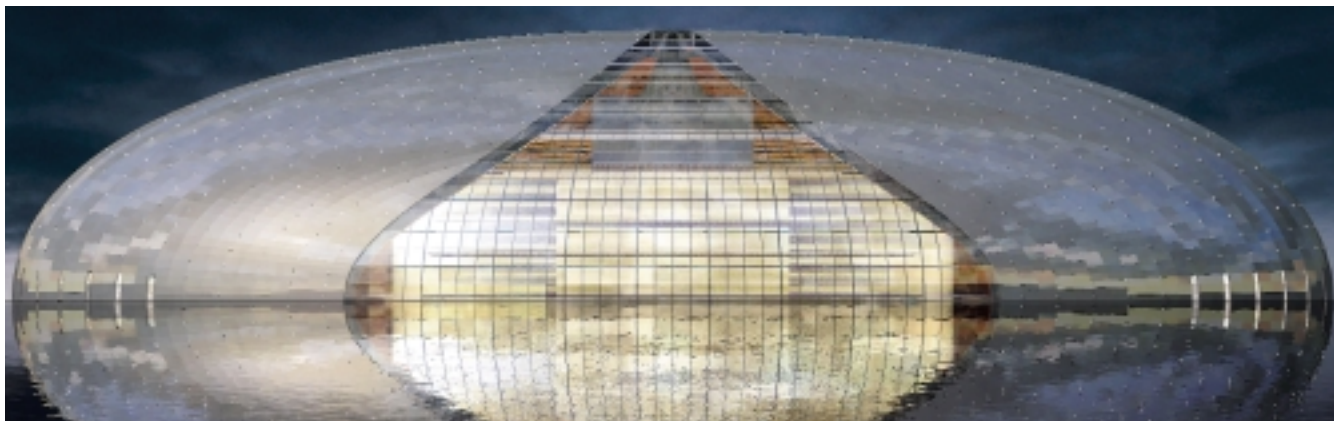


# Laminated Glass News

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## National Grand Theatre of China: an opening curtain of laminated glass



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The National Grand Theatre of China in Beijing by architect Paul Andreu.

The National Grand Theatre of China in Beijing by architect Paul Andreu is one of the most talked-about architectural projects for years, both because of Andreu's audacious and innovative design, and for the grand scope of the project itself; the Theatre will be Beijing's foremost cultural center, situated in the heart of the capital, symbolizing all that is exciting about the new China. It will be, in the architect's words: "A new district of spectacles and dreams open to one and all."

Over 6,355 m² (68,400 ft²) of insulated laminated glass incorporating DuPont™ Butacite® PVB interlayer is used by the architect for a clear curtain wall to the building that aesthetically portrays just that: a grand, invisible curtain, a shimmering mirage that looks as though it has just been

parted this instant to reveal the stage inside. The laminated glass was supplied by Northern Glass of Shanghai.

This stunning laminated glass curtain wall, which continues symmetrically over the top of the building to open up at the north and south-facing façades, is enclosed by the remainder of the elliptical titanium façade. Visually, this opaque, titanium covering frames and highlights the clear laminated glass space that it surrounds, a space from whence can be seen, at night, all the light, movement, action and excitement of a busy theatre, music and arts complex from the street outside. By day, the clear, laminated glass façade soars upwards to form a grand skylight to the upper dome of the building, flooding the interior of the Grand Theatre's atrium lobbies with natural daylight.

The Theatre, due to be completed in early 2006, is situated on Chang'An Avenue, next to the Great Hall of the People and about 500 m (1,640 ft) from Tiananmen Square and the Forbidden City. It is a curved building with a total surface area of about 149,500 m² (1,609,205 ft²) that emerges like an island at the center of a lake. The titanium shell is in the shape of a super ellipsoid with a maximum span of 213 m (700 ft), a minimum span of 144 m (472 ft) and a height of 46 m (151 ft). The building houses three performance auditoria – a 2,416-seat opera house; a 2,017-seat concert hall and a 1,040-seat theatre – as well as art and exhibition spaces open to a wide public and integrated into the life of the city.

