Capturing the Ephemeral may not at first appear to have any relationship to materials, but light phenomena, as any phenomena, exist only in the material world. We associate light phenomena with the careful observation of the material world. In a sense we consider materials to be inseparable from the light phenomena we associate with them—clouds, sky color, or rainbows. Light phenomena occur at every turn, but the distractions of our built environment suppress our ability to observe them. Yet the built environment has the full potential to reveal the natural world, and the careful use of materials can lead to an environment enriched by our ability to experience the ephemeral more fully.

To achieve this we have formulated an approach that can effectively translate our observations of the ephemeral into the built environment. This approach has emerged from over 40 years of experience, beginning as an artist, working with glass, exploring film installations and light, and then working with scientists and manufacturers of glass and eventually with engineers and architects, now applying the full extent of our cross-disciplinary experience to the design of complete architectural projects. The artist’s discipline is one of observation and this observation tells us about the world we live in.

**Volumetric Light**

The quality of light is explicitly related to the specificity of place. Light contains much of the information about our immediate environment. Every moment of ephemeral light informs our conscious and subconscious observations. As light interacts with the material world it reveals itself. Light and its interaction with any family of materials records and presents the information that defines the reading of our immediate context. We aim to synthesize these observations through the exploration of materials in general and glass in particular. By re-presenting this synthesis at a scale or context that is unfamiliar, light phenomena become an observable experience.

We approach architectural design through the architectonics of volumetric light. The architectonics of light considers the material qualities of glass as having the most comprehensive ability to generate a volumetric quality of light. Light simultaneously occurs on multiple surfaces, thereby implying a depth to that field of light. This is a key concept that results in the building surfaces becoming sensitized to qualities of light through the use of materials; however, our approach to materials originates in our understanding of the extraordinary characteristics of glass.

The idea of the “responsive field” is fundamental to this approach—observation; synthesis of that observation; the testing of materials and ideas resulting in an understanding of how glass and other materials can embody the original observation. We think of materials beyond their typical place within a palette available to architects. We explore materials in order to find the qualities that are fleetingly observed in nature and that define a unique sense of place. Every material reacts to light, though some materials are more actively responsive. By taking advantage of those materials’ characteristics, the surfaces can appear optically porous and dimensionally responsive.

The general understanding of glass is still quite limited. It is important to consider that many materials are glass, including metals, ceramics, and polymers. Most people look at a window and see that as the beginning and end of glass, when in fact glass is a state in which many materials can find themselves—a supercooled liquid whose jammed particles present localized discontinuous fields of structure and larger fields of dynamical heterogeneity within them. Its mutable characteristics offer an opening into a world of unfettered opportunities. Transparency is only one of countless capabilities and characteristics available to glass as a material. Photo-sensitive glasses, for example, can be described as having a latent memory: information can be recorded in the glass through exposure to certain wavelengths and reappears in response to temperature, while the glass remains transparent at other times. It is a very malleable material, but unfortunately in architecture, the manufacturer dictates the material and the designer has very little opportunity to manipulate the material beyond the manufacturer’s determination. We have the opportunity to work closely with manufacturers to develop materials specific to our aims.
This “first principles” approach to materials brings a new set of possibilities to architecture. What does it mean to work with a material that is generally defined as a supercooled liquid or a non-crystalline solid? What does it mean that a material is solid to the touch and manipulated like a solid when molecularly it is better described as a liquid? In the scientific community, the very definition of glass has long been and remains a matter of research. We understand that the glassy state exists across a huge field of materials from metals, ceramics, and plastics to colloidal solutions. The notion of jamming refers to very densely packed molecules, which as they become denser, slow down to the point where they are perceived as solids without the organized structure typically associated with solids. The field of granular physics practiced by Sidney Nagel, Heinrich Jaeger, or Hajime Tanaka among other scientists, has modeled these ideas so as to explore them in an observable manner (ills.).

