

# CULTURALLY INSPIRED PATTERNS FOR PHOTOVOLTAICS

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# 1. Introduction

This paper reports the results of an investigation into applying **the inventory of local cultural** heritage, here Japanese traditional family crests, as **an inspiration for technological innovation**, here alternative patterns for solar photovoltaic (PV) panels.

*A sustainable energy supply  
“implies a local scale for energy sourcing”.*

(Acres, 2007, p.102)

*“Energy is all.  
We are still largely unconscious of it,  
but our entire lives (both urban and rural)  
are driven by our access to energy  
(how we use it, why we use it,  
what sort of energy we use).”*

(Webb, 2005, p.75)

*“The essence of culture is in locality.  
There's any such thing as a global culture.”*

(Sen, Caltroni & Hara, 2009, p.94)

## 2. Culture for Architecture and Sustainability



*“[...] the meaning of sustainability depends on the context, in which it is applied.”*

(Kajikawa et al., 2007, p.222)

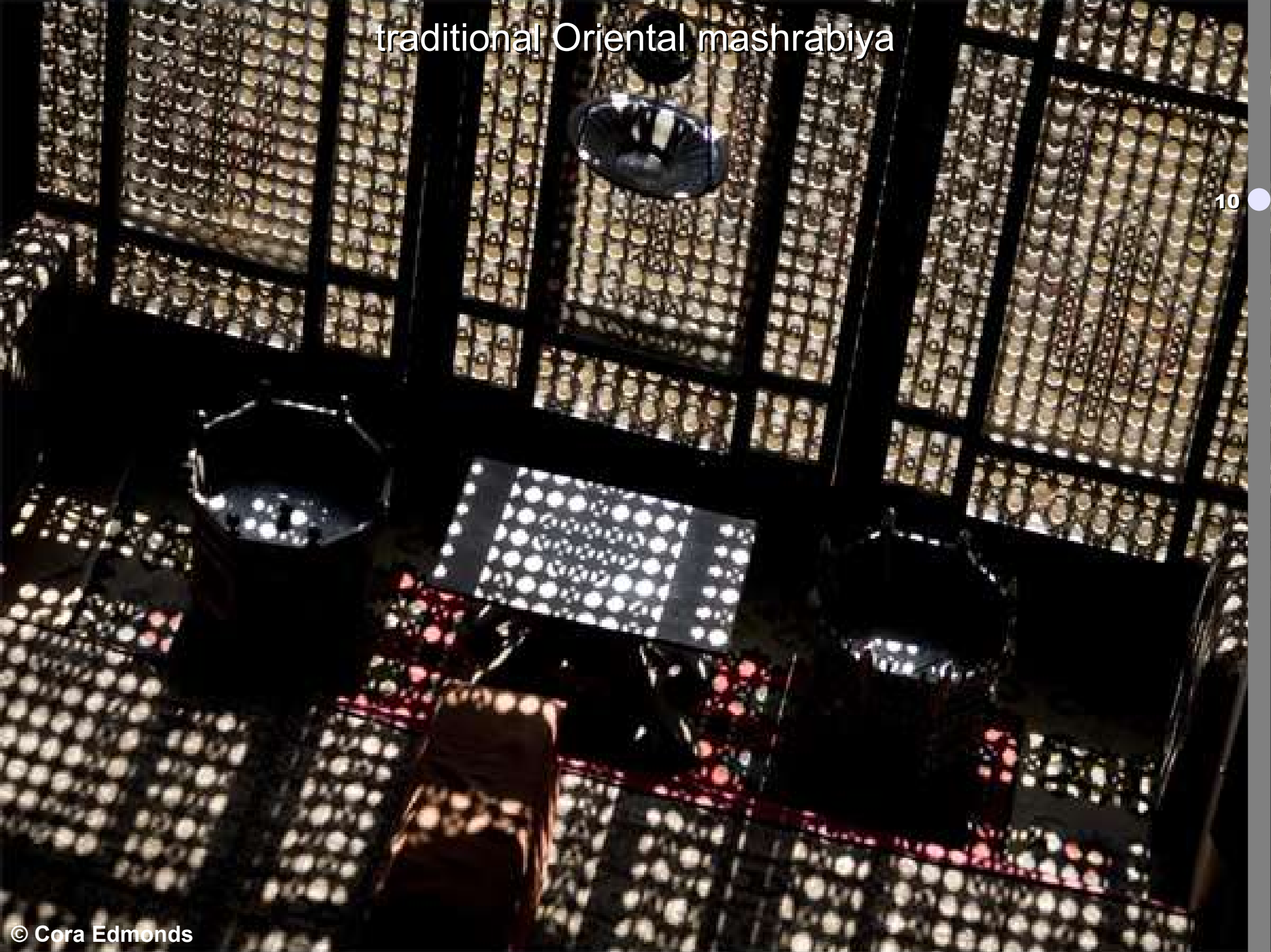
# *“Four Layers of Architecture”*

<b>Layer</b>	<b>Mode</b> (Standpoint)	<b>Program</b> (Design requirements)	<b>Technology</b> (Means of solutions)	<b>Theme of sustainability design</b> (Program of contemporary architecture)
1st layer	physical thing	material parts structure construction	production assembly	reuse and recycling long-lasting lightweight
2nd layer	energy-controlling device	environmental energy	electric machinery climate control	energy conservation high performance
3rd layer	social function	purpose building type	planning organization	family community lifestyle urbanity
4th layer	symbol meaning	form space	representation criticism	virtual reality ephemeralization