Architect Paul Andreu said: "The National Grand Theatre of China is divided into two

by a curved, laminated glass covering, which is 100 m (328 ft) wide at the bases of the north façade and the south façade. During the day, light flows through the glass roof into the building. At night, the movements within can be seen from the outside.

"The building is connected to the shore by way of a 60-metre (197 ft) long, transparent underpass. This entrance leaves the exterior of the building intact, without any openings, and remains mysterious-looking, while providing the public with a passage from their daily work to the world of opera, fiction and dreams.

"A viewing lounge on the highest level of the building, under the laminated glass skylight roof, affords the general public and

theatre-goers alike with a 360-degree view of Beijing that varies with the light according to the time of the day. From the laminated glass window/façades of this viewing lounge, the city can be rediscovered from a hitherto-unseen perspective."

Zhang Yu Tang, chief engineer at Shanghai-based laminator Northern Glass commented: "Laminated glass ensures the safety of visitors in China's newest and greatest cultural attraction. Because of the National Grand Theatre's downtown location, the acoustic barrier properties of laminated glass are very important in significantly reducing the noise coming from outside, enabling opera- or concert-goers to enjoy a still, silent and magical world within the confines of the Theatre complex."

## Clear views of Manhattan from new Rockefeller Center viewing platform

On 1st November 2005 the renovated and much-anticipated 'Top of the Rock' observation deck at the top of New York City's famous Rockefeller Center re-opened to the public. The centerpiece of the project lies with the reopening of an extraordinary city observatory, some 260 m (853 ft) above the sidewalk of 30, Rockefeller Plaza, on the 67th-70th floors of the building.

The observation deck was first opened in 1933 but had been closed to the public since the 1980s. It has now been fully revitalized using 465 m² (5,000 ft²) of large, freestanding panels or balustrades of laminated glass containing DuPont™ SentryGlas® Plus structural interlayer that specialists say are at least 20 percent thinner than any other glass construction tested. Thomas Fuman, project manager with SLCE Architects of New York City said: "The objective in using these unique and very large laminated glass balustrades was to provide a safe and secure viewing experience for all visitors to the observation deck and the Rockefeller Center, while maintaining the thrilling experience and expansive, 360-degree views

afforded from this unique and historic viewing platform, located 70 stories above Manhattan.

"The laminated glass installation consists of freestanding panels, cantilevered vertically up to three meters (10 feet) tall, with all supports and connections hidden below the walking surface of the roof. There are no clips or connections between the panels except at the corners. This allows the laminated safety glass assembly to be a perfect backdrop or frame for the views, as opposed to an obstacle.

"The decision to use laminated glass with SentryGlas® Plus came out of discussions with glazing contractor W&W Glass, LLC of Nanuet (NY), and exterior wall consultant Israel Berger & Associates of New York City. They advised us that the use of SentryGlas® Plus would solve many important challenges regarding the structural complexity of the laminated glass panels, our desire for absolute clarity of vision and the need for minimal reflectivity.

Continued on page 2.



© DuPont

"The Top of the Rock", New York City, with state-of-the-art laminated safety glass balustrades containing SentryGlas® Plus structural interlayer.

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# A design freedom unimaginable 10 years ago

by Ferran Figuerola, CEO of Cricursa, Spain



Ferran Figuerola, looking up from inside Ram Koolhaas's Casa di Musica, Porto, Portugal, 2005: curved laminated glass that needed excellent acoustic performance.

betweeninside and outside melt away and opening up the building to natural daylight to the maximum.

Architects today want more glass in buildings. The laminated glass technologies we have now means they can have that safely, and with a freedom unimaginable 10 years ago - whether in terms of structural strength, colors and decoration or delicately varying degrees of translucency, with the lovely effects this brings.

