7. CONCLUSION

- "There are not more than five primary colours (blue, yellow, red, white and black), yet in combination they produce more hues than can ever be seen."
- "Life has loveliness to sell, all beautiful and splendid things, blue waves whitened on a cliff, soaring fire that sways and sings, and children's faces looking up, holding wonder like a cup." - *Sara Teasdale (1884-1933)*

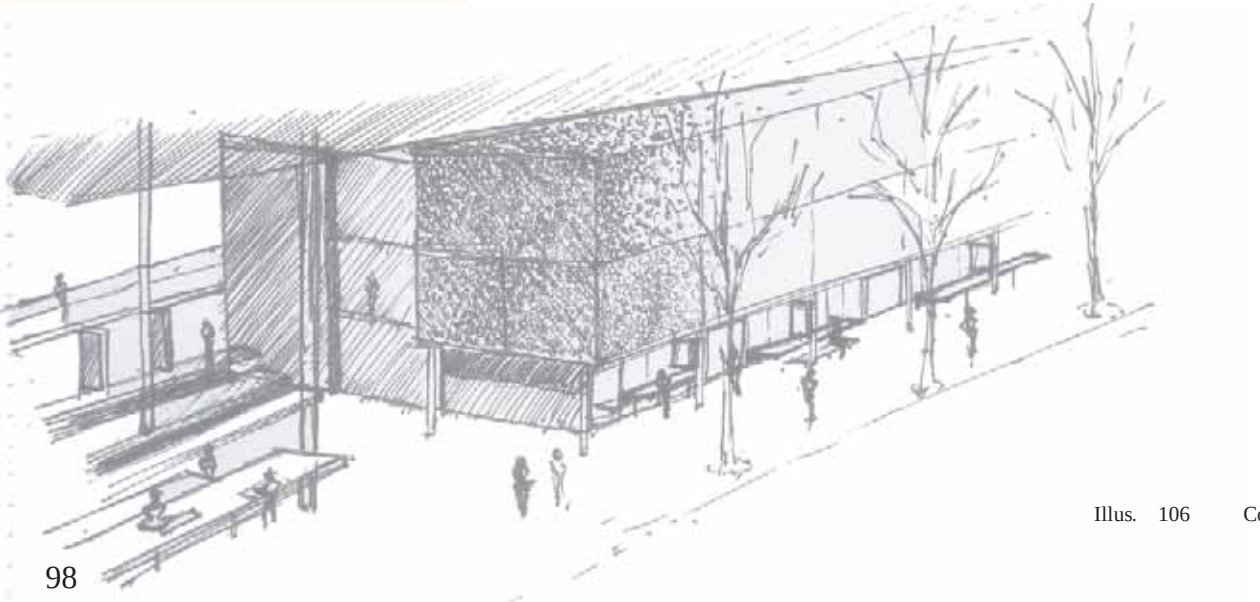
5. CONCLUSION

This dissertation is an investigation of the use of colour and light in creating a meaningful architectural identity and space in an urban environment. The author is of the opinion that there is a lack of attention given to these mediums which could, if used correctly, change the individual's perception of his surrounding environment. As colour and its significant emotional effects on the human being are subjective, there is no definite recipe for creating a meaningful architectural identity and space. Research on the subject produced only scientific information on colour, with a view references to colour and its use in architecture. Unfortunately these references tend to be outdated. This made the task of the author very hard as the written records of combining colour in architecture are limited.

The research was thus mainly based on visual references, where the designs of early masters, as well as a few contemporary architects and designers were investigated. It became evident that the synergy of light and colour in architecture has the ability to create architecture which is meaningful and visually stimulating. These architects understood the importance of using light (and therefore also colour) as medium to inform there architecture.

How a building is perceived and how it responds to its context is altered by the use of colour and light. The program of the building as mainly a paint production factory gives reference to the importance of colour in the individual's daily life. With the specific context of the site, and its importance as a gateway, the use of colour and the play of light in movement were employed in the design to celebrate the building, while simultaneously serving as a landmark. The context of the site became the main form giver together with the specific programme of the building. As colour does not exist without light, light became the main space defining medium of the building.

The site under investigation posed to be challenging in addressing the programme of the proposed building. The significance of the existing building on the site had to be considered in formulating an appropriate design solution. The author chose to frame



Illus. 106 Concept sketch (August) (Author 2007)

the existing building by the proposed development, while subtly penetrating into the ground floor space as to establish a physical connection between new and old development.

The architectural language of the proposed project strives to establish a connection between building and nature through the use of colour and light. The connection between individual and his/her physical environment would be established through the involvement of the individual with the colour producing process. The visitor to the site can use the building as a form of expression. This is achieved through the provision of studio spaces and walls to paint on, as well as areas where the visitor can produce his/her own paint. The individual's involvement in altering his/her environment through the use of colour, make him/her part of the process and therefore part of the urban fabric.

The proposed project does not serve as the exact answer on how to apply colour in the architectural field, but rather to explore how, through the use of this media and its interaction with light, meaningful architectural space within a given programme could be made in the urban fabric.

