. To develop the studio further, it was suggested to place the window seating on the north window so that the space can be used for studying and relaxing.

Evening Render of Final Development





Abstract internal view facing Hartley Library (South)

Principles of Good Design

Design principles were explored to influence the studio's development. These design decisions are explored to the right.

1. Good design is a balance of form and function

A design that is both aesthetically pleasing and functional.

2. Good design is adaptable

Adaptable architecture responds to their surrounding environment such as changing climate or technical advances.

3. Good design is contextual

Contextual design refers to architecture that reflects the forms, and details of a building's surrounding landscape and environment.

4. Good design strives to be sustainable

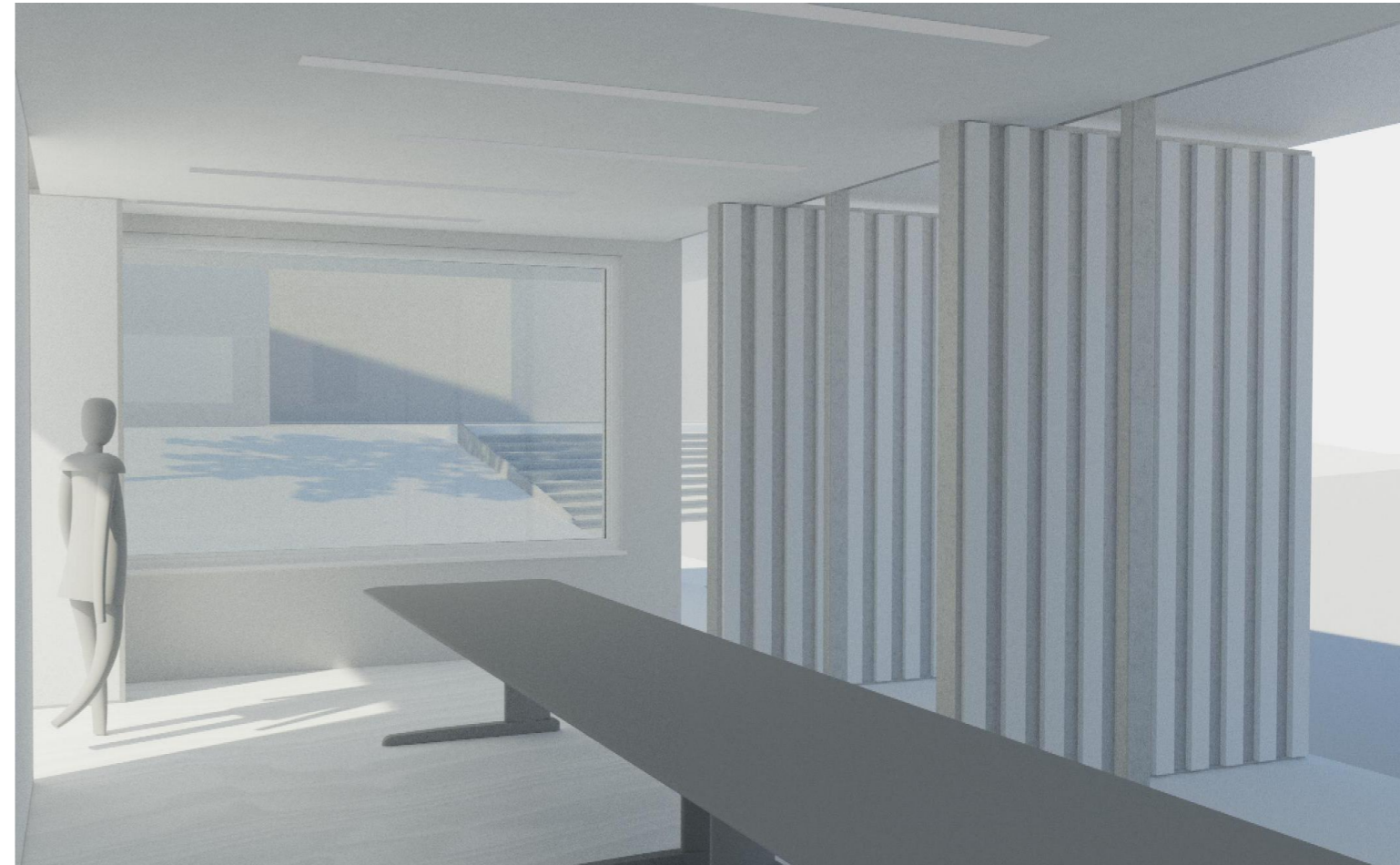
Sustainable architecture is the use of design approaches that reduce the harmful environmental impact from a built environment.