Architects also love using new laminated glass compositions with interlayers such as DuPont® SentryGlas® Plus because it allows them to use thinner, stronger glass constructions in lighter, clutter-free fixing systems like point-fixed glazing - which makes the glass, for all its strength, seem invisible, often making any barrier

## What's interesting / new on the market?

New interlayer technologies like DuPont® SentryGlas® Plus are excellent for our industry, again because they help to stretch the envelope of what can be achieved with glass in buildings. Architects are generally slow to adopt new technologies, preferring to take a 'wait and see attitude', but the quite significant new structural strength properties of the interlayer are becoming more apparent with every project it is used in, throughout the world. At Cricursa, we are beginning to understand that the use of SentryGlas® Plus with annealed glass can complement or even obviate the need for the

strength of tempered glass in a laminated construction needing high strength. This new type of laminated construction also brings the overall weight of the glass down, more good news for architects who want to use very large panes of glass in their façades; the whole façade weighs less and needs a less cumbersome support system. Part of the structural support is coming from the interlayer itself, which is a very interesting concept.

Today's lamination technologies have helped architects apply glamour to glass! And it's not only the aesthetics of the material that attracts the architects and the building industry; today's laminated glass works much harder than anyone could have imagined 10 years ago to meet a range of functional needs - from demanding wind load requirements in high rise buildings throughout the world, seismic loading where this is needed, or impact resistance in typhoon or hurricane regions. The marriage of glass with metal has also captured the imaginations of many architects because of the astonishing visual effects achievable when you laminate glass to metal mesh, and also because of new fixing possibilities if you can glue metal fixings right into the

SentryGlas® Plus structural interlayer - as Apple did for the Apple Store in SoHo and, following the success of that project, for an evolution of similar staircases in subsequent stores.

Most of all, I believe that architects are fascinated by the new ways to control light that laminated glass gives them: by building in various degrees of opacity; by using Low E coatings to control shading very tightly and by the use of colors of decoration within glass, for example. The architects we work with worldwide are very interested in decorative technologies like DuPont™

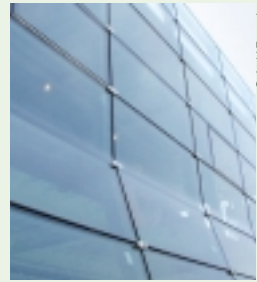
SentryGlas® Expressions™ decorative technology as an efficient and flexible new way of introducing a whole new range of visual possibilities into laminated glass.

## The architectural world is getting more global

Today, I would no longer say that architects from one continent want this or work that way while architects from a different continent work another way or want other things. The architects we work with are very spread out geographically. European architects work in the USA; U.S. architects work in Europe; Japanese architects work in Europe. They are hardly ever to be found in their home office! And a trend I see is that each major city across the planet wants its signature building, and almost by default this has to be designed by an architect from a different continent! Perhaps because an architect from elsewhere gives a refreshing new perspective to the assignment.

As for the future of laminated architectural glass, that depends on which gifted architect walks into our office tomorrow! We are always honored to be working on new architectural laminated glass challenges that go to make incredible buildings, all over the world.

**Ferran Figuerola**  
Founded in 1928 near Barcelona, Spain, Cricursa



Winka Dubbeldam, Archi-Tectonics, Greenwich Village apartment building, New York City, 2004. The architect wanted an unbroken, flat and folding laminated glass facade made out of one piece of flat and sharply curved laminated glass, supplied by Cricursa.

## Stunning coastal landscape photographs give local feel to a McDonald's in North Carolina



The architects of this McDonald's chose to customize the restaurant's interior by showcasing the area's stunning coastal scenery, with laminated glass wall murals using SentryGlas® Expressions™ technology

A customized touch to a new McDonald's in Charlotte, North Carolina (USA) has won the approval of patrons and staff alike. Charlotte's stunning coastal landscape has been made an integral part of the restaurant's interior design via a series of laminated glass wall murals containing photographs of seaside scenes, underlining the restaurant's links with its local community. The murals were made possible by the use of DuPont™ SentryGlas® Expressions™ technology. Charter House Innovations, based in Holland, Michigan (USA) are the interior designers for the Charlotte McDonald's. Charter House's lead designer, Betsy Norden, says her firm was inspired by McDonald's 'Forever Young' brand approach. She added: "SentryGlas®

Expressions™ possesses the modern look and durability that we strive for in our designs. Meanwhile, the use of laminated glass ensures long-lasting protection of the photographs within the glass."