*"However, properly speaking,  
sustainable design should involve all four layers."*

(Namba, 2006)

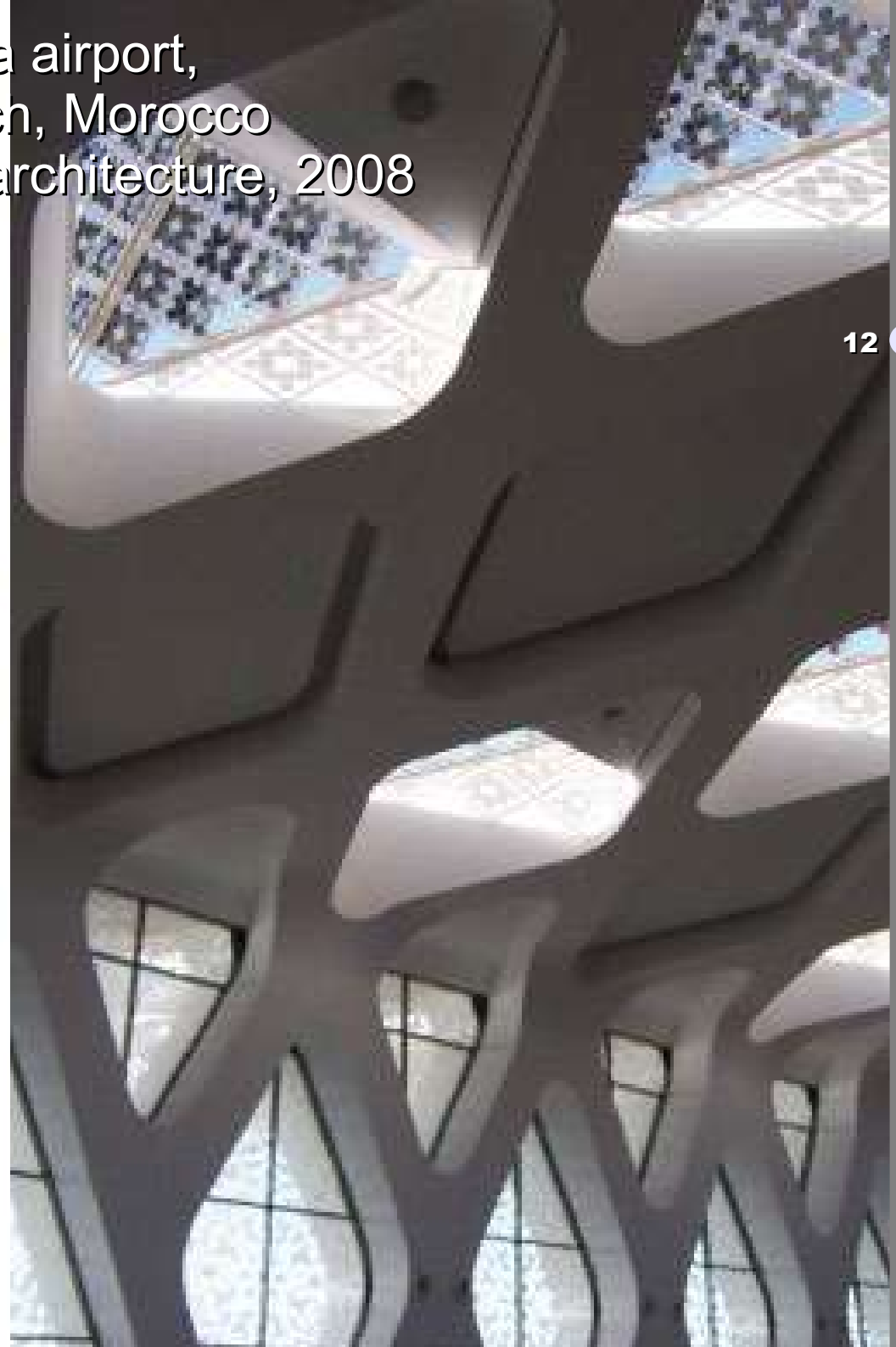
traditional Oriental mashrabiya



Arab World Institute,  
Paris, France  
architect: Ateliers Jean Nouvel, 1987



Menara airport,  
Marrakech, Morocco  
architect: E2A architecture, 2008



traditional Oriental mashrabiya

local craftsmen

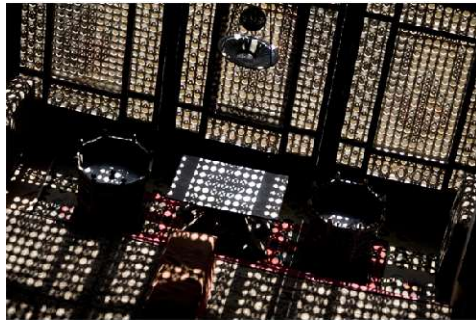


Fig.1 © Cora Edmonds

Arab World Institute,  
Paris, France

arch: Ateliers Jean Novel, 1987

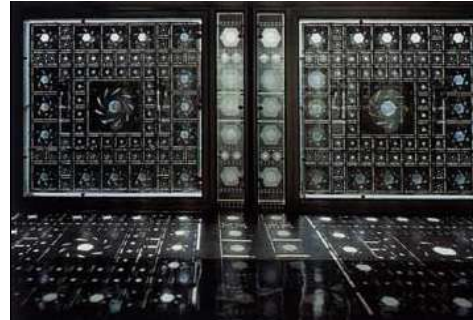


Fig.2 © Jean Novel

Menara airport,  
Marrakech, Morocco

arch: E2A architecture, 2008



Fig.3 © Brigit Varenkamp

1st layer	Wooden latticework	Mechanical devices glass panes	Photovoltaic glass laminate
2nd layer	Daylight transmission, shading, cooling, air conditioning	Daylight transmission, shading, transparency	Daylight transmission, shading, energy generation
3rd layer	Privacy and views in residential houses	Representative street façade of the Arab World Institute	Skylight at an international airport
4th layer	Geometrically crafted patterns in accordance with Islamic laws	High-tech image, modern interpretation of the traditional mashrabiya	Green energy, modern interpretation of the traditional mashrabiya

*“At its highest level of significance,  
architecture is the fusion of culture  
and the need for enclosure  
made material in physical form;  
it is the meeting point  
of the need to build  
and the innate urge to communicate.”*

(Wigginton, 1996, p.10)

