

The following text is supplementary to the set of drawings and motivates decisions made on a technical level. The objective of the investigation is to establish an appropriate strategy to achieve effective daylighting in the building. The investigation includes a historical study that, in conjunction with a technical investigation, informs design decisions.

With growing environmental concerns and the recent energy shortages in South Africa, the implementation of sustainable principles is elementary. The construction industry continues to be the primary energy and resource consumer. Therefore, it is the responsibility of the designer to make decisions that minimally impact on the environment. Although, responsible decision-making encompasses many more issues such as passive systems, material sourcing, and construction processes, the investigation focuses on lighting and the resulting thermal environment. The objective is to ensure energy-independent occupant comfort as far as possible.



### **Historical Study**

The historical study examines materials and shading devices used by the South African architect Norman Eaton in his response to local climatic conditions. The investigation is limited to the study of Eaton's "protective concrete window hoods"<sup>1</sup> as used in several Pretoria houses. In his later houses, climatic sheltering was provided by greater overhangs, while in other buildings, such as the Wachthuis in Pretoria (1955- 1960) and the Nederland's Bank in Durban (1961-1965), different materials (i.e. steel and concrete block) are used. These differing materials will not be covered in the investigation.

The Pretoria-trained architect Norman Eaton is highly recognised for his contribution to the development of modern architecture in South Africa. His work displays a sensitive local adaptation of the International Style with regard to regional materials selection and climatic design. His approach is in contrast to his rand counterpart, Rex Martienssen, who was bound by the traditional forms and materials of the International Style.<sup>2</sup>

"The explanation is that I am working in Africa... naturally I am more influ-

enced by Africa because I live here and travel here and my main interest

Eaton's approach is attributed to a wide range of eclectic influences.

These influences include Le Corbusier's method and approach to design.

Frank Lloyd Wright's integrated approach to architecture and its immedi-

ate context, as well as the use of traditional materials by the local archi-

Eaton's responsive approach is manifested in his response to local site

conditions and landscape characteristics,<sup>6</sup> the location of functions within

the building, 7 the orientation of buildings, 8 natural ventilation, 9 and shad-

is in Africa rather than in the Continent or the USA or anywhere else."4

Harrop Allin (1975: 27)
Eaton's approach allowed him to rise above the universality of the style
Harrop Allin (1975: 119)
and develop an individual "discernable African flavour". <sup>3</sup> At the time, Ea Harrop Allin (1975: 120)
ton commented:

Eaton's Influences:

Eaton's climatic response

ing, which is evident in all of his work.

tect. Gordon Leith.<sup>5</sup>

5. Harrop Allin (1975: 36)

Harrop Allin (1975: 28)

 the horizontality of his designs harmonises with the natural horizon lines of the site as seen in the De Loor House, Muckleneuk, Pretoria (1937 - 1938); (Harrop Allin 1975: 31)

 services and circulation spaces are located on the western facade with limited afternoon sunpenetration into the Nederlands Bank, Pretoria (1946-1953) (Harrop Allin 1975: 90)

 south-west facing facades of the Nicolson House, Brooklyn, Pretoria (1935) are closed to the direction of prevailing rains and winds (Harrop Allin 1975: 119)

9. long and narrow plans allow cross-ventilation as in the Van der Merwe House, Pretoria (1940-1941) Harrop Allin (1975: 35)

10. Harrop Allin (1975:26-28)

The protective concrete window hoods

The "protective concrete window hood" made its appearance in Eaton's very first commission, Boyes House in Brooklyn, Pretoria. The long, thin concrete hood, located above the strip window on the northern façade, provides shelter from the rain and the hot summer sun, while emphasising the horizontality of the design. The cantilevering concrete hoods were typically 450 mm deep, tapered from 130 mm at the wall to 80 mm at their edge.<sup>10</sup>



Figure 11.02 De Loor House, Pretoria



Figure 11.03 Window & chimney detail, Nicolson House, Pretoria

Figure 11.01 Floor Plan of the Nederlands Bank, Pretoria



**Design Considerations** 

## **Building Mass Level**

The investigation was conducted on two levels. Firstly, at a mass level, resulting from the identification of the public space located on the southern side of the building as a problem area due to the space being shaded throughout the day in mid-winter. The second level of investigation was on an individual unit level and focused on indoor light quality within residential and office units, both located on the northern façade of the proposed building. The addition of electrical lighting was examined at unit level.

On a mass level, the investigation informed bulk massing, the position of voids, and the height and position of roofs in order to improve the thermal and natural light quality of the identified problem area. (see figure 11.04)

On a unit level, the investigation informed both the position and the materials used for the shading devices, as well as the position and height of the windows. Electrical lighting is examined in conjunction with the achieved natural lighting scenario.