David S. Cordrey, Venture Manager, DuPont™ SentryGlas® Expressions™, commented: "Franchise restaurant owners today are increasingly seeking a stronger community connection, while architects and building owners are looking for new solutions to customize restaurant interiors. Charter House Innovations' approach at the Charlotte McDonald's shows how both of these objectives can be achieved easily and simply using SentryGlas® Expressions™ technology."

Rockefeller Center, continued from page 1. Also, as the exposed, polished glass edges would be visible, the ability to maintain a clean and weatherproof edge to the glass was very important." The Dlubak Corporation of Blairsville (PA) did all the speciality glass fabrication and lamination for this project.

Scott Haber, managing partner in W&W Glass told Laminated Glass News: "As well as viewing clarity and visitor safety we had to satisfy the city building codes that require the glass construction to be able to withstand substantial wind load requirements of 45 psf or 140 mph at the corners, at the 70th floor of a building in downtown Manhattan. In addition, the glass construction, consisting of two layers of 15 mm (0.6 in.) low-iron laminated tempered glass, with a 2.28 mm (90 mil) layer of SentryGlas® Plus interlayer has to contend with a wide range of inclement

weather conditions such as snowstorms and ice in the winter and high temperatures in the summer. We had originally considered using a 4-ply, low-iron, anti-reflective glass construction for this demanding application - but this proved to be a more expensive and heavier glass type to use. Laminated glass with SentryGlas® Plus - which is 20 percent thinner than any other glass solution we tested - satisfied all the city's stringent wind load and environmental tests with ease."

A visitor to the viewing platform told Laminated Glass News: "It's amazing, really impressive! You're standing there, looking out with all of Manhattan beneath you, and it's like there's nothing between you and what's below, no barrier at all. You feel absolutely safe, yet on a clear day you can see forever!!"

## SentryGlas® Expressions™ "has the aesthetic and functional power to utterly transform the way we stage exhibitions" says Japanese architect Shin Takamatsu

When revered Japanese architect and Kyoto University professor Shin Takamatsu was offered the unusual honor of staging a retrospective of his work in the inner sanctuary or 'Koshibo' of a 1,200 year-old Toji Temple, one of the holiest temples in the ancient city of Kyoto, Japan, he decided that DuPont™ SentryGlas® Expressions™ technology offered the only appropriate medium with which to do so. In the architect's words: "Our design for the retrospective exhibition could never have been realized without DuPont™ SentryGlas® Expressions™ technology; it allowed me to showcase my own architecture in the context of an ancient Kyoto temple sanctuary with the appropriate humility."

Shin Takamatsu went on to say: "I believe SentryGlas® Expressions™ technology has the aesthetic and functional power to utterly transform artistic, photographic and other kinds of exhibitions as we know them today. The potential of laminating high quality images into laminated glass, especially with the proper lighting, are limitless."

"SentryGlas® Expressions™ technology is quite incredible! The physical spaces we had to work with were one narrow corridor or cloister and six tiny 'tatami' rooms (small rooms with straw matting on the floors and walls and sliding paper doors). SentryGlas® Expressions™ decorative interlayer for



A night-time photo of one of Shin Takamatsu's most well-known built projects, Sairei (the meeting place for a religious order, in Osaka, near Kyoto (completed 1998). Sairei is 'enshrined in laminated glass using SentryGlas® Expressions™ technology' in the foreground. Directly behind the glass screen is a large, wooden, construction model of a proposal by the architect of Kyoto City museum (not realized), viewable directly behind the glass screen.

have staged the retrospective in the temple! I will certainly use SentryGlas® Expressions™ in my own work again very soon. I would like to adopt the technology extensively, and give it a leading role in my architecture." The retrospective, which was highly critically acclaimed, took place in October 2005; the laminator of the SentryGlas® Expressions™ panels was Fujiwara Kogyo Co. Ltd. of Osaka.