8. TECHNICAL INVESTIGATION

- "You don't have to travel aound the world to understand that the sky is blue everywhere." - *Johann Wolfgang von Goethe (1749-1832)*
- "Artists can colour the sky red because they know it's blue. Those of us who aren't artists must colour things the way they really are or people might think we're stupid." - *Jules Feiffer*

8. TECHNICAL INVESTIGATION

8.1 DESIGN INFLUENCES

Villa Mairea, Noormarkku, 1938
Architect: Alvar Aalto

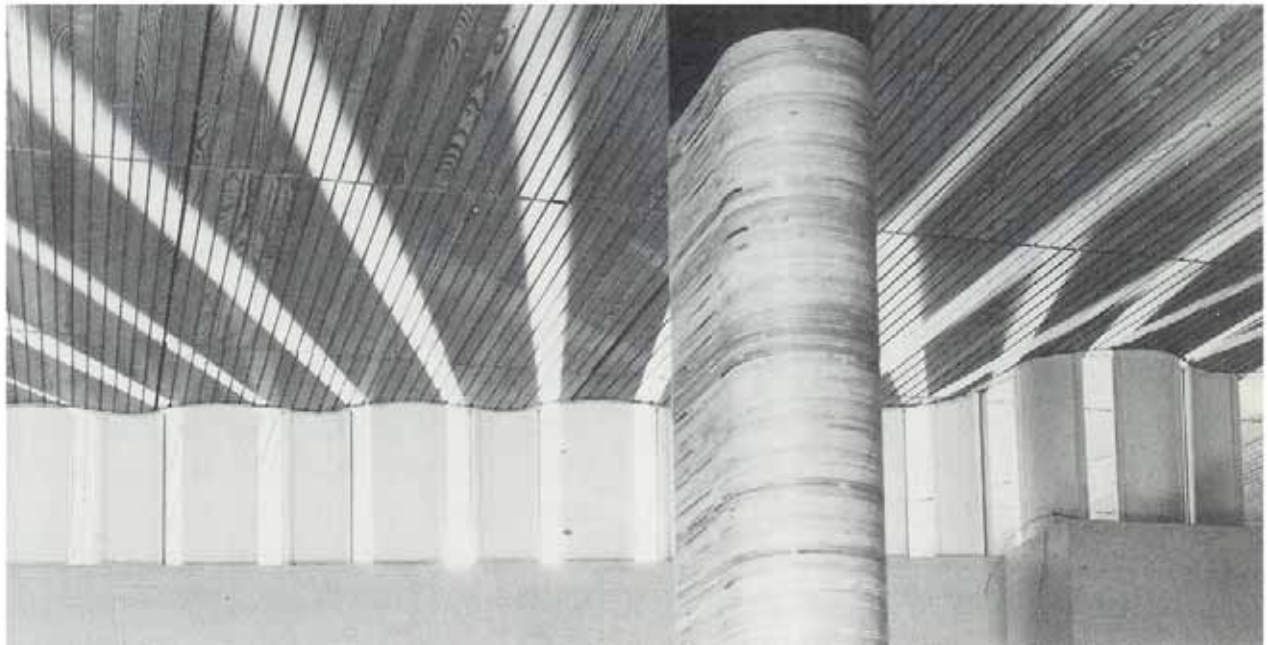
The building is a summer house for the family Gullichsen, which Aalto designed in 1937. A variety of free form elements changed the spirit of the building to one of playfulness. These elements can be seen on the entrance view, as volumes projecting and cantilevering at a different angle than that of the façade wall. A rich play of shadows can be seen on the façade as a result of this. Aalto also designed the living room details in such a way that light falls in dramatically through slices of clerestory windows, casting a play of shadows and light onto the wooden ceiling.
(PEARSON 1978: p.174-175)

Cemetry master plan, Lyngby, Denmark, 1951
Architect: Alvar Aalto

In the master plan for the cemetery, Aalto used his well known wedge or fan arrangement, which was taken from his established vocabulary. The pathways are themselves straight, although rarely parallel and different in length. This arrangement opens the space from one building or mass to another. Aalto frequently used this fan arrangement, in his planning as well as in design, to preserve some natural aspect of the site.
(PEARSON 1978: p.220-221)

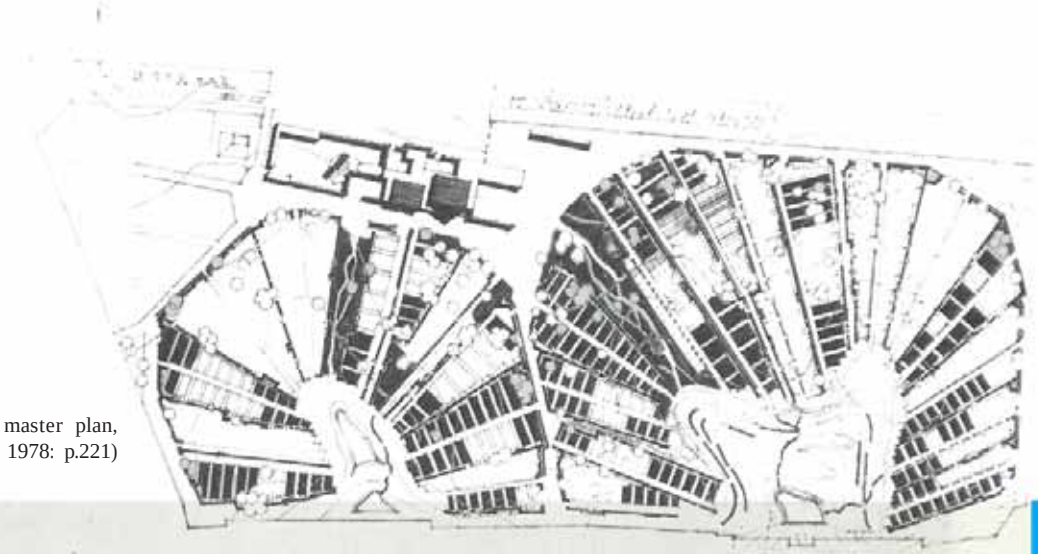
Town Center development, Seinäjoki, 1953-67
Architect: Alvar Aalto

