ARCHITECTURAL INTEGRATION AND DESIGN OF SOLAR THERMAL SYSTEMS

Maria Cristina Munari Probst
EPFL / LESO-PB

Architektonische Integration von Thermischen Solaranlagen - Graz, 24.VI.2009
ARCHITECTURAL INTEGRATION AND DESIGN

1. INTRODUCTION

2. ARCHITECTURAL INTEGRATION QUALITY

3. EXISTING PRODUCTS LIMITS

4. DEVELOPMENT METHODOLOGY FOR NEW SYSTEMS

5. METHODOLOGY VALIDATION:
   - UNGLAZED SYSTEMS: EU PROJECT SOLABS
   - GLAZED SYSTEMS: OFEN PROJECT COLOURED GLAZING

6. CONCLUSIONS

OF SOLAR THERMAL SYSTEMS
ARCHITECTURAL INTEGRATION AND DESIGN

1. INTRODUCTION

2. ARCHITECTURAL INTEGRATION QUALITY

3. EXISTING PRODUCTS LIMITS

4. DEVELOPMENT METHODOLOGY FOR NEW SYSTEMS

5. METHODOLOGY VALIDATION:
   - UNGLAZED SYSTEMS: EU PROJECT SOLABS
   - GLAZED SYSTEMS: OFEN PROJECT COLOURED GLAZING

6. CONCLUSIONS

OF SOLAR THERMAL SYSTEMS
FOCUSES

a - SOLAR WATER HEATING IN BUILDING APPLICATIONS

b - FAÇADE APPLICATIONS

DATA: AEE-INTEC

SUN IRRADIATION [k Wh/m² month]
OBJECTIVE OF RESEARCH:
INVESTIGATE
WAYS TO ENHANCE
THE ARCHITECTURAL QUALITY
OF BIST* SYSTEMS

EXPECTED RESULTS:
FOSTER THE USE OF SOLAR THERMAL TECHNOLOGIES
WITHOUT COMPROMISING THE ARCHITECTURAL QUALITY
OF BUILDINGS.

* BUILDING INTEGRATED SOLAR THERMAL
ARCHITECTURAL INTEGRATION AND DESIGN

1. INTRODUCTION

2. ARCHITECTURAL INTEGRATION QUALITY

3. EXISTING PRODUCTS LIMITS

4. DEVELOPMENT METHODOLOGY FOR NEW SYSTEMS

5. METHODOLOGY VALIDATION:
   - UNGLAZED SYSTEMS: EU PROJECT SOLABS
   - GLAZED SYSTEMS: OFEN PROJECT COLOURED GLAZING

6. CONCLUSIONS

OF SOLAR THERMAL SYSTEMS
DEFINING ARCHITECTURAL QUALITY OF BUILDING INTEGRATED SYSTEMS

Maria Cristina Munari Probst - EPFL / LESO-PB  mariacristina.munari@epfl.ch
DEFINING ARCHITECTURAL QUALITY OF BUILDING INTEGRATED SYSTEMS

FUNCTIONAL QUALITY

CONSTRUCTIVE QUALITY

FORMAL QUALITY

?
WHICH FORMAL CHARACTERISTICS AFFECT INTEGRATION QUALITY?

E.U. WEB SURVEY

12 COUNTRIES

163 PERSONS / 100 ARCHITECTS

GEOGRAFICAL DISTRIBUTION

Maria Cristina Munari Probst - EPFL / LSEO-PB  mariacristina.munariprobst@epfl.ch
WHICH FORMAL CHARACTERISTICS AFFECT INTEGRATION QUALITY?

E.U. WEB SURVEY

Appreciation of 10 existing integrations

over

1. Global integration quality?
2. Module size and shape?
3. Collector Colour?
WHICH FORMAL CHARACTERISTICS AFFECT INTEGRATION QUALITY?

E.U. WEB SURVEY

Appreciation of 10 existing integrations
SYSTEM CHARACTERISTICS AFFECTING INTEGRATION QUALITY

- MODULES SHAPE & SIZE
- JOINTING
- VISIBLE MATERIALS
- SURFACE TEXTURE
- COLOURS
- FIELD SIZE & POSITION

ALL THESE CHARACTERISTICS SHOULD BE COHERENT WITH THE GLOBAL BUILDING DESIGN
ARCHITECTURAL INTEGRATION AND DESIGN

1. INTRODUCTION
2. ARCHITECTURAL INTEGRATION QUALITY
3. EXISTING PRODUCTS LIMITS
4. DEVELOPMENT METHODOLOGY FOR NEW SYSTEMS
5. METHODOLOGY VALIDATION:
   - UNGLAZED SYSTEMS: EU PROJECT SOLABS
   - GLAZED SYSTEMS: OFEN PROJECT COLOURED GLAZING
6. CONCLUSIONS