## Architectural photos framed in translucent panels of laminated glass

Shin Takamatsu explained: "In a classic retrospective, my art and architecture should have been the immediate focus of the exhibition. However, I considered that the interior architecture of the Koshibo itself, a small detached building in Toji temple that is usually opened once a year

its overwhelming historical, religious and cultural value."

Virtually all the 'Shohji' (traditional paper doors) were removed from the six temple rooms and replaced with panels of translucent or transparent laminated glass measuring 190 cm (75 in) tall x 180 cm (71 in) long containing Shin Takamatsu's projects in photographic form, either as completed buildings or in construction, using SentryGlas® Expressions™ technology. Underfoot, the tatami matting had also been removed and replaced by laminated glass supplied by Asahi Glass Co. of Tokyo; underneath this clear laminated glass 1,000 working sketches of the architect were also safely displayed.

Finally, five large wooden models used by the architect, complemented by a number of traditional Japanese 'Fusuma' paintings by well-known artist Insho Domoto, were shown directly behind the translucent and transparent laminated glass display cases containing photographs of Shin Takamatsu's architecture captured in SentryGlas® Expressions™ technology.

Shin Takamatsu summed up: "I wanted visitors leaving the exhibition to remember something more than my architecture or the Fusuma paintings. I wanted them to have experienced space in a new way. My hope was to touch people's hearts with this exhibition, achieved by the innovative use of SentryGlas® Expressions™ technology."



The temple's traditional paper doors were replaced by large panels of laminated safety glass containing photographs of the architect's work, made possible by SentryGlas® Expressions™ technology.

laminated glass is the only material, the only technology we know of that could unify those spaces and transform them in order to create a whole new space that could display my architecture appropriately. Without SentryGlas® Expressions™, we could not

on the occasion of a personal visit from the Emperor of Japan (or his ambassador), and which was being opened to the public for the first time on the occasion of the temple's 1,200 year anniversary, needed to be treated with particular respect, given

**Structural Engineer James O'Callaghan:**

**The Apple Stores: a progression of structural strength in stair/balustrades made of laminated glass**



Structural engineer James O'Callaghan has made his name with a progression of excellence in Apple Store laminated glass stairway and balustrades ensembles worldwide. Formerly of well-known London and New York-based structural engineering firm, Dewhurst Macfarlane PC, O'Callaghan set up his own London-based firm Eckerley O'Callaghan Structural Design Ltd, with a former colleague, Brian Eckerley in March 2004.

For each staircase/balustrade ensemble, O'Callaghan worked with Dr Steven J. Bennison and his team at DuPont Glass Laminating Solutions' Central Research & Development in Wilmington (USA). This research technology was brought online to assist the architects' and engineers' truly state-of-the-art use of DuPont® SentryGlas® Plus structural interlayer for the stair treads and DuPont® Butacite® PVB interlayer for the balustrades in all new Apple Stores to date – as well as more that are due to open in the future.

**Laminated Glass News:** Please tell us about the Regent Street, London Store.

**JOC:** The 10 m- (33 ft)-long, 6 m-(20 ft)-high staircase and balustrade assembly, which is enhanced by a specially-designed, illuminated glass ceiling and bridge by Carpenter-Lowings in the Regent Street Apple Store in London follow on from the original SoHo store except that the stair treads are wider at 2.4 m (7.8 ft) instead of 2.1 m (6.9 ft). Working with Depp Glass for the laminated glass stair treads containing SentryGlas® Plus structural interlayer we knew that we were really pushing the envelope in terms of testing the rigidity and span capabilities of DuPont's structural interlayer here – but the design team and the interlayer rose to the challenge! The staircase is supported by laminated toughened glass walls or balustrades containing Butacite® PVB supplied again by Bischoff. Like in the SoHo store, these balustrades act as the primary load-bearing structure, supporting the annealed laminated glass stair treads, containing DuPont's structural interlayer for rigidity and stiffness.