### 3. Light and Shadow – Nuances of Depth

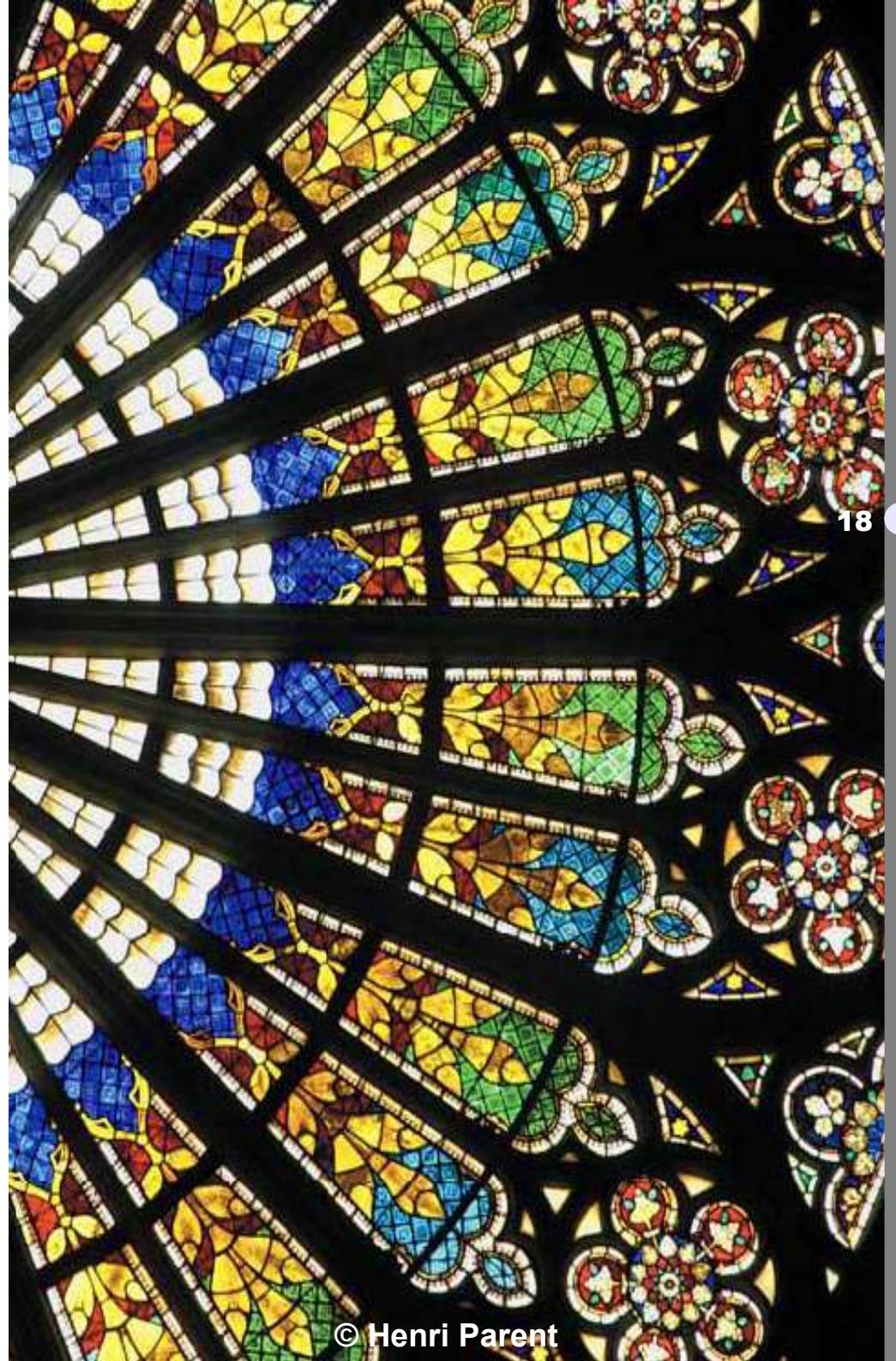
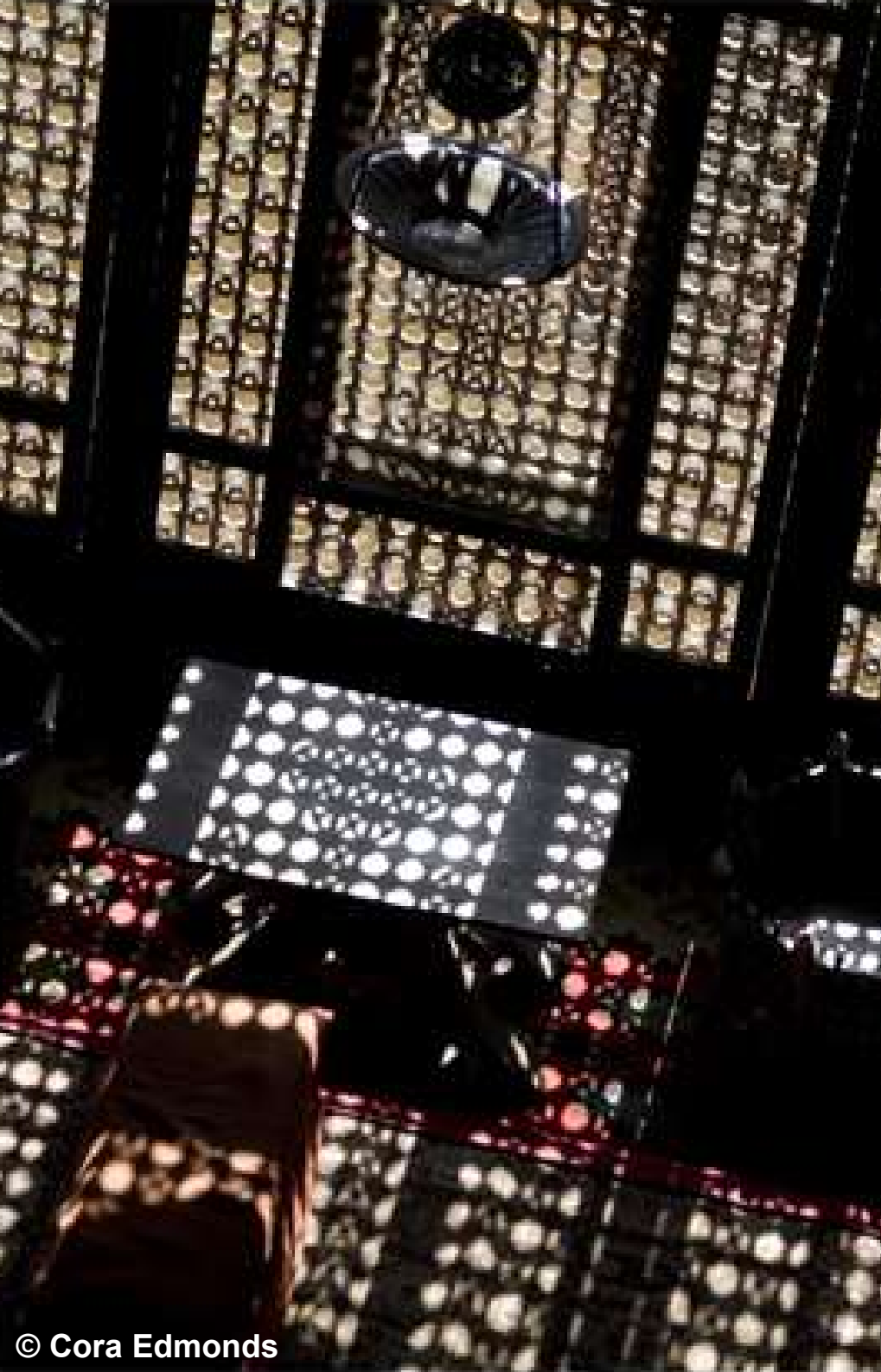


