CULTURALLY INSPIRED PATTERNS FOR PHOTOVOLTAICS

Robert BAUM\textsuperscript{1} and Salvator-John LIOTTA\textsuperscript{2}

\textsuperscript{1}Ph.D. Candidate, Department of Architecture, The University of Tokyo, Japan

\textsuperscript{2}Ph.D., JSPS Postdoc Research Fellow, Department of Architecture, The University of Tokyo, Japan
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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”

<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>
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<td></td>
<td></td>
<td>structure construction</td>
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<td>long-lasting</td>
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<td></td>
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<td>lightweight</td>
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<tr>
<td>2nd layer</td>
<td>energy-controlling device</td>
<td>environmental energy</td>
<td>electric machinery</td>
<td>energy conservation</td>
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<td></td>
<td></td>
<td>purpose building type</td>
<td>climate control</td>
<td>high performance</td>
</tr>
<tr>
<td>3rd layer</td>
<td>social function</td>
<td></td>
<td>planning organization</td>
<td>family community</td>
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<td></td>
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<td></td>
<td>lifestyle urbanity</td>
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<tr>
<td>4th layer</td>
<td>symbol meaning</td>
<td>form space</td>
<td>representation</td>
<td>virtual reality</td>
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<td>criticism</td>
<td>ephemeralization</td>
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</tbody>
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"However, properly speaking, sustainable design should involve all four layers."

(Namba, 2006)
traditional Oriental mashrabiya
Arab World Institute, Paris, France
architect: Ateliers Jean Novel, 1987

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

© Brigit Varenkamp
<table>
<thead>
<tr>
<th>Layer</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st layer</td>
<td>Wooden latticework</td>
<td>Fig.1 © Cora Edmonds</td>
</tr>
<tr>
<td>2nd layer</td>
<td>Daylight transmission, shading, cooling, air conditioning</td>
<td>Fig.2 © Jean Novel</td>
</tr>
<tr>
<td>3rd layer</td>
<td>Privacy and views in residential houses</td>
<td>Fig.3 © Brigit Varenkamp</td>
</tr>
<tr>
<td>4th layer</td>
<td>Geometrically crafted patterns in accordance with Islamic laws</td>
<td></td>
</tr>
<tr>
<td><strong>Arab World Institute, Paris, France</strong></td>
<td>arch: Ateliers Jean Novel, 1987</td>
<td></td>
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<tr>
<td><strong>Menara airport, Marrakech, Morocco</strong></td>
<td>arch: E2A architecture, 2008</td>
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</tbody>
</table>
“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)
“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)
“seascapes as an example of an ever-changing visual experience”

(Eakin, 2007, p.48)
"reflect the polychrome art nouveau façades of the merchants' mansions and the public buildings those merchants sponsored"

(Riley, 2006, p.25)
“reveal the complex patterns of turbulence in the wind”

(Kahn, undated)
“[…] 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
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

Print
Case study A
Maru ni yottsu-wari-ishi
Case study B
Nanatsu-wari sumi-tate yottsu-me
+ Tsunagi kokonotsu-me

Family crest
Solar cells
Print
Case study C
Mittsu-me

Family crest

Solar cells

Print
Case study D
Muttsu kumi sujichigai

Family crest

Solar cells

Print
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