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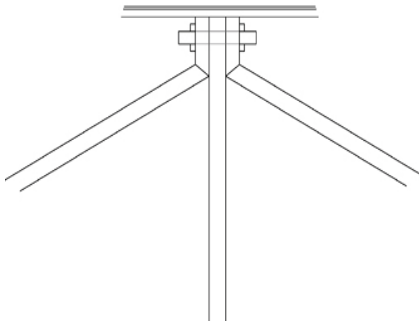
technical

DETAILING

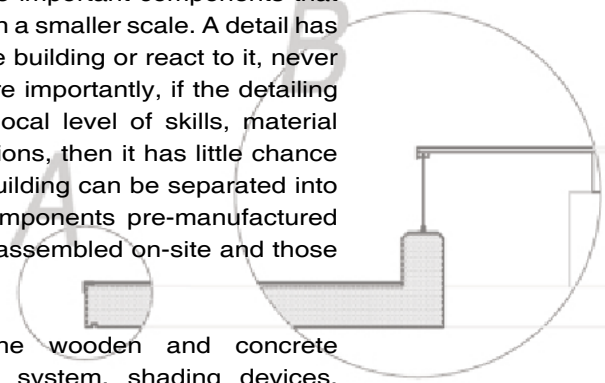
Detailing is the aspect of the product of architecture that warrants that the building survives through its intended life span. Furthermore, it is one of the important components that promote harmonious movement on a smaller scale. A detail has to form part of the language of the building or react to it, never be left open to circumstance. More importantly, if the detailing does not take into account the local level of skills, material availability and weathering conditions, then it has little chance of survival. The detailing in this building can be separated into two categories, namely those components pre-manufactured in controlled conditions and then assembled on-site and those manufactured on-site.

The first category includes the wooden and concrete fins, wooden trusses, bio-glass system, shading devices, balustrading, flat bar connectors, etc. The manufacture of the trusses, for example, might be complicated, but will happen under controlled conditions – what is more important is that the joining on site be as simple as possible. This counts for all the components that are assembled on-site. The simpler the connections, the less chance of mistakes - and proper connections result in the product resisting wear-and-tear for longer. In general, the detailing aims to include as little components as possible, making assembly easier and fewer mistakes possible.

In the second category are the components that are made on-site, like the concrete and brickwork. These skills are less specialised, although some concrete casting, like that of the roof, still remains difficult and needs proper supervision. The good quality of concrete work on the Constitutional Court Building suggests that this is still possible in South Africa. The wooden structures built on-site are designed to have as little cutting and changing of direction as possible. Simple straight beams, columns and floors joined flat to the edge with very simple connections to reduce shear stresses in the wood and ease construction.



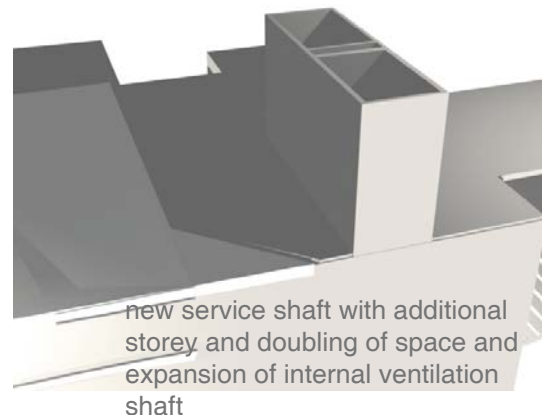
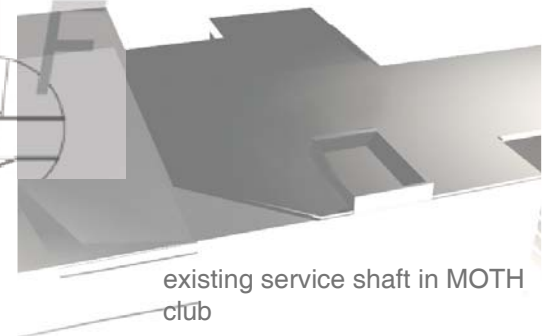
simple on-site connection of complex off-site truss and column with just two wooden staves being pushed through two pre-drilled holes

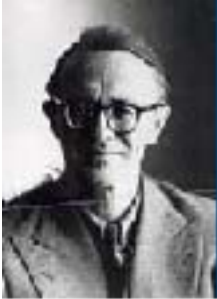


Weathering also played an important role and materials were chosen that resist corrosion and withstand the intense heat of the South African climate. Wood is shaded where possible and treated. The wooden louvres are manufactured from the pine trees that were removed from the site, treated on site and left exposed to weather with the sun. All external balustrading is lifted from the floor to prevent water from being trapped underneath and all metals and their connectors are chosen to prevent ion-exchange related corrosion.