**Latency**

Another unique quality of glass, and a conceptually powerful idea to be applied to materials in general, is latency. The term is used in the field of photo-responsive or photo-sensitive glass. Glass is essentially comprised of chemical elements, combined and put into solution. By adding certain metals such as silver halide, gold chloride, manganese oxide, or selenium oxide— all metals used historically in the production of photo-sensitive paper— and combining them with other chemicals such as fluorines, the manufactured glass maintains the appearance of a conventional piece of glass, but has the capacity to be manipulated using light. This manipulation can be as prosaic as developing a photo image in the glass, though it is interesting to note that the image exists in three dimensions since it occupies the whole depth of the glass. The particular choice of chemicals allows you to achieve intricate three-dimensional forms by selectively exposing parts of the glass to specific wavelengths of light.

The chemicals are melted together when the glass is manufactured in the furnace, then annealed. At room temperature the glass is then exposed to ultraviolet or infrared lasers or even by laying a photographic negative on the glass and exposing it to the sun. The glass at that point has the latent memory in it: it is a clear piece of glass, but as soon as it is reheated close to the softening temperature, the image will appear. Within a non-crystalline field, there is now a matrix of jammed particles with photographically organized areas crystalline in structure. In other words, a solid field is suspended within a non-solid field. You can go further with this— under certain conditions the area that is unexposed (glassy) remains sensitive to acid, so you can take this sheet of glass and dip it into acid, thereby etching away the glassy area, leaving only the ceramic area—a systematic method of chemically machining the material. Latency and latent memory allow the organization of extremely complex three-dimensional structures used in many applications from communications to ceramic filtration systems.

Another application of the same process, developed during work on the photographic glass with Cominex Glass, for Norman Foster’s Hong Kong and Shanghai Bank, aimed at creating permanent louvers integrated into the body of the glass itself. This kind of louver glass was not further pursued, but this family of glass today includes solar-reactive glasses and glass filters. The initial research, which simultaneously explored glass as a photographic medium and a high-performance daylighting system, demonstrated the quality of glass as an ultimately malleable material. Like a chameleon, it can take on almost any property, capacity, or role.

When I talk about light as information, I think of how light is invisible until it strikes something, be it water, dust particles, or any material surface, reflective or absorbent—that is when it manifests itself. Each substrate or subject that it strikes gives back the information about its presence in our world. It is also true to think of light as paradoxically revealing itself as it is interrupted by the material world. Something we never usually put together in our minds is that as light hits one object it is reflected away from us. Light is carrying the information from that reflective surface but it is also likely to strike many other surfaces, each surface being informed by the accumulated content of the light. Each photon is a record of its journey and interactions, and we aim to understand and reveal this cumulative body of information. It is a very complex thing. You can manipulate the transmitted and reflected light but consider also what is occurring within the reflective material, the glass
James Carpenter Design Associates,
7 World Trade Center.

Sectional diagram of curtain wall showing how the linear lap and spandrel daylight reflector interact with daylight.

Plan diagram of podium screen showing how daylight is programmed by the outer screen's prismatic wire orientation.

Plan diagram of podium screen showing how LED lighting integrated within the wall interacts with the screen's prismatic wire orientation.

Podium screen and curtain wall: LED light is inserted between the two layers of the prismatic wire screen.

The linear lap and spandrel daylight reflector transform the full expanse of the curtain wall into a responsive membrane.

The window in this instance is a device that constructs a new reality. It assembles diverse sources of information existing in the exterior environment and re-orders them through superimposition to create a "new" perception of that exterior.

The device during construction: it remains visible from the outside while varying conditions reveal more or less of the device's parts on the inside.

The device is tuned to essentially synthesize and deploy the everyday variety of light conditions.
itself. Glass is a remarkable material in that light passing through is slowed down by it at a molecular level and bent by its indices of refraction. The body and the surfaces of the glass add up to a tremendous amount of manipulation of visual information, but glass also reveals qualities that are inherent in the light itself.

We carry an incredible databank of experience that is significantly impacted by the memory of light, some of it consciously and much of it unconsciously. Our memories constitute one body of information while dreams and the unconscious mind are another body of information. Light reveals multiple layers of information in the course of its passage through glass.