The earthen steps at Seinäjoki are designed by Aalto as a way to preserve some natural aspect of the site. Here it is used as a reinforcement of the contour line. This element keeps the building in close contact with its natural context while giving it is unique architectural identity.
(PEARSON 1978: p.220-221

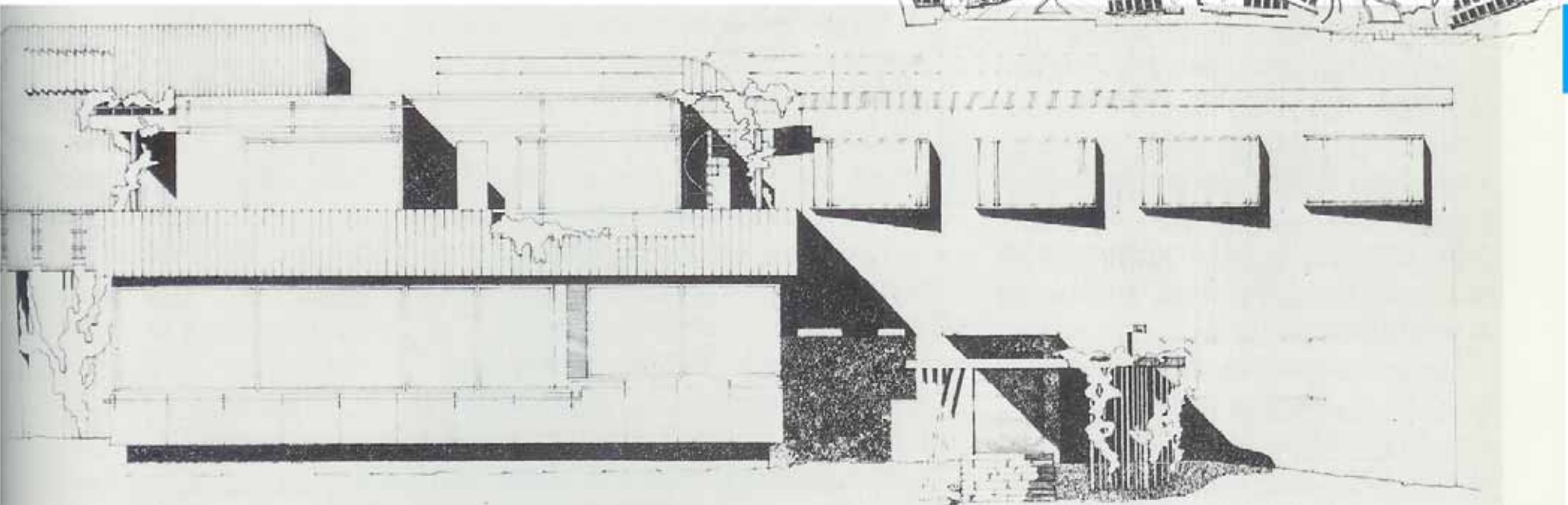


Illus. 107 (left) Villa Mairea, completed house, entrance view, Noormarkku, 1938, Alvar Aalto (PEARSON 1978: p.174)

Illus. 108 (right) Villa Mairea, completed house, living room details, Noormarkku, 1938, Alvar Aalto (PEARSON 1978: p.175)



Illus. 110 (right) Cemetery master plan, Lyngby, 1951, Alvar Aalto (PEARSON 1978: p.221)



Illus. 109 (below) Villa Mairea, final version, southern elevation, Noormarkku, 1938, Alvar Aalto (PEARSON 1978: p.175)

Salk Institute for Biological studies, La Jolla, California, 1959-65
Architect: Louis I. Kahn

Kahn used off-shutter concrete as the main building material in the Salk Institute. His love for raw concrete can clearly be seen in this design. The design shows his interpretation of 'Between Silence and Light', which was his main motivation behind the scheme, where the concrete formwork is emphasized by the play of shadows and light. Concrete formwork was also applied for the design of the water outlets (scupper), showing Kahn's ability to design everything to the last detail. (Architecture and Urbanism 1975: p.188-199)

Illus. 111 Town center development, view of town hall with church, Seinajoki, 1953-1967, Alvar Aalto. (BAIRD 1970: p.94-95)