SERVICES

Existing services are used and extended where necessary to carry additional amenities. A new service shaft is added to the existing shaft in the MOTH, also becoming the ventilation shaft. The stack pipes in the shaft link up to the original sewer connection running East of the MOTH. Water is supplied by a municipal connection on the Eastern border of the site. Electrical connections are also connected to the municipal grid, although the building will be fitted with UPS rooms on the second and third floor. Extensive cabling is essential in terms of server and network cables and this will run horizontally in power skirting along the floor and vertically inside the shaft inside the MOTH.





better than most other architects having practiced in Pretoria, Norman Eaton understood how to fuse Modern ideals with local climate, materials and typology. His work stands a testament for that which seems the goal of any current architecture - to find an appropriate architecture for the African context we live in. And he did this without reverting to any literal pseudo-African typologies.

VERNACULAR/CONTEXT/CLIMATE

Construction has to take local practices and climate into consideration. Construction practices are established out of a direct need, i.e. materials and detailing that respond to local climate and material availability. Material availability has become less critical with the current transportation network, but climatic conditions are still important, although currently many practicing architects seem to negate this fact. This viewpoint is not shared and construction of this building looks at vernacular building practices, such as the roof structure, which conforms to building practices in the 1950s and 1960s in Pretoria. A wooden tongue-and-groove ceiling is fitted directly onto the wooden truss and then waterproofing is applied to the outer surface. The ceiling becomes the beautiful inside skin but also the external structural roof. The roof offers sufficient insulation if painted white on the outside. This type of construction has proved to be virtually leak-proof and outlived many alternatives. The same counts for the louvres, which are typical for Pretoria in dealing with sun influx. Only external shading elements have an effect on the interior conditions. This is done in the form of horizontal elements (the slab overhangs) on the North and vertical louvres on the East and West. In this case no shading is needed on the Eastern façade, as this is shaded completely by the surrounding buildings and trees. Vertical louvres are employed only in the parts where the building is enclosed with glass. This aside the most effective way of shading an external façade is with deciduous trees, which shade in summer and let sun through in winter. This is applied to the workshop by placing it within a forest of trees, needing no shading on the western windows.



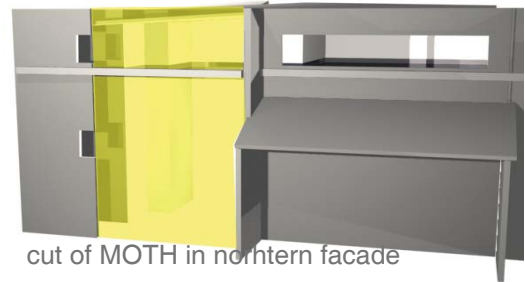
LOAD PATHS

The way in which movement in forces is transmitted inside a building is by flowing the distribution from one structural member to another, i.e. by means of a load path. The importance of just having as many structural members as necessary has already been discussed. The more direct the path is to the foundations the better, both structurally and financially. Vertical load paths are affected architecturally by consideration of column and wall positioning to follow a straight path through the structure. An exception is made on the ground floor, where the shading element's columns rest on the slab of the basement and the path does not move down directly. Because of this fact these columns have been chosen to be thinner and a lighter load has to be spread.

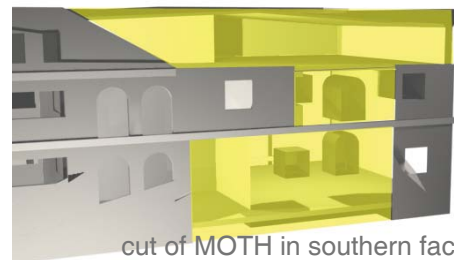
EXISTING

Working within the context of the site remains a prime consideration. Issues such as natural slope, local movement systems, climate, heritage, economy and ecology are all taken into account. Moreover, the tangible aspects of the site - such as existing structures, surrounding structures and services - are incorporated into the design. It is thus integrated in the block in a physical manner by using what exists and sharing it with its neighbours without imposing too much on the existing.

