ATRIUM DELTION REVISED

COMFORT RESEARCH & DESIGN INTERVENTION FOR THE IMPROVEMENT OF INDOOR COMFORT IN THE ATRIUM OF DELTION COLLEGE

BORRIS BOSCHMAN
P5 PRESENTATION APRIL 2015
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HOW CAN A COMFORTABLE THERMAL AND VISUAL INDOOR WORK ENVIRONMENT BE ESTABLISHED IN THE ATRIUM OF DELTION?
RESEARCH QUESTION

HOW CAN A COMFORTABLE THERMAL AND VISUAL INDOOR WORK ENVIRONMENT BE ESTABLISHED IN THE ATRIUM OF DELTION?

1: WHAT IS VISUAL AND THERMAL COMFORT IN THE ATRIUM?

2: ARE BOTH THE VISUAL AND THERMAL COMFORT LEVEL SUFFICIENT IN THE ATRIUM?

3: IF IT IS NOT SUFFICIENT: HOW CAN IT BE IMPROVED WITH A NEW DESIGN?
APPROACH
METHODOLOGY
MUCH TOO DARK

VERY DARK

NORMAL

VERY LIGHT

MUCH TOO LIGHT

Q 19: “The daylight on my work place in summer is ...”

TOO BRIGHT IN SUMMER

GLARE FROM FACADE AND ROOF

REFLECTIONS FROM METALLIC SURFACES
BIT COLD ON WINTER MORNINGS

MUCH TOO WARM ON SUMMER AFTERNOONS

TEMPERATURE STRONGLY INFLUENCED BY SOLAR RADIATION
COMFORT RESEARCH: AIR CIRCULATION

9,1 m/s

< 0,2 m/s

Q 9: “I feel draft during winter ...”

NEVER
SELDOM
SOMETIMES
OFTEN
ALWAYS

NO SIGNIFICANT DRAFT
GOOD MIXED VENTILATION
LOW SPEED AT GROUND LEVEL
LOW RELATIVE HUMIDITY DUE TO TEMPERATURE

AIR QUALITY IS SOMETIMES A PROBLEM
COMFORT RESEARCH: CONTROL

**CONTROL WANTED**

- VENTILATION 80%
- HEATING 40%
- SHADING 25%

**USERS HAVE NO CONTROL**

**USERS WANT CONTROL**

**MORE CONTROL MAY INCREASE TOLERANCE**
DESIGN PRINCIPLES
BOUNDARY CONDITIONS

MACHINE LAY OUT

ADJACENT BUILDINGS

CURRENT CLIMATE SYSTEM
DESIGN OBJECTIVES

MAX GLARE INDEX = 19
500 LUX MIN ILLUMINANCE
750 LUX TASK ILLUMINANCE

AIR SPEED < 0.2 M/S
RELATIVE HUMIDITY 40% - 60%

LEAVE ARCHITECTURE INTACT
MINIMAL INTERVENTION: MAXIMUM EFFECT

THERMAL COMFORT: CLASS A

Fig. 2. Building/climate type Alpha. Maximally allowed operative indoor temperature for a specified acceptance level, as a function of the outdoor temperature $T_{e,ref}$.