OF SOLAR THERMAL SYSTEMS
**SUITABLE LEVELS OF SOLAR SYSTEM FLEXIBILITY:**

<table>
<thead>
<tr>
<th>Field Size &amp; Position</th>
<th>Dummy Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modules Shape &amp; Size</td>
<td>Dimensional Freedom</td>
</tr>
<tr>
<td>Jointing</td>
<td>Alternatives to EPDM</td>
</tr>
<tr>
<td>Apparent Materials</td>
<td><em>(Depend on Technology)</em></td>
</tr>
<tr>
<td>Surface Texture</td>
<td>Finishing Choice</td>
</tr>
<tr>
<td>Colours</td>
<td>Alternatives to Black</td>
</tr>
</tbody>
</table>

**REAL NEED OF NEW PRODUCTS!** 😞
ARCHITECTURAL INTEGRATION AND DESIGN

1. INTRODUCTION

2. ARCHITECTURAL INTEGRATION QUALITY

3. EXISTING PRODUCTS LIMITS

4. DEVELOPMENT METHODOLOGY FOR NEW SYSTEMS

5. METHODOLOGY VALIDATION:
   - UNGLAZED SYSTEMS: EU PROJECT SOLABS
   - GLAZED SYSTEMS: OFEN PROJECT COLOURED GLAZING

6. CONCLUSIONS

OF SOLAR THERMAL SYSTEMS
DEVELOPMENT METHODOLOGY FOR COLLECTORS AS PART OF A MULTIFUNCTIONAL ENVELOPE SYSTEM

SOLAR ENERGY PRODUCTION FUNCTION: TECHNOLOGIES

ECO-IMPACT

PRODUCTION FEASABILITY

BUILDING NEEDS

FUNCTIONAL
ADD A COMPATIBLE BUILDING FUNCTION

CONSTRUCTIVE
RESPECT CONSTR. STANDARDS & REGULATIONS

FORMAL
PROVIDE:
1. FLEXIBILITY ON FORMAL CHARACT.
2. NON ACTIVE ELEM.
3. INTERFACE ELEM.

FORMAL CHARACT.

FUNCTIONAL

CONSTRUCTIVE

FORMAL

ADD A COMPATIBLE BUILDING FUNCTION

RESPECT CONSTR. STANDARDS & REGULATIONS

PROVIDE:
1. FLEXIBILITY ON FORMAL CHARACT.
2. NON ACTIVE ELEM.
3. INTERFACE ELEM.

FORMAL

FUNCTIONAL

CONSTRUCTIVE

FORMAL

ADD A COMPATIBLE BUILDING FUNCTION

RESPECT CONSTR. STANDARDS & REGULATIONS

PROVIDE:
1. FLEXIBILITY ON FORMAL CHARACT.
2. NON ACTIVE ELEM.
3. INTERFACE ELEM.

FORMAL

FUNCTIONAL

CONSTRUCTIVE

FORMAL

ADD A COMPATIBLE BUILDING FUNCTION

RESPECT CONSTR. STANDARDS & REGULATIONS

PROVIDE:
1. FLEXIBILITY ON FORMAL CHARACT.
2. NON ACTIVE ELEM.
3. INTERFACE ELEM.

FORMAL

FUNCTIONAL

CONSTRUCTIVE

FORMAL

ADD A COMPATIBLE BUILDING FUNCTION

RESPECT CONSTR. STANDARDS & REGULATIONS

PROVIDE:
1. FLEXIBILITY ON FORMAL CHARACT.
2. NON ACTIVE ELEM.
3. INTERFACE ELEM.

FORMAL

FUNCTIONAL

CONSTRUCTIVE

FORMAL

ADD A COMPATIBLE BUILDING FUNCTION

RESPECT CONSTR. STANDARDS & REGULATIONS

PROVIDE:
1. FLEXIBILITY ON FORMAL CHARACT.
2. NON ACTIVE ELEM.
3. INTERFACE ELEM.