5. Good design is innovative

Architectural innovation occurs when the building uses existing technology and ideas to create positive change to the building.

6. Good design is simple

Simple designs communicate the building's overall purpose effectively. The elimination of uncertainty improves the communication of the building.



Abstract internal view facing North

Firstly, the studio's design showed evidence of principle one. As mentioned before, the roof balanced form and function, as it evolved significantly to adapt to waterfall and the sun path. Further, it also remained aesthetically pleasing through the compact design of the cantilever (found on page 8).

Adaptable design is found when you look at the function of the pivot doors. The students can alter them to respond to the surrounding climate (open and closed, shown to the right). As mentioned before, transforming the environment will ensure a space where students can remain as productive as possible. (This concept is explored on page 7).

The study space is designed to be contextual to South Africa. Careful analysis of the staining and treatment of the pine flooring, decking and cladding was made to ensure that the colour and finish complimented the rustic soil colour. (See on page 10)

From the use of pine as a renewable material to the use of a steel frame, there were decisions made to achieve a project that was as sustainable as possible. Using these materials will encourage a circular economy for the overall studio project.

Another significant decision was to design the building with natural ventilation to

reduce the buildings' energy consumption and have a very well insulated room (shown on page 2) to keep in heat during the colder months.

Innovation was at the heart of the project, where the decision to respond to principle 4 was evident in the development of 1.94m by 3m pivot doors. The technological advance of the pivot (explored on page 7) allowed such a unique door/ventilation system to be implemented into the design.

Finally, the simplicity of the pivot doors effectively communicates its purpose. The use of the doors to change the inside space will be second nature to the user, as humans tend to adapt their space to feel comfortable in it naturally. The simple design approach ultimately allows for adaptability and customisation.

The top two abstract renders show the simple interior design aligned to principle 6. The design eliminates distractions and creates a calming and familiar space. The renders show the view towards the library and towards the stairs. Both views are lively, as they are hotspots for students to walk through.

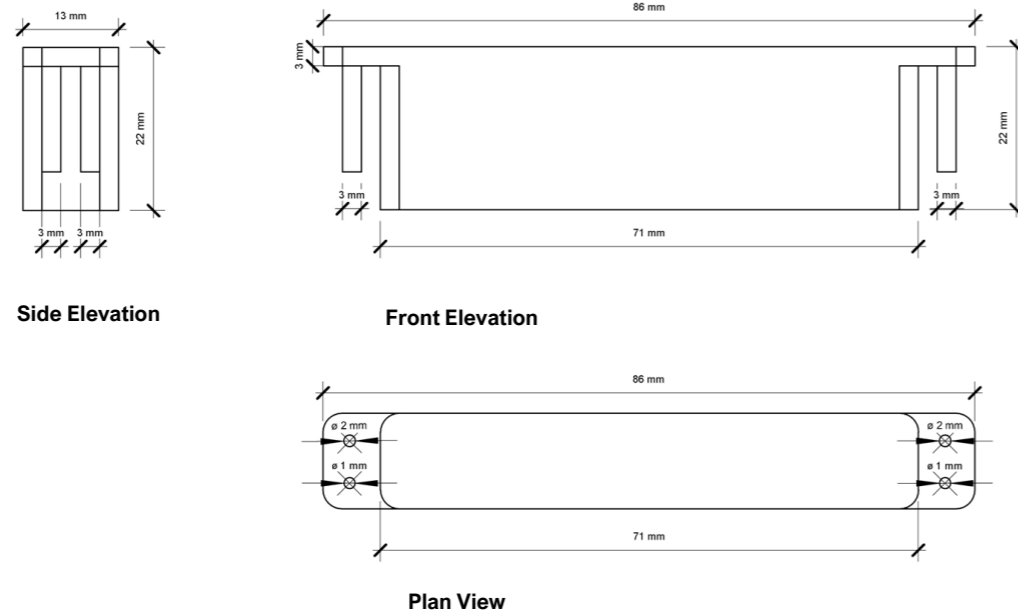
Abstract render of pivot doors opening and closing



Pivot Doors

Covid – 19 has been a significant problem for students, as it has confined them to indoor spaces to study for hours on end.

