JAPANESE TRADITIONAL PATTERNS
AS AN INSPIRATION FOR BUILDING-INTEGRATED PHOTOVOLTAICS (BIPV)

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Photovoltaic → Solar Energy → Energy
Building → Integrated → Architecture
Sustainability → Design → Innovation
Patterns → Performance → Communication
Low-resolution → Pixels → Solar cells
Light → Shadow → Nuances of depth
Tradition → Locality → Culture
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Sustainability

A sustainable energy supply

“implies a local scale for energy sourcing”.

(Acres, 2007, p.102)

→ Locality
“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)
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(Webb, 2005, p.75)
Energy

“Technology is maybe an answer, but we must not forget the question.”

(Cedric Price)
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“[O]ur culture needs to internalise a new valuation of energy.”

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Energy

“Technology is maybe an answer, but we must not forget the question.”

(Cedric Price)

“[O]ur culture needs to internalise a new valuation of energy.”

(Webb, 2005, p75)

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

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

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

(Kajikawa et al., 2007, p.222)
“Four Layers of Architecture”

(Namba, 2006)

Architecture

Sustainability

<table>
<thead>
<tr>
<th>Layer</th>
<th>Mode (Standpoint)</th>
<th>Program (Design requirements)</th>
<th>Technology (Means of solutions)</th>
<th>Theme of sustainability design (Program of contemporary architecture)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st layer</td>
<td>physical thing</td>
<td>material parts</td>
<td>production assembly</td>
<td>reuse and recycling</td>
</tr>
<tr>
<td></td>
<td></td>
<td>structure construction</td>
<td></td>
<td>long-lasting lightweight</td>
</tr>
<tr>
<td>2nd layer</td>
<td>energy-controlling device</td>
<td>environmental energy</td>
<td>electric machinery</td>
<td>energy conservation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>climate control</td>
<td>high performance</td>
</tr>
<tr>
<td>3rd layer</td>
<td>social function</td>
<td>purpose building type</td>
<td>planning organization</td>
<td>family community</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>lifestyle urbanity</td>
</tr>
<tr>
<td>4th layer</td>
<td>symbol meaning</td>
<td>form</td>
<td>representation</td>
<td>virtual reality</td>
</tr>
<tr>
<td></td>
<td></td>
<td>space</td>
<td>criticism</td>
<td>ephemeralization</td>
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"However, properly speaking, sustainable design should involve all four layers."
(Namba, 2006)

Architecture

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</table>
traditional Oriental mashrabiya

Architecture

Fig. 1 © Cora Edmonds
Arab World Institute, Paris, France
architect: Ateliers Jean Novel, 1987

Architecture

Fig. 2 © Ateliers Jean Novel
Menara airport, Marrakech, Morocco
architect: E2A architecture, 2008

Architecture

Fig. 3 © Brigit Varenkamp
<table>
<thead>
<tr>
<th>Layer</th>
<th>Description</th>
</tr>
</thead>
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<tr>
<td>1st layer</td>
<td>Wooden latticework</td>
</tr>
<tr>
<td>2nd layer</td>
<td>Daylight transmission, shading, cooling, air conditioning</td>
</tr>
<tr>
<td>3rd layer</td>
<td>Privacy and views in residential houses</td>
</tr>
<tr>
<td>4th layer</td>
<td>Geometrically crafted patterns in accordance with Islamic laws</td>
</tr>
</tbody>
</table>

**Architecture**

- **Arab World Institute, Paris, France**
  - By Ateliers Jean Novel, 1987
- **Menara airport, Marrakech, Morocco**
  - By E2A architecture, 2008

![Fig.1 © Cora Edmonds](Image)

![Fig.2 © Jean Novel](Image)

![Fig.3 © Brigit Varenkamp](Image)
“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)
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"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)
Building →

“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)

Shadow → Culture
Building

Fig. 1 © Cora Edmonds

Light → Shadow

→ Culture
Building

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

(Jean Novel, about the Arab World Institute)

Light → Shadow

→ Culture
Building

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

(Jean Novel, about the Arab World Institute)

Light → Shadow → Nuances of depth

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“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)
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“[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 Novel, 2005

→ Architecture

“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 Novel)

Fig. 5 © Agbar Tower Corporate Marketing Department
GreenPix - Zero Energy Media Wall, Beijing, China
Architects: Simone Giostra & Partners, 2008

→ Architecture

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

(Eakin, 2007, p.48)

Fig. 6 © Simone Giostra & Partners
Santa Caterina Market renovation, Barcelona, Spain
architects: Miralles - Tagliabue | EMBT, 1997

→ Architecture

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

(Riley, 2006, p.25)
Technorama, The Swiss Science Center, Winterthur, Switzerland
architects: Ned Kahn, Durig and Rami, 2002

→ Architecture

“reveal the complex patterns of turbulence in the wind“

(Kahn, undated)

Fig. 8 © Ned Kahn
Museum of Kanayama Castle Ruin, Kanayama Community Center, Ota city, Gunma, Japan
architects: Kengo Kuma & Associates, 2009

→ Architecture

“[…] 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)

Fig. 9 © Takashi Yamagishi
Hotel Industrial, Paris, France
architects: Emmanuel Saadi, Jean-Louis Rey, François da Silva, 2008

→ Architecture

Solar cells

Fig. 10 © Nicolas Borel
Photovoltaic → Solar Energy → Energy

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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.
Aim

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

crystalline silicon

thin-film
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.
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

Fig. 13 © Robert Baum
Case study A
Maru ni yottsu-wari-ishi

Fig. 14 © Robert Baum
Case study B
Nanatsu-wari sumi-tate yottsu-me
+ Tsunagi kokonotsu-me

Family crest
Solar cells
Print

Fig. 15 © Robert Baum
Case study C
Mittsu-me

Fig. 16 © Robert Baum
Case study D
Muttsu kumi sujichigai

Fig. 17 © Robert Baum
“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
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