Illus. 112 Salk Institute for Biological Studies, view through central court, La Jolla, California, 1959-1965, Louis I. Kahn. (ARCHITECTURE AND URBANISM 1975: p.188)

Illus. 113 Salk Institute for Biological Studies, passage under administration offices, La Jolla, California, 1959-1965, Louis I. Kahn (ARCHITECTURE AND URBANISM 1975: p.199)

Illus. 114 Salk Institute for Biological Studies, scupper on balcony corridor, La Jolla,California, 1959-1965, Louis I. Kahn.
(ARCHITECTURE AND URBANISM 1975: p.195)

Illus. 115 Salk Institute for Biological Studies, scupper from inside balcony corridor, La Jolla,California, 1959-1965, Louis I. Kahn.
(ARCHITECTURE AND URBANISM 1975: p.195)

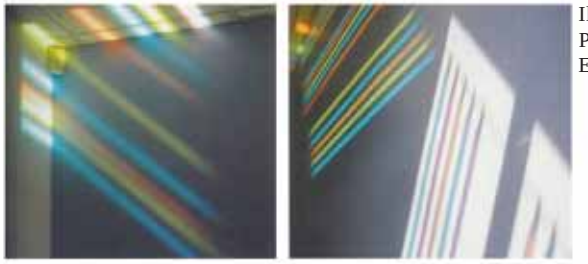
Fire and Police Station, Berlin, Germany, 2004 / Photonics centre, Berlin, Germany, 1998
Architect: Sauerbruch and Hutton

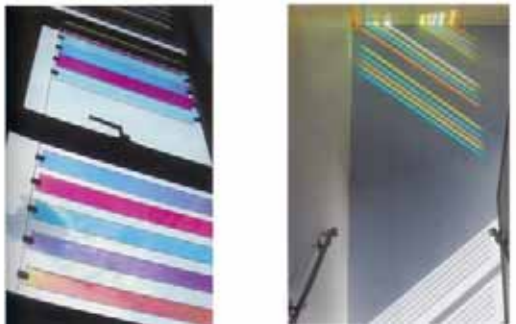
The glazing for the building is printed with an opaque enamel in a reverse dot pattern, with the dots clear and the background printed. At night the building is a dramatic patchwork of red and green. This design shows how the architects work with the dominant program of the building and the colour resembling this program. The red glazing is also contrasting with glazing in its complimentary colour, green, to form a façade with a unique architectural language. From a distance the Venetian blinds, at the Photonics Centre read as coloured glazing, with unusual patterns of reflections that are magnified by the organic form of the building. The blinds create a delicate and irregular play of light in the interior, which is different from the effects achieved with coloured glazing. The blinds can also be controlled individually by the occupants. The 36 different shades of the blinds allude to the theme of optical research that is carried on inside the building. (MOOR 2006: p.34-39)

Illus. 116 Fire and Police Station, Berlin, Germany, 2004, Sauerbruch & Hutton. (MOOR 2006: p.39)

‘Ladder of Light, Papworth Hospital, Cambridge, England, 2003
Architect: Chris Wood

This feature was designed by Wood to create an artwork for the large blank wall of the stairwell of a new extension to the hospital. This work is a simple structure of suspended panels dichroic glass, which project changing geometric forms of coloured light onto the opposite and adjacent walls when illuminated





Illus. 117 “Ladder of Light”, Papworth Hospital, Cambridge, England, 2003, Chris Wood (MOOR 2006: p.139)

by natural or artificial light. This is a clear example of the kinetic qualities that coloured glass possess, which engages the viewer directly with the optical kinetics produced by the shifting positions of the viewer and the varying quality of the light source. (MOOR 2006: p.139)

Illus. 118 Photonics Centre, Berlin, Germany, 1998, Sauerbruch & Hutton (MOOR 2006: p.34)

Storefront for Art and Architecture,
New York, 1993
Architect: Steven Holl Architets
with Vito Acconci

Holl used structural concrete board for the facade of this gallery which opens with hinged panels. The different angles at which the facade opens produces a play of shadows and light in the interior of the gallery space. The panels can also be changed to different angles, producing a constant change of light quality. (OJEDA ET AL 2003: p.54)

Illus. 119 Storefront for Art and Architecture, New York, 1993, Steven Holl Architects with Vito Acconci (OJEDA ET AL 2003: p.54)

High Court (Palais de Justice),
Chandigarh,India, 1956
Arhitect: Le Corbusier
(Charles-Édouard Jeanneret)

The extensive use of off-shutter concrete is the main materal used by Le Corbysier for the design of the High Court. He contrasts this robust material with the use of painted areas on the façade, to form a unique architectural language. The painted areas on the Brise-Soleil façade, which he is famous for, produce a unique play of colour with light and shadow. shadow. Le Corbusier mainly used primary colours, which is reminiscent of the painting of the artist Piet Mondrian, together with the griderion pattern of the Brise-Soleil wall. (TUCKER)

Illus. 120a-d High Court (Palais de Justice), Chandigarh, India, 1956, Le Corbusier .