*“In the thousands of years since he learnt to build, man has had to try to meet two particular, and often conflicting needs: on the one hand, the need to create enclosure for shelter, protection and privacy; on the other, the need to transmit light to provide illumination and view.”*

(Wigginton, 1996, p.10)

*“And so it has come to be that the beauty of a Japanese room depends on a variation of shadows, heavy shadows against light shadows - it has nothing else.”*

(Jun'ichiro Tanizaki, 1933, p.18)



*“The theme of light [...], the blurring of contours,  
the superimpositions, in reverberations  
and reflections and shadows.”*

(Jean Novel, about the Arab World Institute)

## 4. Patterns, Parametricism, Performance

*“[Patterns] have been covering architectural surfaces since time immemorial, in the same way that they have been spread all over manmade objects.*

*The human body was perhaps the first surface to receive designed patterns.*

*Architectural patterns thus have a broad and deep lineage, and one should not expect them to have any well-defined, unitary function.*

*As patterns evolve they acquire new functions and lose their prior functions, or new functions are superimposed upon older ones.”*

(Schumacher, 2009, p.30)

*“Patterns provide architects with a device to connect apparently incongruent categories and synthesize a multitude of performances, project requirements and informational types in a perception-based medium.”*

(Anderson and Salomon, 2010, p.14)

*“The introduction of different surface effects, like different material textures, had already happened within the later phases of Modernism, but artificial, quasi-graphic techniques of surface treatment and surface patterning were now being deployed. [...]*

*Parametricism transforms this technique of parametric pattern design into a new and powerful register of articulation.”*

(Schumacher, 2009, p.33-34)



## 5. Low-res – Pixel and Solar Cell

*“[L]ow-res tactics in order to achieve appropriate, affordable, as well as poetic and more subliminal, effects, harnessing emotion rather than technology. At the same time, these tactics are programmed to be adjustable.”*

(Bullivant, 2005a, p.6)

Torre Agbar,  
Barcelona, Spain  
architects:  
Ateliers Jean Nouvel,  
2005

*“The surface of the building  
evokes water:  
smooth and continuous,  
shimmering and transparent,  
its materials reveal themselves  
in nuanced shades  
of color and light.”*

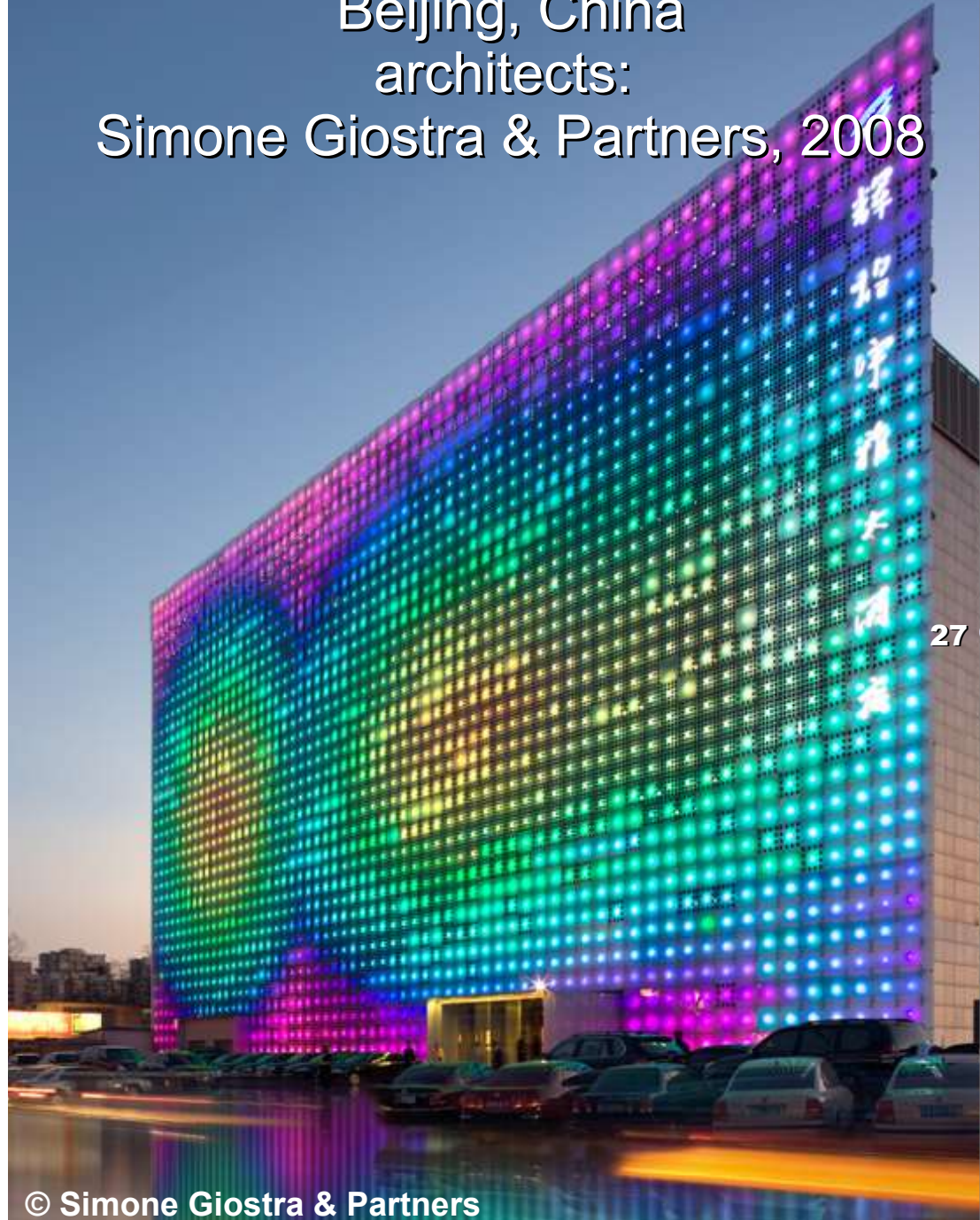
(Jean Nouvel)