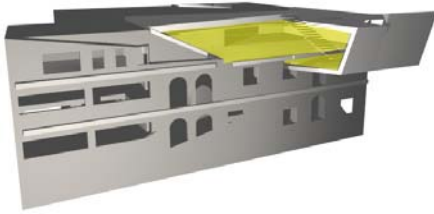
This assimilation starts with the MOTH club - the more detailed incorporation of which is discussed in the design development - where it is employed as an integral structure within the final building. Existing floor slabs line up with new ones. Additional floor slabs are added with the inception of the movement box to improve the rather haphazard circulation of the existing MOTH. Windows



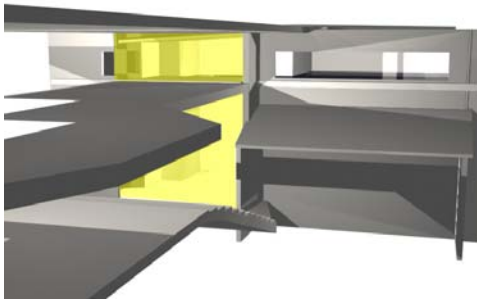
cut of MOTH in northern facade



cut of MOTH in southern facade

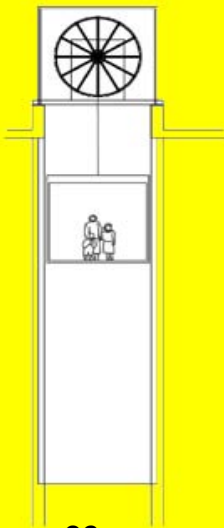


are kept where necessary and adding to the value of the club. The verandah with its distinct roof is incorporated too and becomes the entrance and foyer to the building. The existing service shaft is doubled in size to accommodate the increased service load. The staircase is kept in its position and used to guide movement through the new part. Most of the walls are kept or opened up, none are added.



The Breytenbach Theatre is incorporated by using the back entrance of the prop store and linking it to the function of the workshops of the new building (where props and costumes are made), lying directly next to it. The prop store thus serves as a store for both the Breytenbach and the new building. The same sharing of facilities applies to the new workshops and existing ones at the Breytenbach that are placed close to one another for the purpose of sharing facilities. These decisions to rather work with existing facilities and adding onto and improving these, rather than duplicating and making one or even both obsolete, make financial and tectonic sense.

The tall residential building on the S-W corner of the site with its static western façade is utilised as a screen for the performance of film material, thus obviating the need for a new screen.



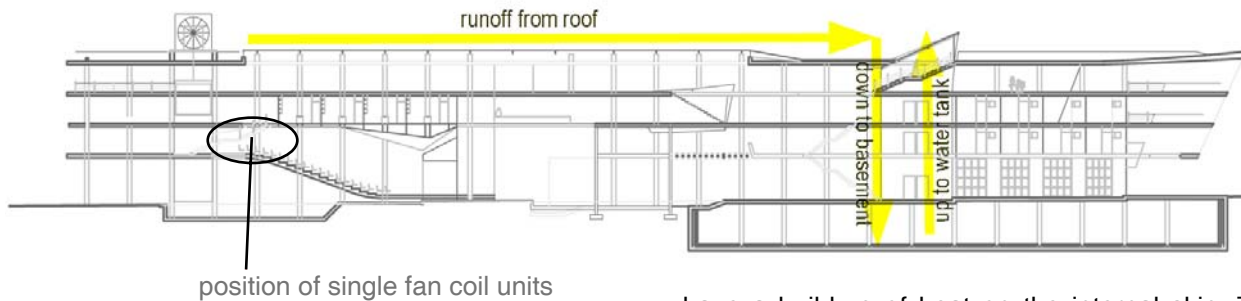
LIFT

Most of the movement inside the building is arranged by means of ramps and staircases, even though an elevator would be necessary to make the building accessible to wheelchair users. The existing MOTH club makes it virtually impossible to fit ramps to an appropriate slope. The elevator also assists movement within the building, all of which is part of the program and inherent process in the building. It thus forms one of the components of this process and aids it in a different way than that of ramps and staircases. The form of this elevator and its shaft echo aspects of the mining history, without which Pretoria probably would never have existed. The cable is wound up on an axle that is connected to a large steel wheel, which in turn is powered by the hydraulic motor. It runs on typical guiding channels on two sides and sits within a glass shaft. The elevator itself is also made out of a steel structure and walls clad in structural glazing, all of which emphasises its role as a light box passing through and lighting up the building vertically.

WATER RETICULATION

For effective rainwater harvesting one would need at least an average of 2000mm per year with two seasons of at least three months without serious drought. The average annual rainfall on this site occurs mainly due to thunderstorms varies between 630mm and 700mm. The rain season falls between November and March, with the peak in January. 50-80 rainy days may be expected, some of which may be hailstorms. The rain is unreliable, thus 12% of all years severe drought may be expected. What this means is that rainwater harvesting is not a sure way of providing continual water supply throughout the

year. Yet, if all conditions exist for proper harvesting without having to add hugely to the structure, then it would be irresponsible not to make use of this. What exists is a large roof area of around 1000m² to gather water, a structural roof area for the storage of a water tank, enough service shafts to take down the gutters into the basement, a basement with enough space to fit a secondary water tank and a sump pump in a pump room to pump the collected water back up to the roof. From here the collected rainwater is put into the grey water cycle and used to flush toilets and water plants.