The pivot door wall is a response to the pandemic, where it provides not only a “safely ventilated” space but also an environment that feels convivial and relaxing. With a desk that can have chairs spaced with social distancing in mind, this study place is a perfect alternative to closed study spaces found in the library or student buildings. The studio is ultimately designed by a student with students in mind.



Example of a pivot door

To reiterate, the studio was designed with pivot doors that open or move to control the light, temperature, and ventilation. Standard doors are easy for users to understand because they're so accustomed to using them. Whereas when users see a pivot door for the first time, it is an exciting experience. The brief specified a creative space yet studying can often become monotonous. Staying in the same space for an extended period can be draining. Therefore, a building that can change its feeling and provide different settings is perfect for creativity.

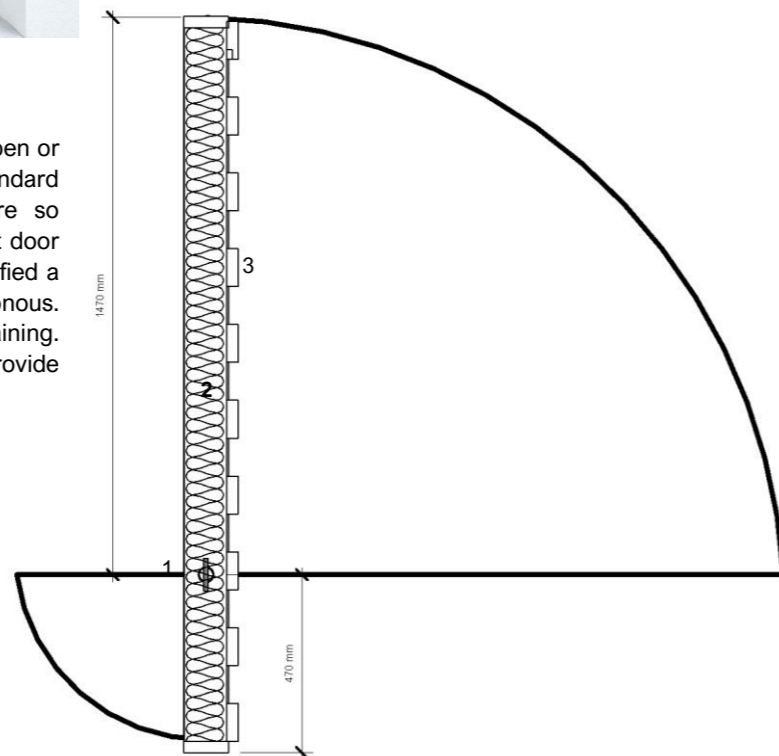
Pivot Door Plan

scale 1:20

Pivot Hinge Plan . Elevations

scale 1:2

- 1 Pivot Hinge
- 2 Insulation of 120 mm
- 3 Pine Cladding



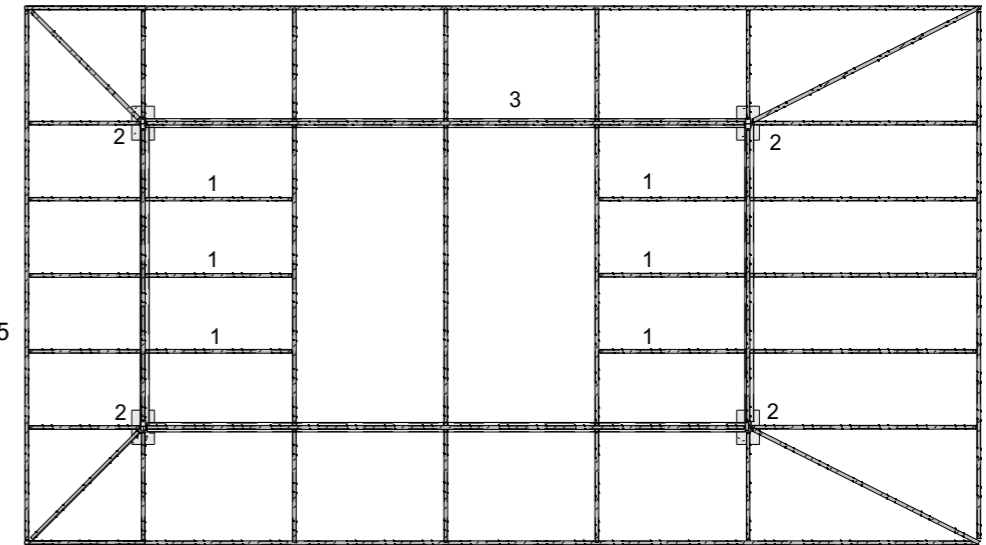