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GreenPix - Zero Energy Media Wall  
(Xicui Entertainment Center),  
Beijing, China  
architects:  
Simone Giostra & Partners, 2008

*“seascapes as an  
example of an ever-  
changing visual  
experience”*

(Eakin, 2007, p.48)



Santa Caterina Market renovation,  
Barcelona, Spain  
architects:  
Miralles - Tagliabue | EMBT, 1997

*"reflect the polychrome  
art nouveau façades  
of the merchants'  
mansions and the  
public buildings those  
merchants sponsored"*

(Riley, 2006, p.25)



Technorama Facade - Technorama, The Swiss Science Center,  
Winterthur, Switzerland  
architects: Ned Kahn, Durig and Rami, 2002

*“reveal the  
complex patterns  
of turbulence  
in the wind”*

(Kahn, undated)

Museum of Kanayama Castle Ruin, Kanayama Community Center,  
Ota city, Gunma, Japan  
architects: Kengo Kuma & Associates, 2009

*“[...] by reverting to an even more primitive condition,  
to search for possibilities in an area that can only be  
resolved by a new, contemporary technology.”*

(Kengo Kuma in Futagawa, 2009, p.116)

Hotel Industrial, Paris, France  
architects:  
Emmanuel Saadi Architecte, Jean-Louis Rey and François da Silva,  
2008





## 6. Case studies – Japanese traditional patterns as an inspiration for BIPV

## Aim

To improve the versatility of **light-transmissive PV panels** used for architectural integration into building skins (BIPV).

## Study Background

With the kind of PV panels called **'light-through'**, translucency is achieved by **spacing the opaque crystalline solar cells**, so that **light can penetrate through the resulting gaps.**

The usual design alternatives offered by the PV industry are mostly restricted to an equal spacing of the cells throughout the grid pattern.

## Methodology

**Cultural individuality**, essential for local and global sustainability, provided the basis for inspiration.

The inherent geometric **qualities of traditional** Japanese family crests are analysed and applied to generate alternative light-transmitting PV patterns.

# two major groups of PV technologies

crystalline silicon

thin-film

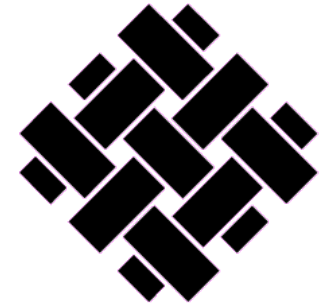
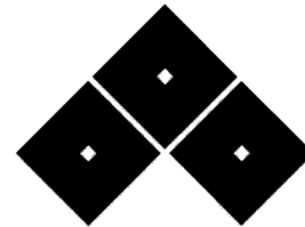
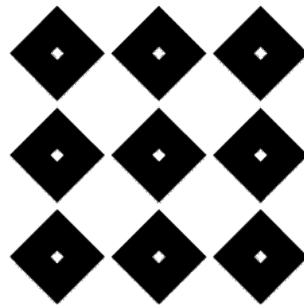


