Sustainable Building
Skin Design

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Introduction

A building’s skin is the first layer that confronts us when we evaluate a design aesthetically and also a crucial element in the overall technological functionality of a building. When we identify the defining characteristics of a building we are commonly describing its skin. Its form and composition have both aesthetic and performative repercussions. It is certainly a design element, yet it is integral to moisture protection, thermal comfort, the overall structural system, and the technical composition of a building.

Skins should be examined both as givers of character and as part of the performative technology of buildings. How does design character emerge out of real performative elements of the building? How does the structure of a building generate real character that begins to define a building aesthetically as well as functionally? These questions can be answered through a careful analysis of the performative qualities of building skins.

Parameters

A list of ten parameters that should be discussed when designing building skins is given below. Each has the potential to define the character and affect the overall perception of a building.

1. Sun Control
   Natural Ventilation
   Day Lighting
   Connection to Outdoors
   Thermal Insulation
   Moisture Control
   Micro-Climate Zones
   Structural Efficiency
   Material Choices
   Potential for Energy Generation

Each of these can generate visual and experiential qualities of a building. Below, each parameter is examined in detail to enable further discussion.

Sun Control
Thermal and visual comfort are dependent on controlling the light entering a building through its facade. The amount of light admitted to a building correlates directly with an increase in interior temperatures, affecting the comfort level of the users within. Blinds can provide a simple way to restrict sunlight subtly without affecting the overall appearance of the building. Alternatively, shading elements can be highlighted by integrating the solar strategy into the facade, as in the GSW headquarters building in Berlin (Figure 2). Here the visual character of the building is defined by the sunshades and by their ability to move.
2. Natural Ventilation

Ventilation strategies can also give a strong character to the elements of a facade. They can be simple, small, repetitive louvers that allow for localized air circulation, or very involved mechanical systems that direct fresh air throughout the building, as in Foster + Partners’ Swiss Re Tower in London. In this building, ventilating the atrium serves to circulate outside air through the rest of the tower (Figure 3). This multi-faceted system exhibits a computer controlled ventilation system.

3. Day Lighting

Daylighting can be achieved mainly through passive measures. A simple light shelf can bounce light deep into a space, illuminating the interior by taking advantage of the reflectivity of the ceiling (Figure 5). In the Reichstag building in Berlin, Foster + Partners employ a central dome and cone as an extreme, visually dramatic way of pulling light into the building (Figure 4). Daylight levels are known to affect the mental health of workers, with workers exposed to natural light reporting higher levels of productivity and general happiness.

4. Connection to Outdoors

Connection to the outdoors is another sustainability feature that is psychological in nature, like daylighting. The Ricola Offices in Basel by Hertzog and De Meuron features large sheets of glass protected by a vegetated screen that serve as a visual connection to the outdoors. Glenn Murcutt designs houses with whole walls that can open, connecting the interior of the house directly with the outdoors (Figure 6). His intention is to blur the boundary between interior and exterior space, enhancing the feeling of dwelling in nature.

5. Thermal Insulation

The invisible insulation in walls has a huge potential to impact the thermal performance of a building. A particular insulation’s makeup and placement within the layering of the building skin can have large consequences that are observable in the thermal performance and aesthetics of the building skin.
6. Moisture Control

Bitumen, a natural substance consisting mainly of hydrocarbons, is frequently used to create moisture barriers in buildings. We often think of the outermost skin as the water barrier, but more frequently it acts only as a rainscreen. There are two kinds of moisture to contend with when trying to keep a building dry: rain and condensation. When large temperature differentials occur between the interior conditioned space and the exterior conditions, condensation forms on the colder surface. Protection is necessary to prevent this moisture from seeping into the building. The rainscreen and moisture barrier work together to prevent unwanted rain and condensation from entering the building.

7. Micro-Climate Zones

Figure 7 shows an ordinary building in Germany that was retrofitted to add a south facing microclimate zone. In winter, the leaves fall off of the deciduous trees, allowing the sun to shine directly into the space, causing a greenhouse effect. In summer the leaves shade the window and the vents at the top open to allow ventilation through. When the temperature outside is 20 degrees, the sun heats the adjacent micro-climate space up to about 60 degrees, helping to decrease the energy needed to warm the building to a comfortable temperature. The micro-climate is adjacent to the coldest parts of the building, attempting to provide aid where it is needed most.

8. Structural Efficiency

The Swiss Re building in London illustrates the strategy of integrating structure into building skin (Figure 9). High-rise construction is primarily concerned with carrying lateral loads, so the diagonal lateral bracing of the building often called the “Gherkin” is expressed as part of the skin, helping to define the character of the building.

9. Material Choices

Materials can give a very distinctive character to a building (Figure 8). Although they are often overlooked by students and professionals early in the design process, materials are seminal because their texture and appearance...
define the experience of the building. Materials also play a primary technological role and have a tremendous effect on the comfort of the building.