Pivot Door – Stealthpivot XL is designed to be placed on top of a solid surface "without the need for any built-in fixtures". The studio's door has pivot support to ensure the design to be as durable as possible (shown on page 2). The hinge is installed inside the door and therefore remains hidden after installation, hence the name "Stealth pivot". The hinge is designed for doors up to 150 kg. The door weighs 62.4 kg, therefore, passes the conservative requirement.

The doors are all connected on a system that allows users to open all the doors at once or adjust them individually. The simplicity of the doors system and the electrical space found between the roof and the ceiling (seen in the *Cantilever and North Wall Build Up*) allow for innovative development. For example, the space could be fitted with sensors that detect when the room is above the comfortable temperature of 20 to 21 degrees Celsius. Thus, in response, the building will automatically open and close the “shutters” to allow for ventilation until it has cooled down.

Details . Structural Floor Plan
 scale 1:100

Structural Floor Plan

- 1 S355 SHS 50x50x7.1
- 2 300 x 450 pier foundation
- 3 S355 SHS 120 x 120 x 5

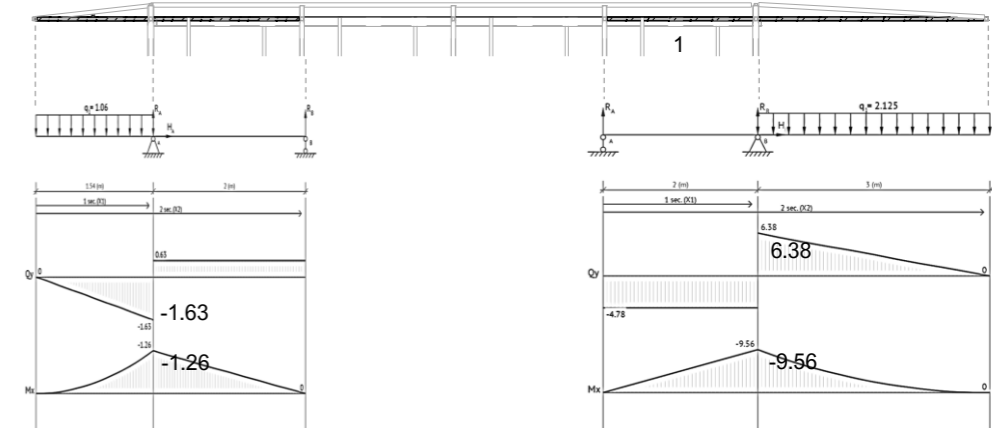


East Structural Detail

Beam SHS 50x50x7.1

Shear Force (kN)

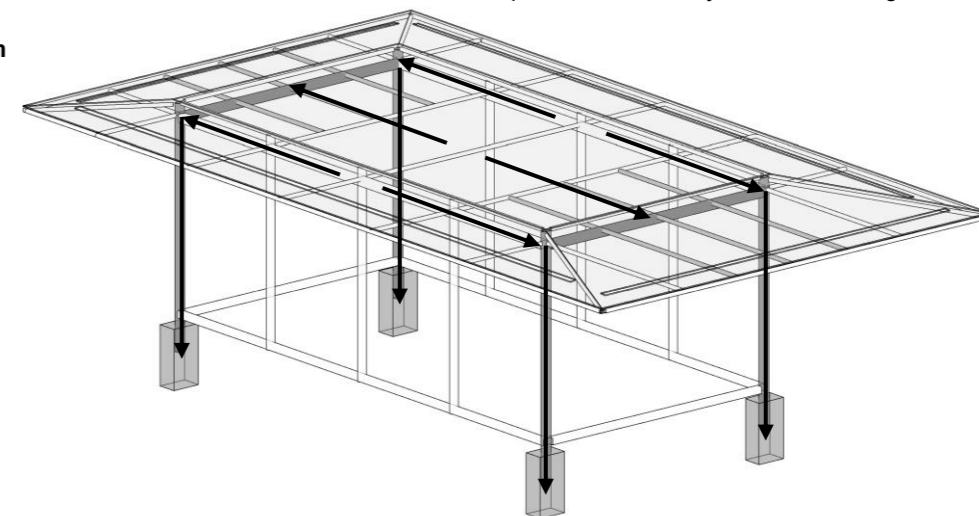
Bending Moment (kNm)