© Emmanuel Saadi

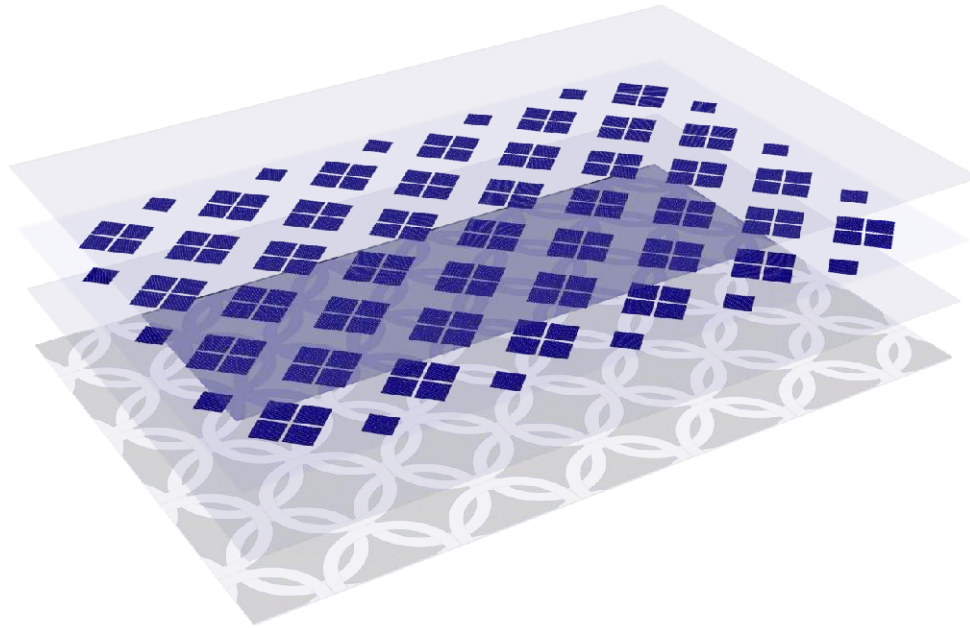


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# Kamon – Japanese family crests



# Layering of photovoltaic laminate

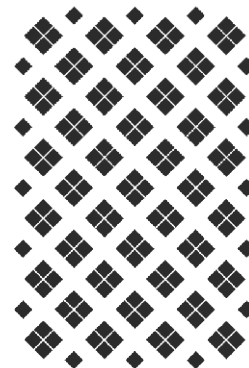


- outer transparent layer of glass or foil
- solar cell layer between films
- inner transparent layer of glass or foil
- semi-transparent print on either side of the inner layer

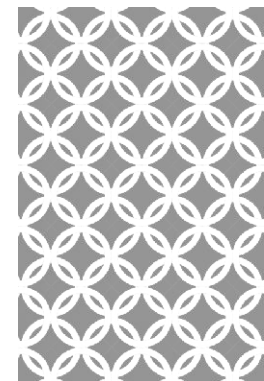
Family crest



Solar cells



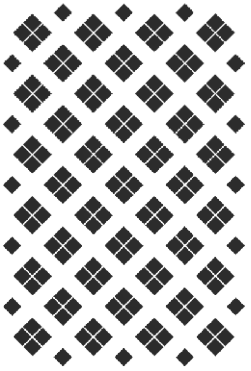
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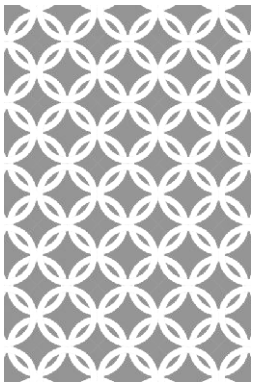
Family crest