FORMAL

FUNCTIONAL

CONSTRUCTIVE
ARCHITECTURAL INTEGRATION AND DESIGN

1. INTRODUCTION

2. ARCHITECTURAL INTEGRATION QUALITY

3. EXISTING PRODUCTS LIMITS

4. DEVELOPMENT METHODOLOGY FOR NEW SYSTEMS

5. METHODOLOGY VALIDATION:
   - UNGLAZED SYSTEMS: EU PROJECT SOLABS
   - GLAZED SYSTEMS: OFEN PROJECT COLOURED GLAZING

6. CONCLUSIONS

OF SOLAR THERMAL SYSTEMS
EU PROJECT SOLABS:
Development of an unglazed, coloured, solar thermal system for façades.

MULTIFUNCTIONALITY: SOLAR COLLECTOR + FAÇADE CLADDING

(Tongue-and-groove) PLANK METAL CLADDINGS

(Maria Cristina Munari Probst - EPFL / LESO-PB mariacristina.munariprobst@epfl.ch)
EU PROJECT SOLABS:
Development of an unglazed, coloured, solar thermal system for façades.

MULTIFUNCTIONNALLITY: SOLAR COLLECTOR + FAÇADE CLADDING
(inspired by existing metal claddings)

DERIVED TONGUE-AND-GROOVE PLANK as MULTIFUNCTIONAL COLLECTOR
EU PROJECT SOLABS

NON ACTIVE ELEMENTS
(field positionning / dimensionning)

INTERFACE ELEMENTS

variable joint 0-20 mm

29 cm

Cut to length up to 4m

Demonstration stand at Demosite - EPFL
Application simulation: new commercial building

Ikea mega store Minneapolis
ARCHITECTURAL INTEGRATION AND DESIGN

1. INTRODUCTION

2. ARCHITECTURAL INTEGRATION QUALITY

3. EXISTING PRODUCTS LIMITS

4. DEVELOPMENT METHODOLOGY FOR NEW SYSTEMS

5. METHODOLOGY VALIDATION:
   - UNGLAZED SYSTEMS: EU PROJECT SOLABS
   - GLAZED SYSTEMS: OFEN PROJECT COLOURED GLAZING

6. CONCLUSIONS

OF SOLAR THERMAL SYSTEMS
AVAILABLE GLAZED COLLECTORS

Visible absorber, welding points, defects

"HIDE THE ABSORBER by COLOURING THE GLASS"

THE IDEA

...DIFFICULT FACADE INTEGRATION!

Maria Cristina Munari Probst - EPFL / LESO-PB marinacristina.munari@epfl.ch
CHARACTERISTICS OF THE IDEAL REFLECTIVE FILTER:

MINIMUM TRANSMISSION LOSSES

WITH THE HELP OF REFLECTIVE FILTERS* (*Developed by Dr. A. Schueler)

Maria Cristina Munari Probst - EPFL / LESO-PB mariacristina.munari.probst@epfl.ch
SOLAR ABSORBER

DIFFUSED GLASS REFLECTION 8%

DIFFUSED COLOURED REFLECTION 6–10%

SELECTIVE FILTER

DIFFUSING TREATMENT

IN

SUN RADIATION

OUT

Maria Cristina Munari Probst - EPFL / LESO-PB
mariacristina.munari@epfl.ch
OFEN PROJECT COLOURED GLAZING

LESO Coloured Glazing - EPFL Laboratoire d’Énergie Solaire –
mounted on standard Schweizer solar thermal collector. The glazing hides the black colour of the absorber and its surface irregularities while letting the solar energy pass through. The same glazing can also be used as facade cladding on the non-explored areas of the building envelope, offering a new level of freedom to architects in solar thermal integration.
A NEW MULTIFUNCTIONAL GLASS FOR ACTIVE FACADE SYSTEMS
ARCHITECTURAL INTEGRATION AND DESIGN

1. INTRODUCTION

2. ARCHITECTURAL INTEGRATION QUALITY

3. EXISTING PRODUCTS LIMITS

4. DEVELOPMENT METHODOLOGY FOR NEW SYSTEMS

5. METHODOLOGY VALIDATION:
   - UNGLAZED SYSTEMS: EU PROJECT SOLABS
   - GLAZED SYSTEMS: OFEN PROJECT COLOURED GLAZING

6. CONCLUSIONS

OF SOLAR THERMAL SYSTEMS
DEVELOPED SYSTEMS APPRECIATION (by architects)

SOLABS UNGLAZED SYSTEM

COLOURED GLAZING SYSTEM
CONCLUSIONS

A. Architectural integration criteria can be assessed.

B. Assessed characteristics affecting integration quality:
   
   Field position and dimension; Module size and shape; Jointing type;
   Collector material, colour, surface texture.

C. These characteristics should all be coherent with the global building design.

D. There is a clear need of new products conceived for building integration

E. Successful results can be obtained applying the developed methodology