If light informs our unconscious memory, just as it informs our conscious mind, it seems possible that the process of revealing the usually unseen nature of light could also deepen a sense of nature that may be ignored but which has a powerful unacknowledged presence within us. By controlling light's transition across materials it is possible to transform the usually planar boundary into a volume of light. In extending the boundary between interior and exterior into a volume, the light's passage across space and its relationship to time can be better experienced. You might say that transparency is the least interesting characteristic of glass.

**Expanding the Boundary Between Inside and Outside**

In some respects this is metaphorical but with projects such as the podium screen and curtain wall for 7 World Trade Center (ills. pp. 107, 109), or the Periscope Window (ills. p. 110), both focusing on this notion of volumetric light, layers of materials have been set up optically to create or extend the perception of volume and the sense of light in nature. The aim is to extend the experience of the boundary between interior and exterior well beyond the physical depth of the building skin by understanding the optical and perceptual transition that occurs at that boundary. In 7 World Trade Center light from the deepest surface of the building is being broadcast back out into the public realm, as well as to the surface of the building. There are multiple sources of light from multiple depths, which are superimposed for the viewer to observe. The viewers may not understand exactly the physics of light and glass, but they will acknowledge that they see something they have not seen before, something which connects them to the immediacy, familiarity, and topiality of nature.

The latency of glass can itself be a metaphor for the idea of the conscious and unconscious mind. In the case of the Periscope Window, the glass looks like a completely normal piece of clear glass although it actually contains information that is revealed only when subjected to significant optical operations. It is intentionally using several optical principles like reflected image, magnified image, and direct projection superimposed on one surface (ills. p. 110). When you look at that surface it is laden with multiple views of the world beyond the interior space, yet unlike a typical window, the Periscope Window is gathering information from points outside that would not be visible to the occupant. A window would normally give you a view outside, but in this case there is no view because of an immediately adjacent fence and neighboring building. The idea is to challenge our idea of what a view from a window should mean or look like. A window has the capacity to be more interpretative and informative of the broader context. The Periscope Window can collect pieces of the surrounding environment from a broad range of vantage points, providing a broader view of nature as opposed to the explicit view of nature from a conventional window.

These operations are not hidden — they are integral to the work. The flat plane of the interior etched glass intermittently conceals the working parts, yet at times, direct projections populate the Periscope Window revealing the lenses as objects in themselves. In this way information from the outside world, such as images of the trees projected on the glass or shadows cast, and the product itself, the optical parts of the window, exist and are revealed simultaneously. All the parts add up to present multiple phenomena simultaneously on the single plane of interior glass, thus powerfully suggesting the invisible accumulation of information seasonally and diurnally. Without this device you would not see what we have actually presented — a compilation of multiple experiences superimposed into one experience. By collating and overlapping all this diversely scaled information, you are presented with a vision of the outside world that might provide a more essential experience of place. The experience
may be fleeting but the optical tuning of the device presents a constancy that helps manage the complexity of the output.

The Periscope Window takes all the characteristics of a simple piece of glass, expands them, and gives an explicit role to each of these characteristics – the front surface might be reflective, the back surface might be refractive, etc. By being manipulated in this way these characteristics bring to bear on the window another interpretation of what is going on outside. And this is why I talk about the volume of light or volume of information, because we are always trying to expand on this boundary condition separating interior and exterior, trying to understand how the boundary condition can be more readily manipulated to allow us a more complex view of the world.

**Transparency, Reflection, and Refraction**

Just as many people think of glass in an optically limited way, they similarly have never really understood the structural potential of glass. Structural glass is still an exception to the standardized approach to building with glass. Conceiving the structure as light and delicate as possible allows the glass to take on a more potent role in terms of defining your experience of the space. By minimizing the usually exuberant role of cables, stainless steel tubes, and all other components of the tensile structures, the latent information and phenomenology of light embodied in the glass can emerge clearly in its capacities for transparency, reflection, and refraction.

The Retracting Screen represents a particularly challenging yet pure example of structural glass (ills. p. 113). This glass wall in a private home emerges from the floor in order to screen a dining area from a gallery and retracts to open this space up at other times. Two layers of glass are located on either side of vertical rods that apply tension and compression to stiffen the glass assembly with a minimum of structure. In this way the glass can unfold its fullest potential to respond to the room’s spatial characteristics and its relationship to the view through the clear glass boundary. The screen consists of an interior surface acting as a heightened plane of reflectivity and an exterior surface as a heightened plane of luminosity. To reveal the material in this way depends on the glass itself being the primary structure so that its phenomenal impact on its environment is not obscured by extraneous structural elements.