Fig. 3. Building/climate type Beta. Maximally allowed operative indoor temperature for a specified acceptance level, as a function of the outdoor temperature $T_{e,ref}$. 
DESIGN BY RESEARCH
<table>
<thead>
<tr>
<th>THERMAL COMFORT</th>
<th>VISUAL COMFORT</th>
<th>USER CONTROL</th>
<th>EASY CONSTRUCTION</th>
<th>LOW MAINTENANCE</th>
<th>FREE FROM DAMAGE</th>
<th>AFFORDABLE PRICE</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exterior Mesh Shade</td>
<td>semi-transparent</td>
<td>no user control at all</td>
<td>requires supporting structure</td>
<td>mesh may catch dirt or leaves</td>
<td>exterior placement makes it more prone to damage by wind</td>
<td>fixed shading is generally more affordable</td>
<td>OHEL JAKOB SYNAGOGUE, MUNICH, WANDEL HOEFER LORCH + HIRSCH, the metal mesh protects the glass cube from too much light. The mesh is tensioned over a supporting structure. The light is filtered by the mesh.</td>
</tr>
<tr>
<td>Interior Mesh Shade</td>
<td>semi-transparent, more heat gain due to interior shading</td>
<td>no user control at all</td>
<td>easily attached from inside (no roof access needed)</td>
<td>indoor mesh will stay clean: no dirt from outside</td>
<td>well protected, because indoor</td>
<td>fixed shading is generally more affordable</td>
<td>BARRILETES, GUATEMALA CITY, P+A ARQUITECTOS</td>
</tr>
<tr>
<td>Exterior Light Baffles</td>
<td>keeps heat outside due to exterior shading</td>
<td>diffused light, tempered light</td>
<td>no user control at all</td>
<td>requires supporting structure</td>
<td>mesh may catch dirt or leaves</td>
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<td>ROOF-ROOF HOUSE, AMPANG, KEN YSANG ARCHITECTS</td>
</tr>
<tr>
<td>Interior Light Baffles</td>
<td>light from sky, but indirect sunlight</td>
<td>no user control at all</td>
<td>weathering of material due to exterior placement</td>
<td>semi-transparent, more heat gain than exterior shading</td>
<td>made it less susceptible to water staining and bird poo</td>
<td>the weight and bearing structure make it less affordable</td>
<td>TRAFFORD CENTRE, DUMPLINGTON, CHAPMAN TAYLOR</td>
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</tbody>
</table>

The table above compares different shading solutions, highlighting their thermal and visual comfort, ease of construction, and maintenance requirements. Each solution has distinct characteristics, such as the ability to keep heat out due to exterior shading, which is advantageous in reducing overheating. The table also indicates the level of user control, ease of construction, and the type of damage they can withstand, alongside their affordability and a reference for each solution.

**Key Points**
- **Exterior Mesh Shade** offers semi-transparent shading and is generally more affordable, but requires maintenance and has a fixed shading system.
- **Interior Mesh Shade** reduces heat gain due to its interior placement, ensuring protection against external damage.
- **Exterior Light Baffles** are semi-transparent, offering more heat gain than exterior baffle types, but require less maintenance.
- **Interior Light Baffles** keep heat outside due to their indirect sunlight properties, providing a comfortable environment.

These solutions are tailored to various architectural needs, ensuring a balance between comfort and visual aesthetics while managing overheating and heat gain.
### SHADING VARIANTS

<table>
<thead>
<tr>
<th>DYNAMIC SHADING SOLUTIONS</th>
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<th>USER CONTROL</th>
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<td>KEEP HEAT OUT</td>
<td>MORE HEAT GAIN</td>
<td>THE SHADING CAN</td>
<td>EASY TO INSTALL</td>
<td>MAY GET DIRTY</td>
<td>MOVABLE PARTS MAY</td>
<td>A HIGH QUALITY</td>
<td>Renson Shading</td>
</tr>
<tr>
<td>INTERIOR LAMELLAE</td>
<td>TO OUT</td>
<td>GREATER</td>
<td>BE MOVED TO</td>
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<td>EXTERIOR MESH SHADE</td>
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#### Thermal Comfort
- Keeps heat out due to exterior placement, high effectiveness when opacity is high.
- Interior shading: more heat gain than exterior shading.
- Keeping heat out due to exterior placement, high effectiveness when opacity is high.
- Interior shading: more heat gain than exterior shading.

#### Visual Comfort
- Shading can be moved to suit users needs.
- The shading can be moved to suit users needs.
- The shading can be moved to suit users needs.
- The shading can be moved to suit users needs.

#### User Control
- Users can control the movable shading.
- Users can control the movable shading.
- Users can control the movable shading.
- Users can control the movable shading.

#### Easy Construction
- Easy to install, because no extra structure is needed.
- Easy to install, because no extra structure is needed.
- Easy to install, because no extra structure is needed.
- Easy to install, because no extra structure is needed.

#### Low Maintenance
- May get dirty, movable parts need checkups.
- Less dirty due to indoor placement, though movable parts need checkups.
- Laminate may catch dirt, needs regular checkups.
- No roof access is needed for montage, still an extra structure is needed.