(Photo SAARSTE) (Wikipedia 2007)

Illus. 120a

Illus. 120b

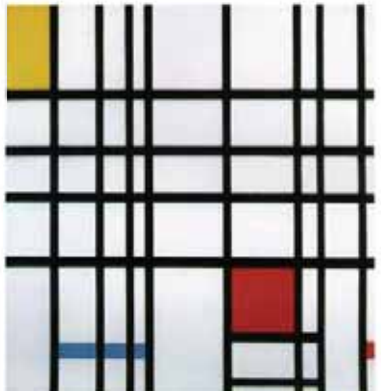
Illus. 120c

Illus. 120d

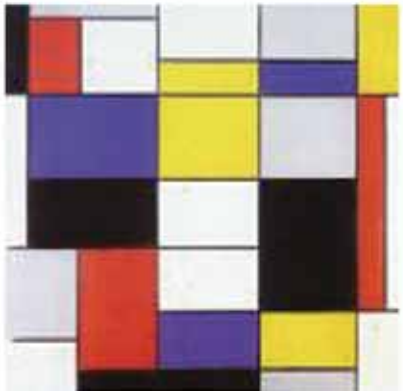
Illus. 121 Millowners Association Builsing, Gujarat, Ahmedabad, 1954, Le Corbusier.
(Photo SAARSTE) (Wikipedia 2007)

Illus. 122a-b Composition in yellow, red and blue,
Piet Mondrian (Wikipedia 2007)

Illus. 122a



Illus. 122b



8.2 MATERIAL SELECTION

Illus. 123 Salk Institute for Biological Studies, passage under administration offices, La Jolla, California, Louis I. Kahn

8.2.1 CONCRETE

The main building material of the proposed development is off-shutter reinforced concrete. The superstructure is a post-tensioned reinforced slab and column structure, including a reinforced concrete roof and exterior and interior walls.

There are numerous advantages of concrete construction:

- It can achieve large spans.
- It has a good thermal mass due to its high density.
- Various finishes and textures can be obtained with concrete depending on the formwork, and by adding pigments. Artevia produces a wide range of aesthetic concrete with pigments to produce a natural colour palette. Litracon TM is light transmitting concrete that, through the addition of optical fibers, produces concrete that transmit light, while retaining its high compressive strength. These advances in technology makes the use of concrete as a building material interesting while adding to the building's aesthetic appeal. The proposed design requires the off-shutter reinforced concrete walls to be cast with rough-sawn timber formwork shuttering, in a vertical texture, which is reminiscent of the industrial nature of the proposed paint producing area. 150mm wide by 38mm thick boards are used to create the texture, with chamfered edges and tight butt joints. The flanking reinforced concrete walls of the western façade is to be cast with Artevia coloured concrete, in three specific tones: Welsh Slate, Plum Slate and Alpine Green. The reinforced concrete floor and roof structure is to be cast with Self Compacting Concrete (SCC), which will finish of the delicate curve and cut-out detail of the floor and roof slabs. The light boxes on the first floor of the colour therapy area is to be constructed with Litracon TM, light transmitting concrete, to create a pay of light and shadow. The western façade wall, which separates the delivery area from the taxi rank access road, is designed to act as a Brise-Soleil wall, which protects the laboratories and offices

Illus. 125 (left) Litracon, Light Transmitting Concrete. (LITRACON 2007)

Illus. 126 (bottom) Home Office Building, London, England, 2005, View of multicoloured glass fins. (MOOR 2006: p.55)

Illus.124 Concrete texture created by rough sawn timber boards.(DEPLAZES 2005: p.57)

Illus. 127(top) Boehringer Ingelheim Pharmacological Research Laboratories, view of coloured glass facade, Biberach, Germany, 2002. Sauerbruch & Hutton. (MOOR 2006: p.37)

from the harsh western afternoon sun, while creating a play of shadows and light that disperses throughout the delivery area and into the laboratories and offices. This wall is constructed with a designed modular system of 6 precast reinforced concrete modules, which is bolted to galvanized steel profiles that is cast into the reinforced concrete columns.

8.2.2 COLOUR GLAZING

The glazing of the coloured boxes on the first floor passage is designed to be square panels of Smartglass Colourvue 15mm toughened safety glass. The glass box structure is steel H-columns and I-beams, with the glass fixed as an exterior cladding by 15mm toughened safety glass finn clamped by steel equal angles bolted to the steel H-columns and I-Beams. Smartglass Vanceva glazing is to be used, with every box in a different primary colour, with one square glass pane of the primary colour which will create a glow of secondary colour within the glass box. The different coloured glazing for each box would be: Deep Red with Deep Regal Blue to create purple secondary coloured light, Sahara Sun with Ruby Red to create orange secondary coloured light and Deep Coolblue with Golden Light to create green secondary coloured light. The elevated viewing concrete walkways have longitudinal pieces cut-out of the wall and roof area, which is filled with a spectrum of vanceva coloured glass. This creates changing geometric forms of projected coloured light, which will fall onto the floor areas of the walkway as well as onto the gathering space on the ground floor. The viewer will be engaged directly by the optical kinetics of the shifting position of the viewer and the varying quality of the light source.