The Structural Glass Prisms Window, well over 20 years old but remarkably timeless, responds to the wish for a clear window to observe the beautiful landscape surrounding a chapel (ills. p. 113). How to manage the material choices and structure of such a large window (9.75 m H x 3.05 m W x 61 cm D) and have it bring another level of spirituality, observation, or mystery into the chapel? The millions of a metal framing structure would have stacked up and obscured the view from most points in the chapel. Instead, long vertical pieces of tempered glass span the width and depth of the opening, providing the primary structure while smaller horizontal pieces feature dichroic coating and at the same time stiffen the entire structure.

Similar to the Periscope Window’s simplicity that belies the multiple levels of transmitted and reflected information, the Structural Glass Prisms Window is a device transposing the experience of interior space relative to exterior space. In each case, depending on the conditions, you may see a blank surface there, then fragments of the device may appear, disappear, or be very intense and there is the powerful cumulative effect of abstracted information experienced over the passage of time. The judicious use of materials has tremendous potential, yet time’s influence over materials has to be understood. The diurnal and seasonal interaction of light within a particular site or space must be systematically calculated in order to strategically select materials that can embody the relationship of light and time.

**Responsive Planes**

Materials have the potential to act as responsive planes. They can be responsive to the environment, responsive to your vantage point, and responsive to qualities of light. In fact, the careful manipulation of materials results in optical devices that are highly responsive – these devices require that the depth of the device and its parts work precisely together. The operations that can be applied to glass – laminating, tempering, coating, polishing, etching, etc. – are informed by the pragmatic issues
Two qualities of glass are layered to generate the sense of simultaneity between reflection and transmission.

Video still of glass testing.

The two layers of glass consist of an interior surface acting as a heightened plane of reflectivity and an exterior surface acting as a heightened plane of luminosity.

The structural glass tension structure retracts into the basement.


The window maintains the view out to the landscape by using structural glass and forgoing the need for mullions.
of thermal energy, daylighting, glare, and other performance requirements that deal with occupant comfort and functionality for the space. Then there are the contextual questions of the program, culture, traditions, and history and finally we mine the glass’s potential to respond to these issues and generate the experiential qualities of light that bring a presence to the structure and a momentary pause to those that encounter it. Every project is a pragmatic process, but by the refined selection of responses to code, daylighting, and other issues of function and performance we allow those perceived limitations to become opportunities.

Small-scale models may be used for testing ideas surrounding these observations, a process that may result in material mock-ups for performance analysis (Ill. p. 113). An example is the Reflection Threshold, which explores a location that has virtually no daylight, an alleyway which runs north-south between two buildings now owned by the New York University Institute of Fine Arts—the Sheldon H. Solow Library and Study Center to the east, recently donated to NYU, and The Duke House to the west, near Central Park in Manhattan (ills.). As a result, the narrow alley would become the connection between each eight-storey building. A pavilion was envisaged as connecting the buildings, but the minimal amount of light that filters down from above was considered a hindrance. The project is about enabling your eye to be sensitized to the modest level of ambient light and to capture and redirect light into this restricted environment. Specific surfaces can be deployed to allow the eye to observe in a more focused way while specific optics can be applied to render the light that is present. The pedestrians passing by on the street, looking down what they know to be a dark alley, are being presented with light from Central Park, captured by a metal tri-wire combined with textured and perforated metal paneling which extends the length of the alley on its east side.

From within The Duke House, which is on the west side of the alley, you will experience the vertical tri-wire wall with brighter horizontal tri-wire sections that align with The Duke House’s windows. The wires of the horizontal tri-wire sections are oriented to capture the brightness of the sky directly overhead, and also you will always see an implied reflection of the window.
James Carpenter Design Associates,
Dichro: Light Field, New York, New York, USA,
1995.