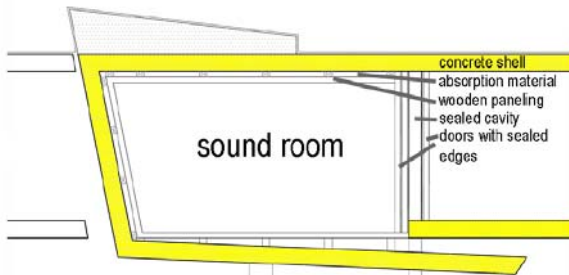


VENTILATION

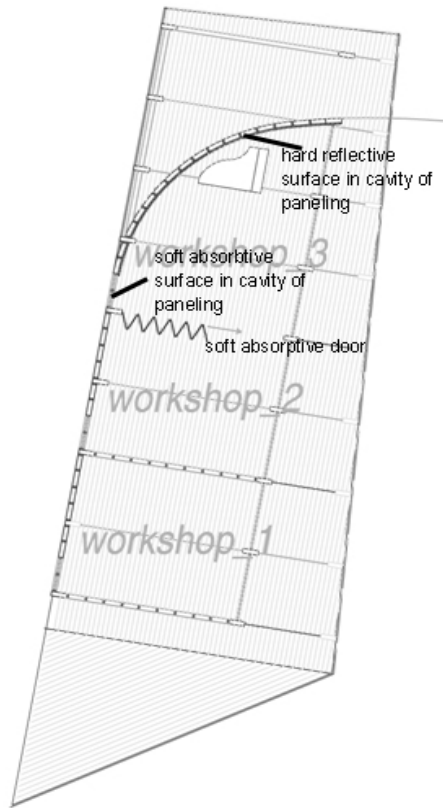
After much contemplation it was decided that little mechanical ventilation will be necessary in the building. External openings are shaded sufficiently to cool down the interior and heating will only occur during short periods of the year and will be regulated locally. The shape of the building aids cross ventilation with a slender E-W direction and windows are placed on those two sides (E and W). By adding those openings on both sides ventilation is increased by 47%. Furthermore, heat-generating processes, such as the filming and computer editing (where the apparatus generate heat) are placed on the S side, which is the colder side of the building. Natural ventilation will occur on the inner side of the W façade windows, where low-e glazing tends to

have a build-up of heat on the internal skin. This heat gathers in the inside leaf of the glazing, is released upwards through the building through the gap in the pre-cast concrete fins and released at the top of the roof.

Mechanical ventilation will be limited to the auditorium only, where windows are largely closed and the biggest number of people gather on one location in the building. Some ventilation will take the form of a single fan coil unit mounted on the E wall of the auditorium, fitting into the grid of curtain wall glazing. In addition, vents are installed on the N side of the auditorium, the highest side of the auditorium and bordering on the outside balcony.



acoustics in sound room



acoustics in workshops

FIRE

New fire regulations allow for something called a “rational solution”. An escape route can thereby be planned logically in terms of whether it is viable and safe, even though it does not conform directly to all fire regulations. The escape route in the building fulfils most regulations with respect to distances towards escape routes to the internal staircase in the MOTH club and the external fire escape with fire breaks and doors at the exits. The position where this rational solution is applied is in the design of the fire door at the fire escape on the S side. Normal carbon fire extinguishers and fire hoses are installed at prescribed distances.

ACOUSTICS

Wherever sound is propagated with a certain quality higher than normal a proper acoustic treatment is necessary. This would apply to the outside workshop, where acting and music are played, the auditorium, where lectures and film performances take place and the small filming studio in the movement box. All the other rooms like the offices and editing rooms and restaurant conform to general acoustic requirements.