#### Free from Damage
- Movable parts are more prone to damage.
- Movable parts are more prone to damage.
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- Movable parts are more prone to damage.

#### Affordable Price
- A high quality shading is expensive.
- A high quality shading is expensive.
- It is a very customized solution, thus expensive.
- It is a very customized solution, sprinkler ducts replaced.

#### Reference
- Renson Shading
- Indoor shading by Renson provides various possibilities regarding transparency and colour. A metallic reflective side reduces the heat gain.
- Greenhouse Botanical Garden, Madrid, Ángel Fernández Alba
- The greenhouse has on the roof of the tropical part a metal lamellae system. The lamellae can only be rotated. The incoming light is filtered.
- LameLLaE
- Lamellae make it possible to control the extent of the shades and the transparency by changing the angle. The downside of these systems is that they are fragile.
## VENTILATION VARIANTS

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### NATURAL VENTILATION SOLUTIONS

- **High Openings**
  - Large roof surface enables large amounts of ventilation
  - Operable windows allow much user control
  - Roof shading may obstruct ventilation openings
  - The roof is not easily accessible
  - Replacement of large glass panes needed
  - The replacement of the roof is rather costly
  - The roof support needs to be replaced

- **Low Openings**
  - The roof connection enables a moderately large opening
  - Operable vents allow much user control
  - Internal shading may obstruct, external shading is no problem
  - The roof is not easily accessible
  - Replacement of large glass panes needed
  - Operable vents hardly need maintenance
  - The roof support needs to be replaced

- **Ground Level**
  - Operable windows allow much user control
  - Lower facade part does not conflict with external shading
  - Windows at ground level are not burglar safe when nighttime ventilation is required
  - Replacement windows at ground level are easy to change
  - Operable windows hardly need maintenance
  - The windows can be changed within the modular system
  - Lower facade part does not conflict with external shading

- **All Openings**
  - Operable windows allow much user control
  - Internal shading may obstruct, external shading is no problem
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VARIANT SELECTION

LOW FACADE VENTILATION
ROOF EDGE VENTILATION
ROLLER SHADES
## Simulation Approach

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<th>Model</th>
<th>Configuration Comparison</th>
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<td>Reality Check</td>
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<tr>
<td>Shading Schedule</td>
<td>Exterior shading</td>
<td>120 W/m² VS Glare</td>
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<tr>
<td>Type of Shading</td>
<td>Interior shading</td>
<td>Light Opaque VS Verosol</td>
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<td>Best Combination</td>
<td>Natural ventilation</td>
<td>Exterior shading VS Interior shading</td>
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</tbody>
</table>
SIMULATION MODEL INPUT

ATRIUM GEOMETRY & STRUCTURE

ACTIVITY

LIGHTING

HVAC
STEP 1: REALITY CHECK

SUMMER WEEK

AUTUMN WEEK SIMILARITY

SIMILAR RHYTHM, SIMILAR TEMPERATURE IN AUTUMN

OPERATIVE TEMPERATURE ABOVE 30°C IN SUMMER
STEP 2: SHADING SCHEDULE

GLARE CONTROL: SUMMER WEEK

- Morning shading only
- Glare factor 19 (NEN)
- No effective cooling

120 W/m²: SUMMER WEEK

- Shading all day
- 8°C cooling effect
STEP 3: TYPE OF SHADING

INTERNAL LIGHT OPAQUE SHADING: SUMMER WEEK

120 W/M², TRANSM. 0.05, REFL. 0.5
3° COOLING EFFECT

INTERNAL VEROSOL SHADING: SUMMER WEEK

120 W/M², TRANSM. 0.05, REFL. 0.77
4° COOLING EFFECT
STEP 4: VENTILATION COMBINATION

NAT. VENT. INTERNAL SHADING  6° COOLING EFFECT

NAT. VENT. EXTERNAL SHADING  10° COOLING EFFECT

COOLING 1ST DAY
TEMPERATURE GRADIENT ALLOWS STACK VENTILATION

AIR VELOCITY IS ACCEPTABLE

± 3 AIR CHANGES PER HOUR EXTRA

AIR STREAM SPREADS WELL
DESIGN ELABORATION
**Quick Fixes**

- Change lighting in lower part.
- Ceiling heating is not effective.
- Increase sound absorption.
- Provide task lighting per machine.
- Ventilation works well, no draft.
- Fix chink above outside door.
- Make black wall lighter for less contrast.