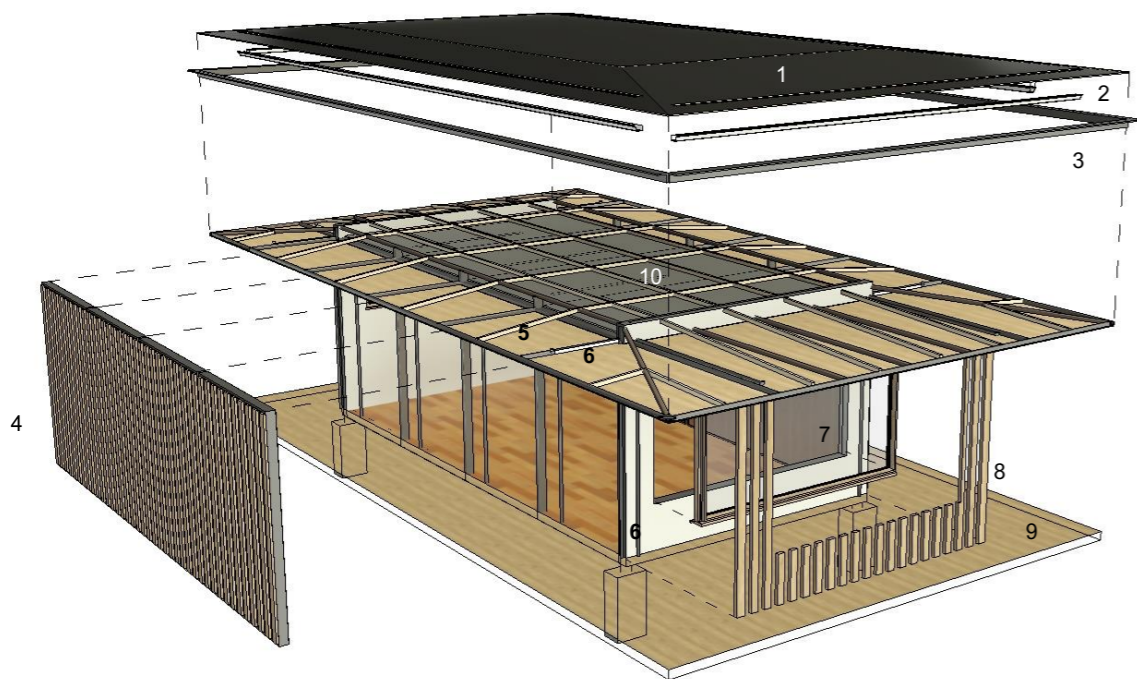


Cantilever Check – One of the design's most elegant feature is the 3m cantilever. Design checks were complete to ensure that the roof could be as slim as possible. The calculations found that the 3 centre beams shown at the top should resist a bending moment of 9.56 kN m and Shear force of 6.38 kN. Therefore, the S355 SHS 50x50x7.1 is chosen with a moment resistance (Mc,Rd) of 10kNm and shear resistance (Vc,Rd) of 149kN.

Load Path Diagram – The structure is a portal frame, where the horizontal and vertical loads are transferred to the end walls shown in the diagram below. The end wall consists of two columns which are fixed at the ground by a pier foundation. The roof acts as a diaphragm which transfers the horizontal and vertical loads to the end portals. The roof is attached to timber rafters as shown on the next page. The design of the building has fundamentally reduced the cost of the project, as the use of materials and space has been optimised over many iterations throughout the year.