### Orientation

The building is situated on a restricted site. Its long side runs in an eastwest direction, exposing a large portion of the building to northern light and shading the public space located on the southern side of the building between the Old Synagogue and the new building. While the northern orientation is advantageous concerning sunlight and dominant northeastern summer winds for ventilation purposes, the southern side of the building, which opens onto the public space, is exposed to the direction of prevailing winter winds and rain.

### Form

The narrow form of the building, being primarily informed by its surrounding historical context, allows for good cross ventilation and natural light penetration into interior spaces and thus, is suited to the proposed office and residential functions. The south-facing atrium can be opened in summer to ventilate the partially enclosed interior public space while simultaneously, allowing protection from summer rain and winter winds when required. Ventilation at a high level allows for rising hot air to escape the atrium and aids cross ventilation.





<sup>89</sup> 



### Structure

The primary reinforced concrete structure of the building is based on a 7,6 m x 8,4 m grid, which is informed by its surrounding context. The structure consists of columns and beams, and it resists shear forces in the service cores, lift shafts and concrete slabs. This skeletal structure, not unlike Le Corbusier's "Domino Structure",<sup>11</sup> allows for flexibility within the building thus, accommodating future changes to the building programme.

The exposed circulation spine within the internal atrium is light in appearance. It is made of steel and reveals its construction.

#### Flexibility

Due to the adaptable nature of the proposed building and because of its variable functions, the building is designed to achieve flexibility. This is achieved by the bulk of interior walls consisting of dry-walling that can be easily moved to achieve required spaces. This reduces the overall weight of the building and allows for easy adaptation. Dry-walling achieves the required acoustic levels and can be re-used.

Similarly, services are provided by means of vertical shafts. Indoor floorto-ceiling heights are 3 345 mm high (this height is reduced in the top residential units) to accommodate suspended ceilings in the event of then being required for effective distribution of services.

### Skin

The building skin on ground level is primarily, glazed, allowing for visual continuity, allowing for the user's experience of the existing context on a human scale. Only serviced areas are enclosed. Above ground level, the building skin is primarily off-shutter concrete with glazed openings.

### Scale

11. Weston (1996:7-10)

Due to the large scale of the multi-storey building, horizontal elements have been used throughout the building to reduce the scale of the building to a human scale. On the northern edge of the building, a large concrete overhang provides shelter from the sun and rain in summer while defining the circulation space. Similarly, on the upper levels, the circulation bridges restrict and define movement paths, entry points and seating areas throughout the building. A large horizontal plane, situated between the public exterior space and the interior atrium, blurs the threshold between the two and, once again, reduces the scale on entry into the building. The tree situated in the courtyard, in addition to providing shade during summer, also reduces the scale and defines the space to comfortably accommodate seating.



## **Finer Scale and Resolution**

Recently, the City of Tshwane commissioned Ngedweni Design and the Trinity Session to develop a proposal for public art for the greater metropolitan council of Tshwane. The proposal<sup>12</sup> for public art is in line with the vision for Tshwane as a whole and differentiates between approaches for different regions within Tshwane, based on their individual strengths and weaknesses.

Church Street and Paul Kruger Streets have been identified<sup>13</sup> as "the two most ceremonial<sup>14</sup> routes in Tshwane". In line with the urban framework<sup>15</sup> of the area the objective is that each road:16

- "is as wide as possible;
- is an intensively developed Open Space; .
- contains at least two rows of trees on either side of the road as • well as one row within the median island, if relevant;
- contains trees responding to ceremonial, place-making, • legibility, structuring functioning;
- provides wide pedestrian sidewalks on either side of the road;
- does not contain overhead utilities:
- contains public art and street furniture" .

Ngedweni Design and the Trinity Session define public art<sup>17</sup> as a

"loosely used term that refers to works of art in any media or discipline that are planned and executed with the specific intention of being presented or executed in the public domain".

With this in mind, architecture can be described as a form of art that embodies both functional and spatial qualities. Located in the public realm, architecture can potentially function as a form of public art. In the same way as public art is used to change the perception of a place as a means Trinity Session (2007:31) to urban regeneration, architecture can potentially achieve the same and more.

12. Ngedweni Design & the Trinity Session (2007:29-34)

13. Ngedweni Design & the Trinity Session (2007:31)

14. "Ceremonial routes are the most important symbolic streets in the city and are typically used during important festivals and celebrations. They are the streets that carry the image of the city and are typically tourist attractions," Naedweni Desian & the Trinity Session (2007:31)

15. refer to p 34

16. Ngedweni Design & the

17. Ngedweni Design & the Trinity Session (2007:2)



## **Proposal for Public Art**

The proposed building is situated on a public space as a functional piece of sculpture that allows for strategically placed visual and physical accessibility. The building, generated by its surrounding context, challenges the public's current perception of the site by allowing the user to become aware of the surrounding historically significant buildings. In this manner, the building engages the user as well as passers-by.