Solar cells



Print



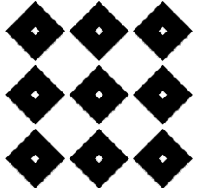
# Case study A

## Maru ni yottsu-wari-ishi

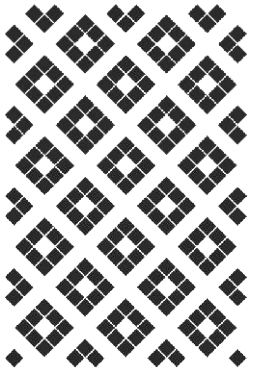




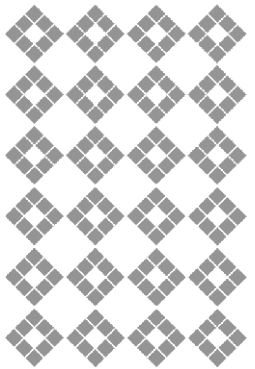
Family crest



Solar cells

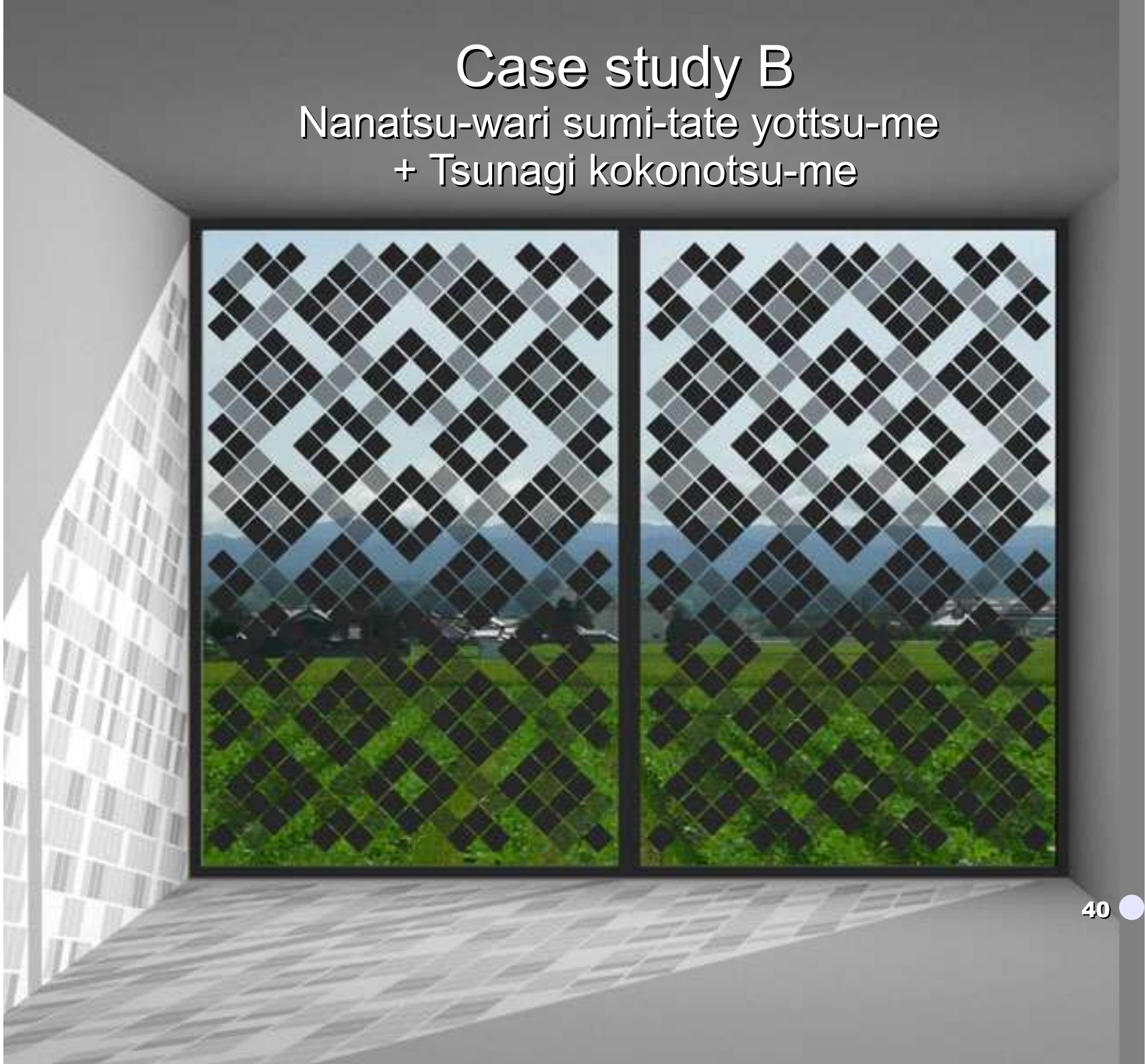


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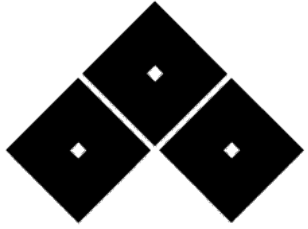


# Case study B

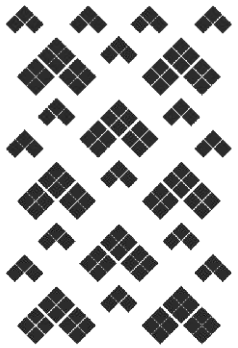
Nanatsu-wari sumi-tate yottsu-me  
+ Tsunagi kokonotsu-me



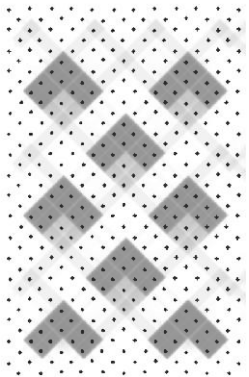
Family crest



Solar cells



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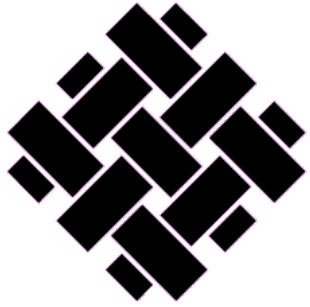


# Case study C

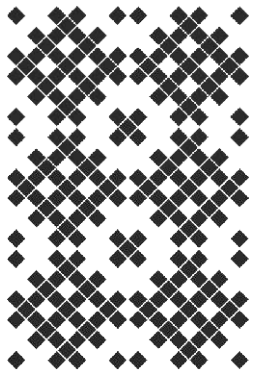
## Mittsu-me



Family crest



Solar cells



Print



# Case study D

## Muttsu kumi sujichigai



# 7. Conclusion

*“Japanese architecture  
is a treasure trove of boundary techniques. [...] Diverse screens  
(such as louvers and [curtains])  
and intermediate domains  
(such as verandas, corridors and eaves)  
are gaining attention once more as devices  
for connecting the environment to buildings.”*

(Kuma, 2010, p.15)

*“This is not a dream, because  
technology plus poetry equals architecture [...].  
All architects [...] have to do is make it happen.”*

(Wigginton, 1996, p.238)

*Thank you for your attention*

Robert BAUM and Salvator-John LIOTTA