Illus. 128 (left) Cranbrook Institute of Science, Michigan, 1999, Steven Holl Architects. Double layer perforated plywood panels showing the effect the perforated steel plate will have on the eastern facade.(OJEDA ET AL 2003: p.22)

8.2.3 PERFORATED STEEL PLATE

Perforated Steel Plate (50mm diameter cut-out holes) is used on the eastern façade. This will protect the interior spaces from direct eastern sun while giving the offices and therapy practices a large amount of privacy without compensating on the light quality within these spaces. The perforated plate has an H-column and steel equal angle structure that is fastened to the structure with a 500mm distance between internal glazing and the perforated structure. This will allow adequate ventilation to the interior spaces. The façade will have a double layer of coloured perforated steel plate, with a different colour plate as a second layer. This will create an illusion of colour 'mixing' as the pedestrian walk past, as well as for the passing vehicular traffic, which will experience this effect at a much faster pace. The effect will create a constant flux of colour on the façade, giving the spectator a sense of interactivity with the building façade.

Illus. 129a

Illus. 129b

Illus. 129c

Illus.129a-c(below)Sarphatistraat Offices, Amsterdam 2000, Steven Holl Architects. The outer perforated skin of prepatinated copper and inner stucco layer with intense colours, showing the effect the perforated steel plate will have on the eastern facade (OJEDA ET AL 2003: p.86-87)

Illus. 130a

Illus. 130b

Illus. 130c

Illus. 130a-c (top) Chapel of St. Ignatius, Seattle, Washington, 1997, Steven Holl Architects. Light shafts made of scratch-coat plaster, patterned by hand during application with large-toothed trowels and left unfinished. (OJEDA ET AL 2003: p.120-121)

8.2.4 INTERIOR WALL SURFACE

The interior surface of the reinforced concrete walls, as well as the brick infill wall surfaces in the store areas to be covered with scratch-coat plaster, patterned by hand during application with large-toothed trowels and left unfinished. Coloured glass inserts in the clerestory windows of the main production areas will cast different shades of colour onto the unfinished patterned walls, creating a coloured relief on the wall surfaces. This effect can be seen in Steven Holl's Chapel of St. Ignatius in Seattle, Washington, built in 1997.

Illus. 131 (right) Plascon 2008 Colour Forecast, 32 Light-Inspired Colours (Plascon pamphlet)

8.2.5 PAINT

The robustness of the concrete Brise-Soleil western façade wall is to be contrasted with Plascon painted areas, which will give the western façade a unique architectural identity, while dually acting as an advertising board for Plascon, where they show their forecast colour for the season. This will constantly be repainted as the forecasts change, altering the aesthetics of the façade so that it becomes an interactive façade that is in constant flux. The forecast for 2008 is Light-Inspired colours, alternating from Firstlight, Purelight, Twilight and Moonlight colours. Sunset in the Desert O3-B1-1, Angel's landing P2-C1-2, Wake Up Orange 05-A1-1, Lapis Blue B6-B1-1 and Burnt Horizon R7-B1-1 is recommended in a Plascon Double Velvet Exterior paint.


Firstlight
Tequila Pearl O1-C2-3
Cloud Number Nine B6-A2-
Dreamcatcher B4-B2-2
Veldrift Y2-D2-3
PLASCON
2008 COLOUR FORECAST


Purelight
Wake Up Orange O5-A1-1
Golden Daffodil Y3-A1-1
Lily Pad Home Y7-B2-1
Green Shrub G3-C1-3
Surfing Sarah B4-A1-4
Blue Bay B5-A1-3
Yellow Ribbon Y5-A2-1
PLASCON
2008 COLOUR FORECAST


Twilight
Platinum Bar P2-E1-4
Amarula Y2-B1-4
Dung Beetle Y1-E1-2
Beach Wood Y3-D2-1
Winter Sky B5-B2-1
Lapis Blue B6-B1-1
PLASCON
2008 COLOUR FORECAST


Moonlight
Stardust B5-C2-2
Moon Beam Y5-A2-3
Angel's Landing P2-C1-2
Moonlight Melody P4-D2-2
Gravel Road B5-E1-3
Black as Night B6-E1-1
Blueprint B6-C1-2
Evening Glade G3-E2-2
PLASCON
2008 COLOUR FORECAST