10. Possibility for Energy Generation

There is also the possibility for a building’s skin to become an energy source. Photovoltaics can be integrated into facades, as seen in Figure 10, to simultaneously generate power and shade a building.

Case Studies

The following is a compilation of buildings whose primary architectural distinction is their integration of the technological elements of their skin into the design of the building.

Daimler-Chrysler Building, Berlin
Renzo Piano Building Workshop

Sun Control: Stationary horizontal sun shades on south side; egg crates keep heat from collecting under shading devices. Operable sun shades on main building; open when occupied, closed when not, computer controlled with manual overrides.
Natural Ventilation: Hopper windows aid in ventilation, no cross-ventilation because of building type.
Connection to Outdoors: Daylight throughout, clear visual connection to outdoors.
Micro-Climate Zones: Microclimate zones in specific low level areas; double skin with airspace.
Material Choices: Screens of clay tiles as fixed sun shades throughout building; clad with clay tiles manufactured locally.

Cal-Trans Building, Los Angeles
Morphosis

Sun Control: Sun control as major generating theme, simple stacked screens cover façade; Daylighting through perforated metal and light wells. The entire west face screened by perforated metal, operable pieces run by simple motors that allow it to shut down in the afternoon, with single ply roofing material used behind as a moisture barrier.
Micro-Climate Zones: Double skin on south allows for a 2 foot catwalk, creating a microclimate to reduce cooling loads
Possibility for Energy Generation: Horizontal sunshades on south are made of photovoltaic panels.
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Museum of the 21st Century, Kanayana, Japan
SANAA

Sun Control: Seasonal sun control; deciduous vines generate dappled light and help limit heat gain while creating a softer light quality. Micro-Climate Zones: Microclimate between vines and glass.

Austin Convention Center, Austin, TX
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Sun Control: Extensive sun control; indigo translucent glass with photovoltaic panels that face south west to capture sun’s energy and block hottest sun. Maximum levels of daylight captured through extensive glazing. Natural Ventilation: Air enters underneath the soffit overhang. Micro-Climate Zones: Created between photovoltaics and glass. Structural Efficiency: Minimized structure with two thinner layers of structure spaced a few feet apart utilizing depth to create a vertical truss.
Federal Courthouse in Alpine, TX
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Daylighting: Minimal glass on exterior, with interior courtyard providing light for functions that need it as well as a connection to the outdoors.

Thermal Insulation: 22" thick masonry wall made of red sandstone. Their thermal mass is used to take advantage of temperature differences due to diurnal swing. In winter, the walls absorb heat from the sun during the day, then radiate it into the space at night.

Material Choices: Dry stacked local red sandstone preserves the character of the place.

Conclusion

The methods illustrated in the case studies provide effective ways to create healthier buildings that consume fewer resources than other buildings of the same size and function. What good is a green building in a brown world? In order to achieve our goals of sustainability, these skins must exist where transit oriented development is a priority. We must concentrate development and preserve surrounding open space while promoting pedestrian circulation and developing centralized public transit to prevent sprawl and encourage a sense of place. There may be resistance to this change because of political apprehension or the public's resistance to change. Through education, we can expose policy makers and the general public to this better way of growing. Transit oriented development can increase the health of communities, encourage economic growth by centralizing commercial areas, and improve environmental quality.²

Notes

1. Most of the information is from a presentation given by Larry Speck to the UT School of Architecture on September 22, 2008.


Figures

Figure 1. http://www.flickr.com/photos/clickykbd/491534331/in/photostream/


Figure 4. http://darkwing.uoregon.edu/~akwok/VSCS/AshCreek/lighting/images/classwindows.jpg


Figure 12. http://www.flickr.com/photos/tmiko/2796610559/


Biography

Lawrence W. Speck is a professor in the School of Architecture at The University of Texas at Austin, where he has been on the faculty since 1975. He was dean of the School of Architecture from 1992-2001. Professor Speck received all three of his degrees from M.I.T., where he was on the faculty from 1972-75. As an academic, Professor Speck has won numerous awards, including both the Amoco Award and the Blunk Professorship, both for outstanding undergraduate teaching. He has been a Fulbright Senior Scholar and has written 40+ articles in professional journals and other publications on art, architecture, engineering and design. Professor Speck also has a distinguished career as a practicing architect. His buildings have garnered 28 design awards and have been published in 60+ articles in the U.S., Germany, England, Italy, Japan and Brazil. His completed buildings include the Umlauf Sculpture Garden and Austin Convention Center. He is currently working on the Barbara Jordan Terminal at Austin-Bergstrom International Airport, the Robert E. Johnson Legislative Office Building and an extension to the Austin Convention Center. In 1995 Professor Speck was elected a Fellow in the American Institute of Architects.³
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