Apple Store staircase and balustrade, Regent Street, London. Grand Opening in 2004.

Provision for seismic loading was essential for the staircases and balustrades in the Japanese Apple Stores. Seismic loads are effectively resisted in the Osaka staircase/balustrade ensemble by the combination of the laminated glass stiffness inherent in the helix design of the laminated glass handrail or balustrade containing PVB and the stainless steel helical handrail.

There was actually a significant earthquake in Osaka, just two weeks after this stairway was installed. I flew out to inspect it, and the laminated glass stair and balustrade were both in perfect condition.

**LGN:** Please tell us about the laminated glass stairway and balustrade at the Apple Store in Nagoya, Japan.

**JOC:** This stairway and balustrade ensemble is perhaps the most innovative that I have worked on. The glass walls or balustrades to the stairs in Nagoya structure demonstrate an engineering step-change compared with the SoHo staircase. In SoHo, the laminated glass



Apple Store staircase and balustrade, Shibuya, Japan (August 2005).

walls came down to meet the floor. In Nagoya, the staircase itself is constructed as a spanning beam so that there is no need for the laminated glass walls to touch the floor; they surround and protect the stairway with a constant depth that is much more demanding, structurally, and very elegant!

**LGN:** Please tell us about the Apple Store in Shibuya, Tokyo.

**JOC:** The fourth Apple Store in Japan in the famous downtown bustling district of Shibuya, Tokyo, represented new structural challenges. The glass stair evolved from the helical form developed for the Osaka store. The handrail or balustrade laminated glass panels are joined with stainless steel fittings, creating a single, structurally continuous ribbon that spans from the ground floor up to the first floor as a vertically-spanning, curved glass beam. This laminated glass curved glass beam supports the glass treads, which are laminated using SentryGlas® Plus, and are used to laterally tie the glass ribbon back to a surrounding metal frame encased in steel panels.

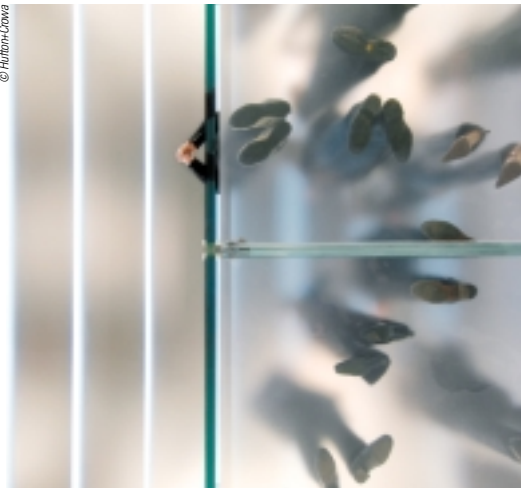
**LGN:** Are there any major changes that the laminated glass industry should be making as a result of your learning on the Apple Stores stair/balustrade progression and commercializations?

**JOC:** When we take on the challenges of developing complex glass structures, we need the industry to share the enthusiasm we have for developing new ideas. This is not often the case and it would be more encouraging - and result in industry progression - if a lot of the



Apple Store staircase and balustrade, Osaka, Japan (2004).

capacity of the laminated glass to withstand load, the redundancy mechanism and the manner in which all the glass elements are connected. This process is no different should the structure be a stair, a fin or a floor, there are just different types of loads and different redundancy considerations. This being the case architects should not feel initially restrained when considering the use of laminated glass! It is the job of structural engineers to harness architects' inspiration in the form of safe and achievable structures. With this approach in mind, I believe we have many avenues open to us for the use of glass in varying structural forms and these should not



Man leans over balustrade of laminated safety glass. Apple Store staircase and balustrade, Regent Street, London with illuminated laminated glass roof by Carpenter-Lowings (2004).