Polishing the ends of the glass blades generates
the glass's ability to register this one light
condition on the site.
James Carpenter Design Associates,
Moiré Stair Tower, Deutsche Post
(architects: Murphy/Jahn), Bonn, Germany,
2002.

View from the outside.

James Carpenter Design Associates,
Moiré Stair Tower.

Viewing platform at the stair tower’s apex.

Details of the complex play of reflected and
transmitted images captured by the stair tower.
that you are looking out of, expressed as a brighter surface on
the screen wall across the alley. The Sheldon H. Solow Library
and Study Center on the east side of the alley contains many
rare books and while it is appropriate that these be protected
from direct light, users need not be deprived of a vivid level
of light information. A light box provides the occupant with the
sense of an extending luminous volume, simply by increasing the
depth of the window’s interior and exterior sills with reflective
material – a device based on the idea of brick sills in England
being painted white to create a brighter aperture than the
window itself when you look through it. Thus an expansive
sense of space is created. The design for this alley extends
across every surface of the basement and ground level; there
are different types of glass, stainless steel screens, and paving
materials; the whole vocabulary of materials will turn the dark
alleyway into an environment exquisitely responsive to light.

It is often the details that complete a device’s ability to
encompass a phenomenal experience of light. The Dichroic Light
Field’s dichroic glass fins feature polished ends which refract bars
of light onto the screen under particular conditions (ill. p. 115).
The Retracting Screen (as seen on p. 113) features beautifully
polished edges which bring light into the glass, brightening the
plane itself. Often a frosted edge makes the plane go flat. Even
when we do acid etching we are very careful to retain the glass’s
optical brilliance. This comes down to a careful calibration of the
glass’s properties. We could describe the taxonomy of glass as
being distilled to reflection, transmission, diffusion, absorption,
refraction, and diffraction.

A mirror, being a completely reflective surface, presents itself either
as the complete presence or absence of light. A mirror reflecting
toward you is the presence of light and image, but the same
mirrored surface reflecting away from you presents a void. There is
a presence/absence quality to mirrors that I find remarkable. In the
Dichroic Light Field, from one viewing angle all the light coming
from behind you is being reflected away from you, so the field
appears to be totally black and you just see the light reflecting back
toward you from the fins against that void, while someone looking
at it from the other direction sees the presence of light. The same
mirror has two totally different readings.

Prismatic effects, pixelation, and fracturing can be described as
subsets of reflection. The Moiré Stair Tower in the base building
of the Deutsche Post in Bonn, Germany, contains selective areas
of reflectivity, diffusion, and light re-projection in the glass, but
more obviously it is about pixelating (ills. p. 116). Looking at the
stair tower from the outside of the building this field of mirrored
elements presents the landscape and sky behind you. When
approaching you see more of the sky plane and also notice the
blue squares facing the inside of the tower, which then merge with
the blue of the sky. The mirror/blue elements were screenprinted
onto the glass to heighten the levels of reflectivity and reflection.
The project is essentially a mirror, but being presented as a field of
rectangular dots, it begins to challenge your interpretative ability
to read what you are seeing. It challenges your perception. The
glass surface itself is reflecting the same information as the mirror
dots, but by layering the reflective and transparent planes, the
information is being reduced to the experience of ephemeral light.

Reconnecting to Natural Events

Materials are critical to deepen our experience of light, to reveal
what is unique to a site through the experience of light, as
light’s interaction with the material world largely defines one’s
interpretation of place. A phenomenon as simple as clouds becomes much more complex under scrutiny. We take for granted
the phenomenon of light captured and diffused by water vapor,
and yet there is great beauty to be found in such observations.
Luminous Threshold, a project announcing the entrance to
Sydney’s Olympic Park with a phenomenal experience which
speaks to the industrial site’s reclamation and transformation,
investigates a synthesis of the natural phenomenon caused by
water vapor interfering with the passage of light (ills.).

As we occupy a progressively more urban environment, we can
become disconnected from the natural forces that prevail. Our
approach to materials always begins with the questions: how do
you reconnect people to the phenomenology of natural events
in their day-to-day experience? How does the public realize that
there is the potential within the built environment for something
to take on a presence that is ephemeral, beautiful, informative,
and enriching?
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