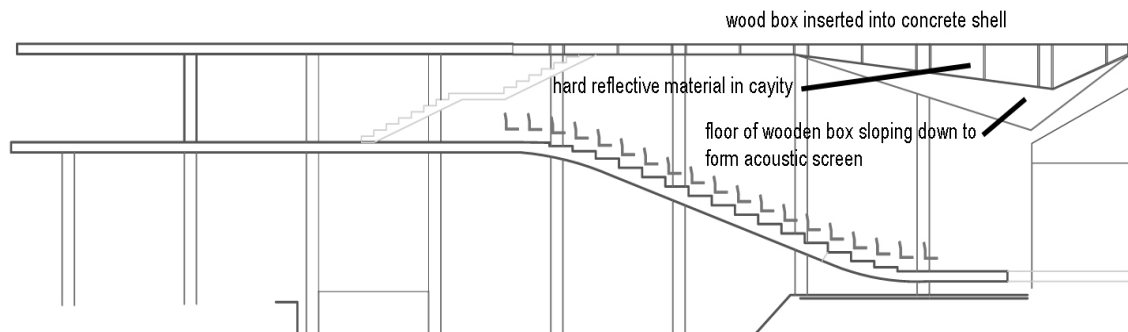
The outside workshop is a wood structure with wooden floors, sloped wooden ceiling and vertical internal cladding. The cavity of the internal cladding will be filled with either soft absorbent material or hard backing, depending in whether reflection or absorbing of sound is wanted. A piano stands in the corner and from here sound is reflected into the room or the extended room if the folding door is opened. The back walls are filled with absorbent material to prevent the wave's interference. Acoustics for this kind of general music and speech prefer a reverberation time of around 2,8 seconds. This room has a volume of 198 m² and absorption of 16,8 Sabines. The calculated time is now 1,9 seconds, which is too little. More absorbing material was thus added, in the form of dissipative absorbers in the folding door and the wall panels. This increases the total absorption to 16,8, which equates to a reverberation time of exactly 2,8 seconds.

The auditorium needs a reverberation time of around 1,2 seconds and is fitted with a reflective screen, which is the wooden floor of the wooden box floor sloping down. This screen reflects the sound outwards and then towards the back. A curtain is drawn during performances to darken the room, also fulfilling the dual purpose of forming the absorbent plane on the E and N side. It also provides a plane that is uneven and non-parallel to the opposite wall. This has the added advantage of breaking any possible standing waves that cause flutter and interference. The same counts for the skew wall at the entrance, which becomes the non-parallel wall from which sound is projected into the room. A quick calculation would reveal the following: reverb. time: $0,161 \times V / A$

The Volume has been calculated at 1044 m² and the total absorption (when the curtain is drawn) is 150 Sabines, which would give us a reverberation time of 1,12 seconds. This is almost the reverberation goal and it is decided that this is close enough (only 0.08 seconds less reverberation) and could easily be changed by increasing the absorption to 150

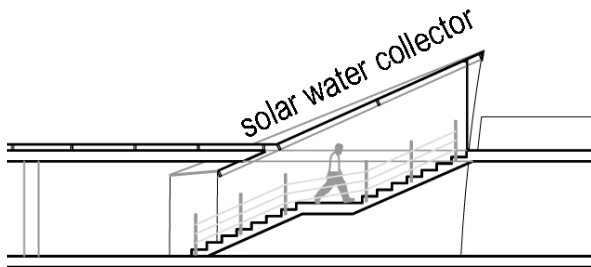
Sabines, which will only be done should a problem arise.

The most specialised of acoustic treatments in the building will occur in the dark room and filming studio. Here, a neutral sound is striven for and very little reverberation time is wanted, around 0,5 seconds. In this design the reverberation time was the starting point and then it was calculated how much total absorption is needed to achieve this time of 0,5 seconds at the 122 m² of that room. The total absorption this needs to be 39 Sabines and the only solution was to install panel absorbers, covering a narrow band of frequencies. A Helmholtz resonator was considered, but the panel absorber seemed more viable. Furthermore, two doors with a cavity of 200 mm were installed and fitted with sealing strips at the edges.



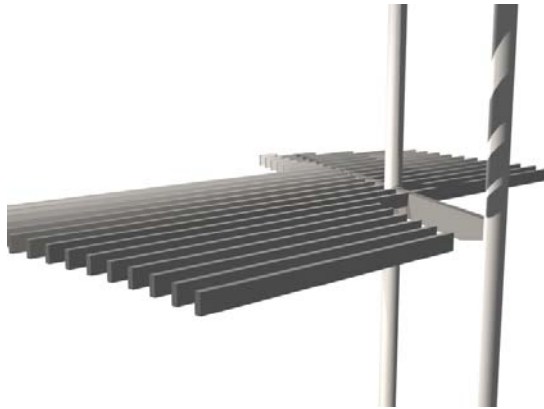
acoustics in auditorium

Climate remains a prime consideration when considering sustainable energy usage. South Africa is the country with the most solar radiation in the world and this has to be used. Many an architect immediately opts for the installation of solar panels, which is always a very easy and short-sighted view. Photo-voltaic cells are still very inefficient and with batteries only 80% effective, only about 12% electricity reaches the end-user. This will probably change soon, which will make most current p-v cells dormant and replaceable, leaving a huge amount of waste. A more efficient way of employing the sun would be passively, as in the louvres and the bio-glass system and actively in terms of the solar hot water collector (which is close to 50% efficient) on the sloped roof of the new service shaft. Its orientation is virtually straight to North, which is ideal and the tilt is at the ideal position for less summer and more winter usage. The collector can heat water up to 70°, but this specific unit will heat 300l (which needs 10kWhr) of water to 43°, which is good for domestic usage. The global irradiation in Pretoria on the absorber is 5kWhr/m² in winter and 7kWhr/m² in summer. The unit produces 60 to 70 l of hot water per m² and for the 300l water this would need an absorber of around 4,5 m². All the hot water feeding in the shaft will come from this source.