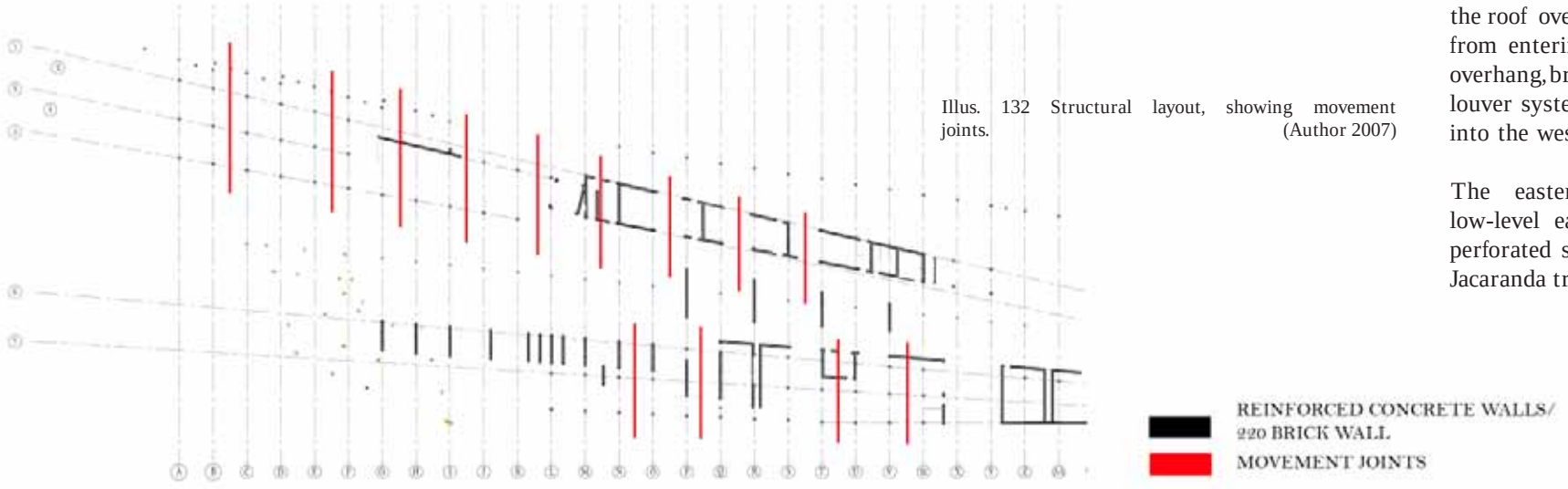
8.3 STRUCTURE

8.3.1 MAIN STRUCTURE

The main production area and laboratories, as well as the eastern building, have a 330mm diameter reinforced concrete column grid at 4600mm in the east/west direction, and an altering grid in the north/south direction. The altering grid is due to the liquids tank farm and hoisting passages. The western flanking walls are cast in-situ with 300 mm diameter reinforced concrete columns. The elevated concrete walkways in between the main building spaces is supported by 200 mm diameter reinforced concrete columns, which link the southern and northern part of the site and follows the main east/west grid. Concrete is to be cast with vertical movement joints, with a clean break through the entire structure. The vertical movement joints in the reinforced concrete walls are of 10mm bitumen-impregnated soft board. All reinforced concrete walls are 200mm thick and the thickness of the reinforced concrete floor slabs 255mm, with a maximum span of 10m.

8.3.2 ROOF STRUCTURE

The proposed project's roof structure is reinforced concrete with a minimum depth of 170mm. The minimum insulating cement screed thickness is 30mm laid with a minimum fall of 1:50 to full bores which is provided on the main grid pattern, and connects with 100mm diameter PVC down pipes which is cast into the reinforced concrete columns. The waterproofing of the concrete roof consists of a double layer 4mm modified bitumen membrane, with 100mm side laps and 150mm end laps. The waterproofing is sealed by torch-on fusion and taken up 200mm against parapet walls, protected with a 20mm parapet wall overhang.



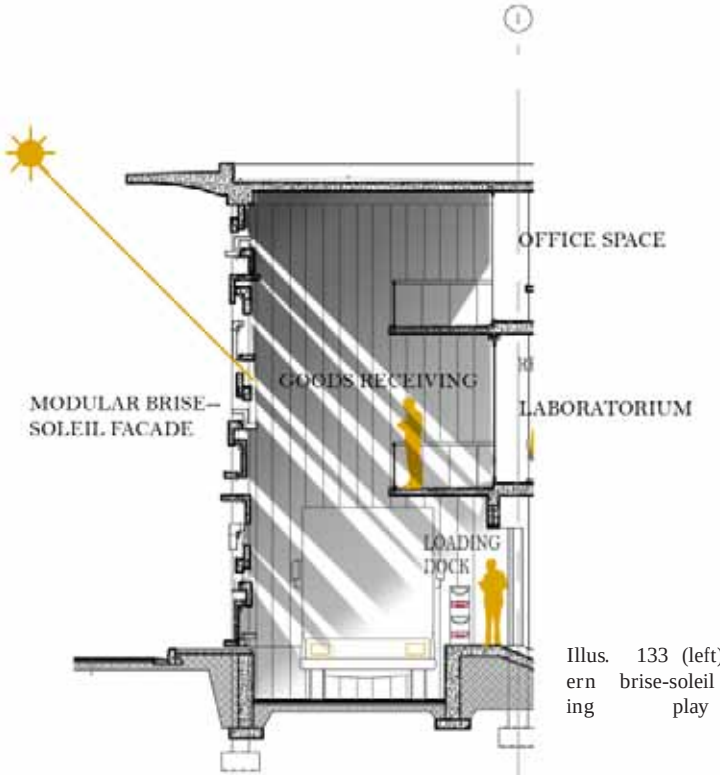
Illus. 132 Structural layout, showing movement joints. (Author 2007)