The architects for the Apple Stores worldwide, Bohlin Cywinski Jackson of Berkeley (CA) USA, worked with a 'cast of thousands' of laminated glass specialists, including Seele GmbH of Gestorfen (Germany), the glazing contractor for every staircase undertaken to date; Depp Glass Inc. of Long Island, New York City (the laminator for the stair treads containing SentryGlas® Plus structural interlayer); BGT Bischoff Glasstechnik GmbH of Bretten, Germany, the laminator for the balustrades and skylights of the stores in SoHo and Regent Street; Tripramid Structures Inc. of Westford, MA (USA) who worked on the stainless steel fittings. For the Regent Street (London) store, Carpenter-Lowings of London worked on the aesthetically striking glass ceiling, which features illuminated, laminated glass panels. More recently, credit goes to laminator Isoclima of Padova, Italy which supplied the curved, laminated chemically tempered glass balustrades for each of the Japanese stores.

**LGN:** Please tell us how the new Japanese Apple Store staircase/balustrade ensembles were achieved.

**JOC:** The balustrades of the stairway in the Apple Store in Osaka, which takes the form of a helix, are formed with curved, chemically toughened glass panels, spliced together with stainless steel fittings. We selected chemically-toughened laminated glass because it is about three times stronger than standard, heat-toughened laminated glass in the construction used by supplier Isoclima (three layers of 10 mm (0.4 in) glass and two 1.52 mm- (60mil)-thick PVB interlayers). The 1.8 m- (6 ft)-wide treads, meanwhile, are made of layers of a four-ply annealed glass, laminated together with SentryGlas® Plus, with a special, crystal-like, polished edge. The overall effect of these wide treads is that of a 'grand curved staircase', an architectural fixture that could easily be used for special product launches or other special marketing or social events.



Apple Store staircase and balustrade, Nagoya, Japan (January 2005).

be limited to floors, balustrades and façades. laminators were prepared to invest a little more in the development of some of the ideas we propose! It has to be a team effort for there to be success - from the client level right the way through every step to the final installation team. Clearly, the laminators are a key factor to this team success.

**LGN:** Lastly, how do you think architects can apply the learning from all your work with the Apple Store staircase/balustrade ensembles when it comes to other laminated glass applications like façades, structural fins and floors?

**JOC:** With the development of these glass structures we have always had to consider the

Clearly, the enhanced strength of SentryGlas® Plus interlayer has resulted in the ability of the glass floors and treads we have used to span the distances they have, to resist the loads they do, and to provide a very high level of redundancy in failure. This would have not been possible in the same manner with PVB, and for that reason the application of SentryGlas® Plus should always be considered where the laminated glass element is structural, or when failure modes are an important design or engineering consideration.

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**Warranty program for DuPont™ SentryGlas® Plus**

DuPont Glass Laminating Solutions has introduced a warranty program for SentryGlas® Plus structural interlayer to its architectural glass authorized laminator customer base worldwide. The program warrants SentryGlas® Plus, as used by authorized laminators, for five years from the date of laminate manufacture. DuPont Venture Manager for SentryGlas® Plus, L. Todd Becker, said: "The excellent polymer properties of SentryGlas® Plus allow DuPont to offer performance warranty for certain stability defects. The warranty will encourage new and existing laminators working with SentryGlas® Plus to use our structural interlayer with confidence!" The warranty is applicable to both open-edge and silicone applications and covers the interaction of approved sealants with SentryGlas® Plus against the appearance of edge delamination. Becker continued: "We believe that our warranty program for SentryGlas® Plus will open up new market opportunities for users of architectural laminated glass. The program underlines the confidence DuPont has in SentryGlas® Plus and the value that our structural interlayer brings to our customer base worldwide." For more information on the warranty program, DuPont authorized laminators should contact their DuPont representative.