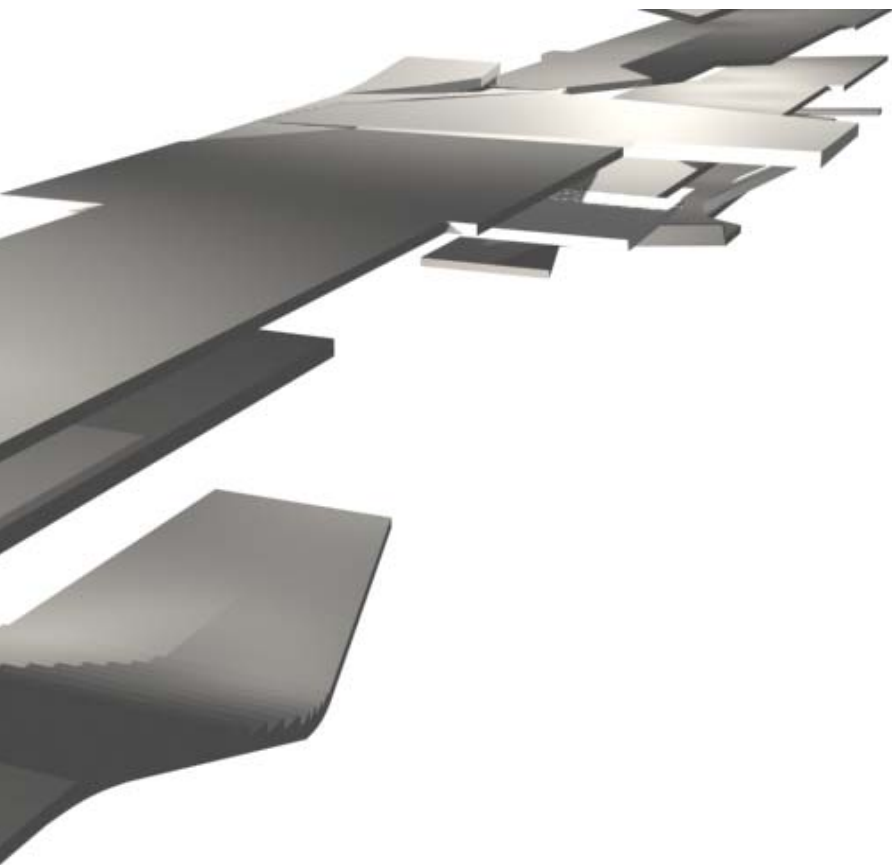
MATERIALS CONCRETE

Pretoria has a rich history of using materials in their natural way. In post-war times, where most building material was scarce, rock was used, joints left as thin as possible to save on mortar, roof slopes left minimum to save space and material (later the butterfly section was introduced, which epitomises this fact) and when bricks were used then very sparingly and efficiently. The properties of the material determined what it is used for and ensuring that very little extra has to be done to make that material work structurally and functionally. The same applies to this building, not so much out of an economy of means, but more out of the belief of working appropriately with a material.

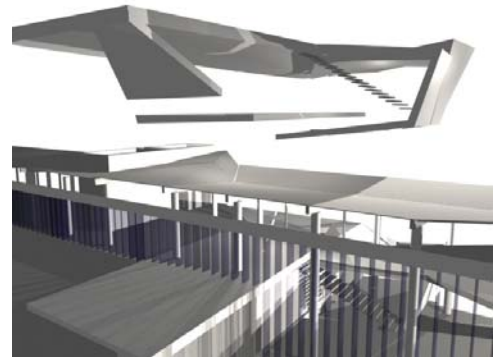


concrete beams

pre-cast concrete fins and haunches

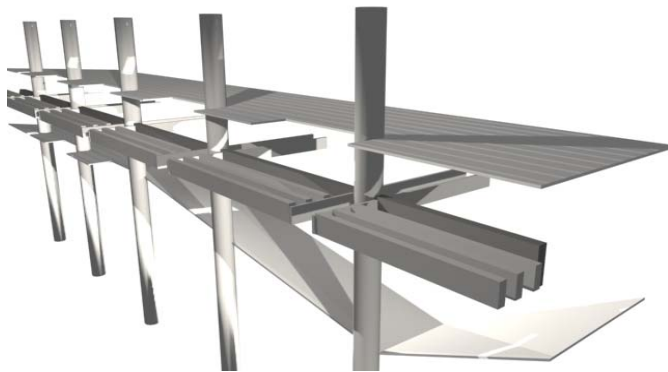


concrete movement box





laminated wooden trusses



wood box inserted into concrete slab

Concrete wants to display its plastic nature, the mouldability, versatile textures, its light carrying capabilities and its structural integrity. All of these are evident in the building. Slabs open and close, rise and dip, ramps and staircases “grow” out of them. They span regular distances and cantilever at important points. Pre-cast concrete panels, such as the haunches and fins ensure high quality. Finishes are off-shutter on the outside parts, studded PVC tiles in the offices, painted epoxy in the passages and open areas.