In addition to the proposed building, other forms of public art should form part of the activation process<sup>18</sup> on site. A series of activities and events should take place on site prior to the construction of the building itself:

The process should begin with the activation of the intersection. This may be done by placing a large of grass installation in the middle of the intersection and encouraging the public to approach it and take in the impressive views both towards the Union Buildings and south towards Church Square. The intention of the installation would be to challengethe publcis's perception of their daily surroundings in addition to documenting the public's reactions. The documentation is then to be exhibited on the site as a public photographic exhibition.<sup>19</sup> The objective is to generate an interest in the site while physically activating it.

Physical forms of public art on the site, such as sculptures, should be minimal with a focus on functionality. Street furniture and lighting as well as a drinking fountain (refer to figure 11.07) located below the main staircase become opportunities for artistic yet functional interventions. A tactile 'story-board' attached to the concrete balustrade of the viewing balcony of the second floor of the main staircase should be commissioned by an artist. The 'storey-board' should inform the user of his surroundings while telling of the historical events that took place on the site. The artistic qualities should be manifest through the pattern detail of the floor of the city that runs throughout the building. This approach should also be manifest in the texture of interior finishes (refer to figure 11.05).



Court in Braamfontein



igure 11.06 Winding Mosaic Bench, Park Guëll, Barcelona



Figure 11.07 Mosaic Fountain, Park Guëll, Barcelona

18. refer to p60

19. refer to fig 8.02 for conceptual sequence of activities on site



Other forms of public art to take place on site should be primarily auditory reflecting the practices and traditions of Jewish culture. In doing so, such performances allude to the many hearings that took place in the Old Synagogue. The partially removed additional building north of the Synagogue should be used as a 'stage' for such events.





## Investigation

## **Natural Lighting**

### Mass level

By means of placing a 1:200 scale paper model on the solarscope and examining the existing daylighting scenario, followed by making adjustments to the model, a building mass was established that allowed light to penetrate into the identified problem area. Natural lighting scenarios were examined on the summer and winter solstices at 08:00, 12:00 and 16:00.20

Initially, it was assumed that by removing three sections on the lower levels of the model (coloured red on model - figure 8.0?), light would penetrate through the central atrium space into the identified problem area. However, as a result of the investigation, it was established that only by removing the top levels of the model would light penetrate into the public space on the southern side of the building. Subsequently, a large multiple volume opening was punched through the northern facade in order to allow northern lighting to penetrate deep into the most shaded area of the public space. The result strengthens the argument for activating the public space in an attempt to bring about urban regeneration. In addition, by introducing louvers on the southern edge of the roof, light is able to penetrate from above into the space below during winter months. While the thermal impact of direct light in winter is minimal, the impact on the percieved thermal environment of the southern public space is notable.

The scenario in summer differs greatly from the winter scenario. In summer, the public space is exposed to sunlight for the bulk of the day, with minimal shade in the morning and afternoon. By means of the sun study, the position of a large indigenous deciduous tree was determined to straof the technical investigation tegically provide shade during summer months.

21 December 12:00





21 July 16:00

21 July 12:00

Figure 11.11 Sun investigation

Figure 11.10 Problem Identification

Figure 11.09 Sun study and documentation

20. refer to Appendix E for the

full photographic documentation



### Individual Unit Level

The northern block of the building houses a variety of functions including both office and residential accommodation. It is important that both functions are adequately provided for in terms of natural lighting and its impact on the thermal environment. Occupant comfort ranges from 16° to 32° Celsius, with optimum temperature between 21° and 22° for a seated person exposed to air movement of 1 m/s.<sup>21</sup> The amount of light that enters though the glazing has a significant impact on the indoor thermal environment, especially due to the high heat retention properties of the exposed concrete structure. By means of a further investigation, the depth of direct northern light penetration into the interior space was determined and limited by means of lightshelves that further improve luminance distribution and reduce glare. Lightshelves are especially effective in a clearsky climate such as in South Africa.

The following equation<sup>22</sup> assumes a rectangular room where the depth of the space is not more that 2.5 times the window height. This is the case with each individual bay on the northern facade of the building.