Load Path Diagram





Exploded Diagram

- 1 12 mm Plywood Roof with EPDM membrane
- 2 Gutter (See below)
- 3 Roof Fascia
- 4 Pivot Door Wall
- 5 100 x 47 timber rafters
- 6 Water Pipe (See below)
- 7 Double glazed window
- 8 Pine Cladding
- 9 Pine decking
- 10 Ceiling 145mm insulation - Knauf-Earthwool

Roofing construction

- 1 12 mm Plywood sheet 2400 x 1000 cut from a 2420mm x 1220mm sheet.

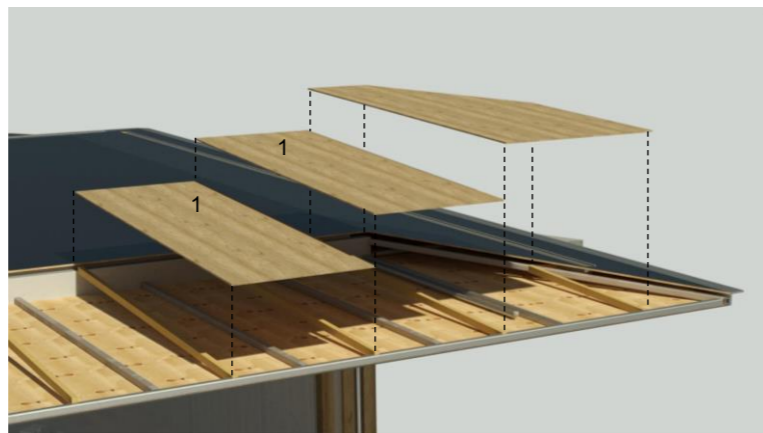
Gutter and drainage system



Construction Process

- 1 Excavation for pier foundation's
- 2 Pouring of reinforced concrete with end wall column (as seen on page 2)
- 3 Transport of prefabricated pivot doors to site
- 4 Steel Frame on site welding
- 5 Construction of timber floor frame and pine floor finish
- 6 Weld pivot support and attach the Pivot doors to the steel frame
- 7 End walls constructed around steel frame
- 8 Temporary scaffolding constructed to allow access to roof
- 9 Ceiling constructed to end walls
- 10 Timber roof supports bolted to steel frame
- 11 Drainage and pipes installed (see bottom left)
- 12 12 mm ply wood sheets nailed into rafters (as seen below)
- 13 EPDM waterproof membrane rolled out and nailed into plywood.
- 14 Pine Cladding fixed to wall
- 15 Plaster boarding, painting and furnishing.
- 16 Pine decking constructed

Plywood sheets exploded diagram



The durability of a building is essential in design. It is important to note that the timber found throughout the design are sourced from local plantations that are in line with environmental standards. The pine has been treated with 'Seasonite' to ensure that the pine's colour and finish can remain bold for as long as possible. Pine was chosen because when it is exposed to sunlight, it causes a chemical change in the wood, resulting in the wood taking on a golden or orange tint. This effect beautifully complements the colours of Johannesburg soils. Having a red façade could potentially blend the building too well. Therefore, having a subtle contrast in colour to the soil can ensure that the studio is bold but not out of place (Principle 3). The bottom right diagram shows this analysis.

As mentioned before, the room is fully insulated. A low-E coating is provided to the double glazing with "low-E glass", which helps reduce the UV light that passes through the window. Thus, keeping the room thermally insulated during the winter.

The roof's metal fascia is designed to look like it's concentrating to a very thin point. This design gives the roof a sleek finish.

The membrane (right) is durable enough to have people on the roof during maintenance and provides waterproofing. The roofing and studio room is well insulated with Knauf Earthwool. It is an easy-to-install glasswool made using up to 80% recycled glass and a bio-based binder. This environmentally friendly material aligns with principle 4.

The studio opens to surrounding pine decking. This decking provides a shaded area for students to sit on and socialize during break hours. The north decking is surrounded by greenery and is opposite benches, thus indirectly promoting the deck as a social space. The gutter and overhang are designed to prevent the rainfall from falling and rotting the deck over time.

Knauf Earthwool Insulation with timber battens



Pine Cladding



EPDM membrane



Pine decking



Soil Colour in Johannesburg