Brick is used in compression only and joints are exposed. This is evident in the face-brick of the shaft and the workshops. Furthermore, brick has an expressive and plastic nature, such as it curving around the spiralling staircases and the top of the shaft.

Glass is used both as a semi-transparent (as discussed in the part about transparency) agent and structural member. It is the skin that demarcates open and closed and is only employed in the parts that are closed off.

Wood - and in this case laminated wood - can be bent into many shapes and still retain, or even increase, its structural integrity. A laminated wooden beam is a modular unit where laminates are added in modules and the beam itself becomes a module, as in the wooden trusses and columns, where certain parts of the beam react differently to others. The wooden louvres show off the rustic and robust nature of wood, where the trees on the site are roughly sawn and dried on-site and filled into the louvres. The wood-shop is made entirely out of wood and so too the wooden box inserted into the concrete frame with its wooden floor.

Steel is used very sparingly and mostly in connectors. It has very strong tensile strength and this point is exploited by making it the element from which components hang. Trusses, benches, glass and shading all are connected with steel parts.

TREES

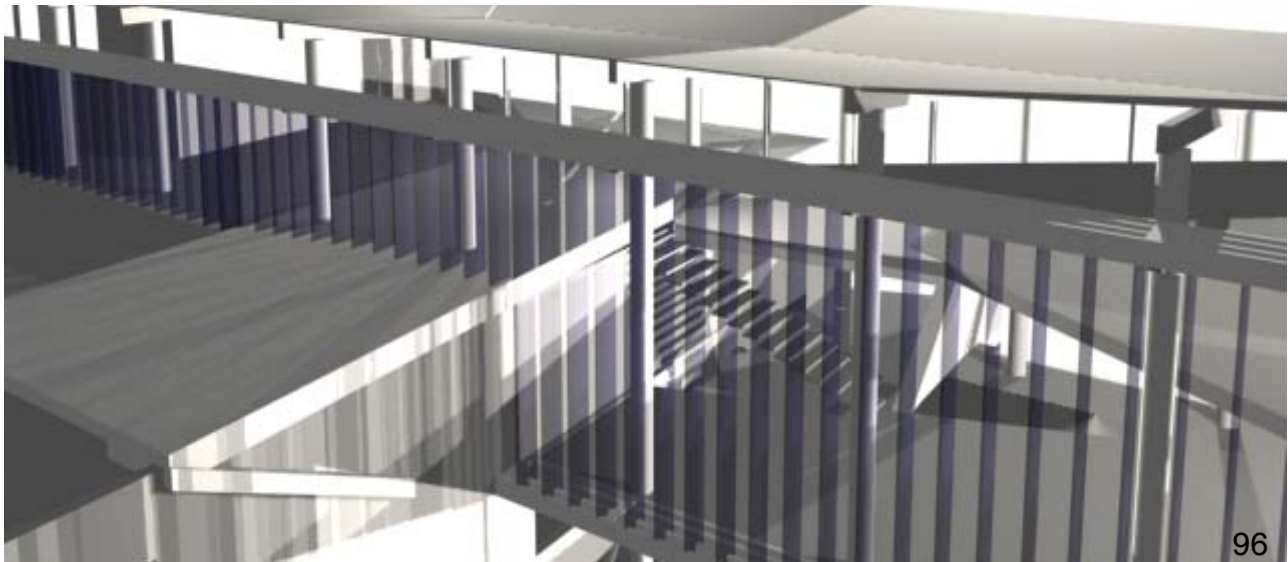
Most trees on the site are retained, some of which are indigenous, such as *Celtis africana* (older ones around the MOTH and new ones along the road) and some tall *Acacia siberiana*. Some foreign trees exist, most of which will be retained around the MOTH to add to the “jungle atmosphere”. One conifer on the S-W corner of the MOTH will be removed, as well as the four pine trees on the W side of the Breytenbach theatre.