Facade shading is essential.

Ventilation works well: no draft.
ROOF SHADING

RENSON TOPFIX MAX:
HORIZONTAL APPLICATION

SIDE SUPPORT OF CANVAS:
WIND RESISTANCE UP TO 11 BFT
Dubbelglas bovenscharnierend
• Thermisch gescheiden
• Isolatieglas dikte 32-40 mm
• Bovenscharnierend
• Vlakke aansluiting
• Volledig gekaderd / semi- of volledig structureel
• Max. breedte per element:
  - 1200 mm (semi-)structureel
  - 1700 mm volledig gekaderd
• EN 12101-2 gecertificeerd (geldt alleen voor semi- of volledig structureel)

Estra TG Top Duurzaamheid:
• Toepassing in hellend dak 5°-75°
• Thermisch gescheiden
• Isolatieglas dikte 32-40 mm
• Bovenscharnierend
• Vlakke aansluiting
• Structureel
• Max. breedte per element: 1400 mm

Estra TG Dak Duurzaamheid:
• Brakel atmos
LAMELLAE IN FACADE

VERTICAL DETAIL LAMELLA FRAME TOP

VERTICAL DETAIL LAMELLA FRAME BOTTOM

HORIZONTAL DETAIL LAMELLA FRAME
Architectonisch (brand)ventilatieraam

De Lumera is net als de Luma een hoogwaardig architectonisch (brand)ventilatieraam. De Lumera is een combinatie van de Luma en de Ventria: het is een uitzetraam met slanke profielen én een in het frame verborgen bediening. De Lumera is speciaal ontwikkeld voor structurele glasdaken met een kleine dakhelling.

Brakel® Lumera

Uitvoeringen

De Lumera is een ventilatieraam dat ingebouwd kan worden onder een hoek van 0-90º. De openingshoek van het raam ten opzichte van de base is variabel met een maximum van 90º. Hierdoor is de Lumera geschikt voor zowel dagelijkse ventilatie als rookventilatie.

De Lumera bestaat uit geheel thermisch gescheiden aluminium profielen waardoor een hoge isolatiewaarde wordt bereikt. Hoewel de Lumera meestal voorzien wordt van isolatieglas is ongeïsoleerd glas (of een andere paneelvulling) op aanvraag ook mogelijk.

De Lumera is ontworpen met oog voor detail en is daarmee uitermate geschikt voor toepassing in gebouwen met zeer hoge esthetische eisen. Indien gewenst kan de Lumera worden geanodiseerd of gepoedercoat (in iedere gewenste RAL kleur).
DISCUSSION & CONCLUSION
DISCUSSION

- Questionnaire: small sample group
- Only autumn measurements & questionnaires
- Similarity real situation = relative
- Visual effect of shading = unknown
- Architectural freedom vs. applicability
- Glass = serious climate design component
HOW CAN A COMFORTABLE THERMAL AND VISUAL INDOOR WORK ENVIRONMENT BE ESTABLISHED IN THE ATRIUM OF DELTION?

1: WHAT IS VISUAL AND THERMAL COMFORT IN THE ATRIUM?

AUTUMN INDOOR CLIMATE = ACCEPTABLE

2: ARE BOTH THE VISUAL AND THERMAL COMFORT LEVEL SUFFICIENT IN THE ATRIUM?

THERMAL COMFORT = MOST PROBLEMATIC (CONTROL, SUMMER AFTERNOON)

VISUAL COMFORT = MEASUREMENTS MORE CRITICAL THAN QUESTIONNAIRE

3: IF IT IS NOT SUFFICIENT: HOW CAN IT BE IMPROVED WITH A NEW DESIGN?

EXTERNAL SHADING: SCHEDULE: 120 W/M2

GLARE

GLARE

NATURAL VENTILATION: 10° COOLING

MINUTE INTERVENTION, HUGE EFFECT
FURTHER RESEARCH

- Yearround monitoring of indoor climate
- Visual comfort analysis of shading variants
- Detailed climate system design for energy saving
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