|                        | 2 x Average Daylight Factor x Total Area of Interior Surfaces x<br>(1-Weighted Average reflectance of all interior surfaces) |  |  |  |
|------------------------|--|--|--|--|
| Required Net Glazing = |  |  |  |  |
|                        | Visual Transmittance x Vertical Angle of Sky visible from centre of Window   |  |  |  |

| Total Required Net Glaz                              | zing   | 5.1m <sup>2</sup>   | 22.<br>Sell | Lee, O'Connor, Rubinstein &<br><owitz ([s.a.]:17)<="" th=""></owitz> |
|--|--|---------------------|-------------|--|
| Vertical Angle of Sky<br>(90° – obstruction and      | gle of trees)  | 75°                 | 21.         | Holm (1996:5)  |
| Visible Transmittance<br>(for medium sized wir       | ndows)   | 0.5                 |             |  |
| Area Weighted Average I<br>(default value)           | Reflectance  | 0.5                 |             |  |
| Total Area of Interior Surf<br>2(6960 x 3345) + 2(36 | aces<br>600 x 6960)  | 96.67m <sup>2</sup> |             |  |
| (for average-light spa<br>minals (VDTs): ambie       | ces: suitable for offices using visual disp<br>nt lighting of max 300lux is appropriate) | lay ter-            |             |  |



## Window Design Parameters

The following parameters were set up to determine a strategy for glazing on the northern facade of the building. They informed the decision making process.

| Depth of Beam                    | 795mm  |
|----------------------------------|--------|
| Max Depth for Suspended ceilings | 270mm  |
| Desk Height = 750mm + 300mm      | 1050mm |
| Height of solid balustrade       | 1100mm |
| Height of steel balustrade       | 950mm  |

Depth of penetration (with no light shelf) 1.5 x h 1st & 2nd floor: 1.5 x (3345 - 270 - 50) = 1.5 x 3025 = 4537.5mm 3rd & 4th floor: 1.5 x (2755 - 270 - 50) = 1.5 x 2435 = 3652.5mm

Depth of penetration (with light shelf) 2.5 x h 1st & 2nd floor: 2.5 x (3345 - 270 - 50) = 2.5 x 3025 = 756.25mm 3rd & 4th floor: 2.5 x (2755 - 270 - 50) = 2.5 x 2435 = 6087.5mm

- Higher windows result in deeper light penetration
- Strip windows (horizontal window shapes) ensure a more uniform light distribution
- Avoidance of glare by minimising direct summer light and using splayed or round surfaces at window openings. Direct winter light gain up to 1600mm for desired heat gain

### • Light shelf: 23

improves luminance distribution and reduces glare doubles as a shading device exterior light shelf is better than an interior one used only on north-facing facades only has an impact in individual bays positioned above any visible point in the room to be positioned in line with underside of beams painted white/ diffusely specular to improve luminance distribution and reduce glare Ceiling to be smooth and painted white

- · Deep facades act as a buffer zone for shading
- In a room deeper than 4600mm, provide vertical illumination on back wall – within two feet of back wall) with a cool light temperature of 4000K



Figure 11.12 Illumination with incresing depth of unit



Figure 11.13 Impact of light shelf on illuminance distribution

23. Lee et al ([S.a.]:14)



especially for those working in close proximity to glazed surfaces. This will also allow for improved passive heat gain in winter. Similarly double glazing is required on the southern façade to allow for large openings that permit occupants the benefit of viewing the synagogue without compromising the indoor thermal comfort. Large glazed areas on the southern side of the building ensure high quality light distribution in the interior.<sup>24</sup>

The Visual Transmittance is slightly reduced when using clear double glazing (VT single glasing = 0,89 in comparison to VT double glasing = 0,80), but the impact on the indoor light quality is minimal, with its benefit evident in the improved thermal properties.

Window shapes have an impact on the interior lighting quality. The greater the continuity of glazing, the more uniform the lighting distribution is within the space. Therefore, the window openings in the office spaces are horizontal rather than vertical. Breaks between windows are limited to avoid a contrast between light and dark, which results in increased glare. Window head height is as high as possible in all cases to allow for deep daylighting within the interior units.<sup>25</sup>

A deep-façade approach has been taken to create a buffer zone to allow for effective lighting and shading control. The introduction of lightshelves emphasises the horizontality of the northern façade, while allowing for diffused light to enter more deeply into the interior space. These envelope features improve daylight distribution and help control glare. In addition, splayed and rounded window openings that soften light contrasts have been implemented in office units.

### Electrical Lighting:

Electrical lighting is to be introduced parallel to the glazing to ensure consistent lighting levels with increasing depth of individual units. The installation of an automatic lighting system with a dimming device is proposed.

Lee *et al* ([S.a.]:13)
Lee *et al* ([S.a.]:11-14)

### Material Selection

Two different types of shading devices were examined for use as lightshelves. While vertical louvres have a minimal heat gain and are effective for shading, they offer a limited surface for reflecting light deeper into the interior space. Based on this evaluation, it was determined to use a precast concrete light shelf with a matte white or diffusely specular finish to minimise heat gain and maximise its reflective qualities.

### Glazing

Due to the limited space available and the resulting efficient use of interior space, it was decided that windows on both the northern and the southern façades should have double glazing to ensure occupant comfort and reduce temperature fluctuations within the space. This reduces heat loss through single glazed windowpanes and ensures occupant comfort,