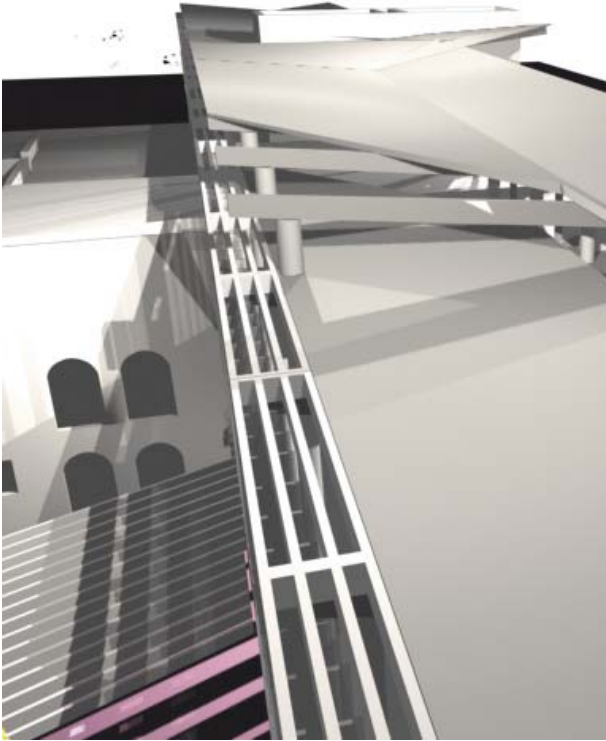
BMS

It was realised at an early stage that a completely passively functioning building would not be acceptable for this kind of scheme. Conditions need to be controllable for specialised kind of work and this is also the reason why an air-conditioning system was included in the auditorium. Passive principles are nevertheless applied wherever possible, such as the bio-glass system and the louvres that need to be managed to function efficiently. A Building Management System (BMS) is installed and placed in the



wooden louvres within facade





same room as the server for the computers. This system monitors the internal and external conditions, opens or closes louvres and windows, switches lights off when a room has not been used for some time. The individual user can still override these actions, but will be warned not to do so by a message or warning tone.

LIGHTING

A large amount of day lighting is necessary for the kind of services that are catered for in the building. The offices and editing area need an internal intensity of 200 to 300 lux and the workshops need 100 to 150 lux for general assembly. Glare is also one of the more problematic occurrences on computer screens and computers are never facing direct light, mostly turned towards the East or the South, where only indirect light will enter. The calculation for this would be:

Required Daylight Factor = Design Daylight
 Factor X External Obstruction Factor /
 Glass Factor X Dirt Factor
 = 3,5 X 0,9 / 1,1 X 1,5 = 1,9 and
 when working with an average
 external illuminance of 15 000 lux
 we get :

internal illuminance = RDF X external illuminance / 100
 = 15 000 X 1,9 / 100
 = 285 lux, which is sufficient, if not
 almost a bit high (which can be changed with the louvres,
 this being just the maximum to be expected), without any
 artificial lighting

For the workshops the calculation would be:

Required Daylight Factor = Design Daylight
 Factor X External Obstruction Factor /
 Glass Factor X Dirt Factor
 = 2,3 X 0,7 / 1,1 X 1,5 = 0,98 and
 when working with an average
 external illuminance of 15 000 lux
 we get :

internal illuminance = RDF X external illuminance / 100

$$= 15\,000 \times 0,98 / 100$$

= 147 lux, which is sufficient without

any artificial lighting

What must be noted here is that in the workshops a lot of outside work is done and here the daylighting calculations do not apply, because of the full solar radiation. The louvres and curtains are also the means to change the internal light, from totally dark as in the auditorium, to a relative darkness in the rest of the building. The louvres can be rotated into any position, the more square they sit, the darker the inside. This is also adjustable with the BMS.

In terms of artificial lighting, external lighting is provided by the fluorescent tubes inside the concrete beam as detailed and the armatures running on the light chain. These provide general lighting for exterior evening conditions, together with the light filled helium balloons, rising on the public square on special occasions. These provide both broad rays of light as well as providing a strong magnet for movement. Interior lighting is provided with fluorescent tubes in general areas and down lights for more specialised work and the residences.

ACCESSIBILITY

Accessibility throughout the building is not only a requirement by law, but just good social practice. Additional wheelchair ramps were not necessary as soon as the elevator became a necessity for the internal movement. The movement through the MOTH still remained the biggest challenge and this was solved by inserting the movement box. Wheelchair access is possible in all areas, except in the internal vertical movement of the workshops, which is private space and is only used by the inhabitants of the workshop.

ACCESSIBILITY

Accessibility throughout the building is not only a requirement by law, but just good practice in terms of social responsibility. Ramps were not necessary as soon as the elevator became a necessity for the internal movement. The movement through the MOTH still remained the biggest challenge and this was solved by inserting the movement box and allowing for lateral movement. Wheelchair access is possible in all areas, except in the internal