8.4 CLIMATE CONTROL

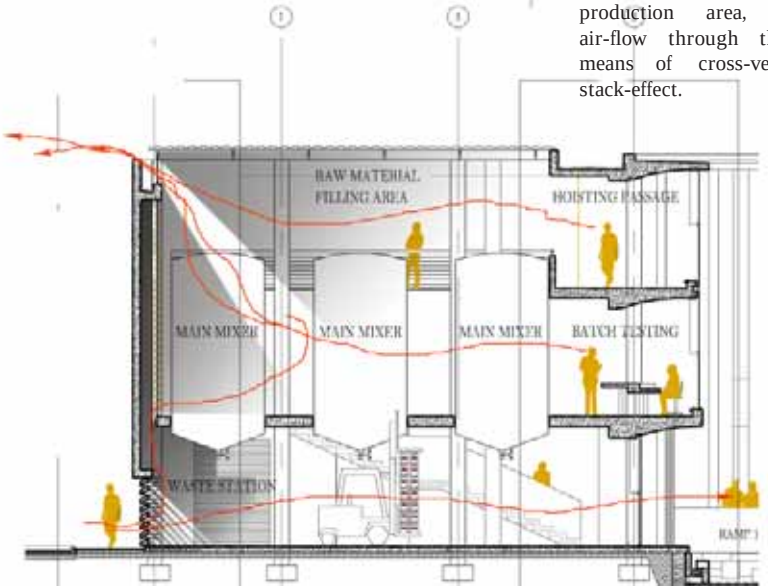
8.4.1 SOLAR CONTROL, NATURAL LIGHT AND ORIENTATION

The site is long, thin and wedge shaped, with the south-eastern and north-western boundaries forming the edges. As a result of this, the building has a long south-east and north-west facing façade. As natural daylight is 100% white light, it is very important to bring as much natural light as possible into areas that deal with products requiring good optical vision, especially in the laboratories and research areas. Natural daylight was thus incorporated into the design by means of clear and frosted glass facades for the laboratories as well as research and office areas. Roof lights are also incorporated to let as much daylight as possible into the building where the roof overhang prevents good light quality from entering the building. The large roof overhang, brise-soleil western wall and internal louver system prevents direct solar radiation into the west facing façade in the afternoons.

The eastern façade is protected from low-level eastern sun by the double layer perforated steel plate, as well as the row of Jacaranda trees along Dr. Savage Road's edge.



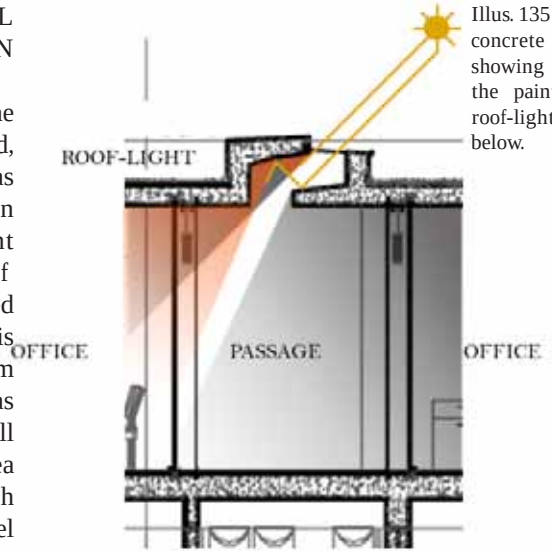
Illus. 133 (left)Section through western brise-soleil facade wall, showing play of light. (Author 2007)



Illus. 134 (below) Section through primary production area, showing passive air-flow through the building, by means of cross-ventilation and the stack-effect. (Author 2007)

8.4.2 NATURAL VENTILATION

In order to reduce the amount of energy used, passive ventilation was employed in the design of the building. The paint production area is one of the main spaces that need adequate ventilation. This is provided for by the bottom concrete fins, which act as open louvers. Fresh air will enter the production area through these fins, which are fastened onto steel angles spanning between the 300mm diameter concrete columns, at an angle that will prevent excessive wind and rain to enter the building. By means of cross ventilation the ground floor space will be ventilated. Stack ventilation as well as single sided ventilation will ventilate the production and mixing spaces on the first and second floor, by means of pulling in the fresh air through the concrete fins, which will in turn pass through a manually operated louver system on the southern ends of the production and mixing areas. Hot air will leave the space by means of clerestory windows which is manually operated. These ventilation systems result in cheaper capital cost and lower operating costs, with increased flexibility in workspaces and a reduced environmental impact. It must be remembered that there is a reliance on the user for the effectiveness of this system. The depth of the building is also narrow enough for the effectiveness of cross ventilation.



Illus. 135 (below) Section through concrete ceiling and roof light, showing how light reflect onto the painted undersides of the roof-light and back into the space below. (Author 2007)

8.4.3 THERMAL MASS

Thermal mass uses free cooling available when the outside air is cooler than that in the interior of the building. As concrete has excellent thermal mass properties, the flat concrete roof and exterior concrete walls will absorb solar radiation during the day, and radiate it into the space during the night, while the concrete is cooled down by ventilating the space which will result in reduced temperatures during the day.

9. TECHNICAL RESOLUTION

▪ "Roll on, deep and dark blue ocean, roll. Ten thousand fleets sweep over thee in vain. Man marks the earth with ruin, but his control stops with the shore." - *Lord Byron (1788-1824)* ▪ "If the sight of the blue skies fills you with joy, if a blade of grass springing up in the fields has power to move you, if the simple things of nature have a message that you understand, rejoice, for your soul is alive." - *Eleoora Duse (1858-1924)*