# A 'brave new world' of beautiful laminated glass balustrades!

**Laminated glass balustrades or handrails are coming into their own! Laminated glass with PVB is a great choice where the laminated glass is fully supported. However, for point-fixed or freestanding balustrades, laminated glass with DuPont® SentryGlas® Plus interlayer is an optimal solution for today's architects. As well as structural strength, SentryGlas® Plus provides other advantages for glass balustrades such as allowing the laminated glass to be thinner and lighter, and have improved edge stability. Also, the need for metal railings is obviated when SentryGlas® Plus is used because of the interlayer's innate structural strength and rigidity.**

## San Diego Padres fans have wonderful views at Petco Park stadium

The owners of the new Petco Park Ballpark, home to the San Diego Padres baseball team, moved fast when fans seated in the upper concourse of the Ballpark complained about obstructed sightlines to the field, due to both a metal cap rail as well as metal hand rails attached to the 76 and 107 cm (30 and 42 in)-high, 152 cm (60 in)-wide glass guard rails in front of these seats.

meant that the tops of the balustrades could have neat, polished exposed glass edges. This resulted in greatly improved viewing clarity for the fans. The architects' goals of safety, clarity, visibility and all-around unobstructed sightlines were met, to the satisfaction of fans and owners, and the new laminated glass guard rails were installed in time for the beginning of the new season in March, 2005.

Architects Hellmuth, Obata + Kassbaum Inc. (HOK Sport) working with engineering consultant A. William ("Bill") Lingnell, designed a replacement for the old 12 mm (0.5 in) glass guard rails incorporating 1, 858 m<sup>2</sup> (20,000 ft<sup>2</sup>) of new laminated glass guardrails with DuPont® SentryGlas® Plus structural interlayer. This solution obviated the need for both the metal cap and the metal hand rail attached to the field side of the guard rail because of the inherent structural strength of the interlayer, and also

Andy Stallings of Petco Park's Development Manager, Hines, explained: "Fans in the front row of the upper concourse had complained vociferously about the metal caps along the top edge of the impact-resistant laminated glass guard rails as well as the hand rails attached on the outside of the guard rail. These visual obstructions meant that fans had to move their necks this way and that in order to follow the action during a game. The original handrails had been required by



Sports fans worldwide can benefit from clear views thanks to balustrades of laminated glass using SentryGlas® Plus like these at the San Diego Padres' Petco Park ballpark.

Building Department Officials for to provide an extra safety margin solution to answer code officials' concerns about fall protection." Engineering consultant Bill Lingnell, who is based in Rockwall, Texas, said: "The glass balustrades initially were code-compliant and designed with the ballpark officials' approval.

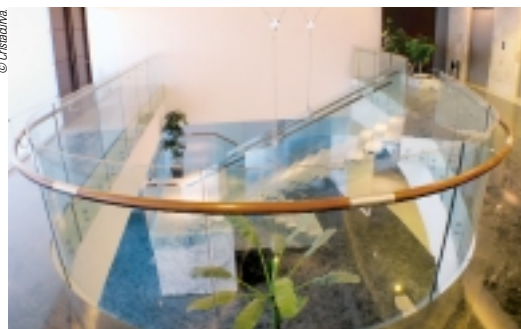
The architectural objective for HOK was to eliminate a horizontal top rail strengthening system for these balustrades, which was causing visual obstruction.

"The new laminated glass balustrades with SentryGlas® Plus and exposed edges passed

three important testing criteria: the general building code, the special codes of practice that are applied to the use of glass balustrades (ASTM testing protocol), and overload conditions for demonstration to the San Diego code officials." Steve Pettit, vice president of Sunset Glazing, confirmed that the construction of the new balustrades for Petco Park Stadium was achieved with 10 mm + 10 mm (0.4 in + 0.4 in) clear, fully tempered glass with a 1.52 mm (60 mil) interlayer of SentryGlas® Plus.

Speaking in March 2005 to the Washington Post about his firm's win of a USD 18.6 million contract for a new D.C. baseball stadium, HOK Sport's lead designer Joseph Spear said the new stadium will use laminated glass as a predominant material to underline "the transparency of democracy." "The new balustrades at Petco Park are just one example of how laminated glass with SentryGlas® Plus is helping sports complexes worldwide to enjoy "the transparency of democracy" from the lowest-priced seating to VIP boxes.

## Large curved balustrade for Ford Dealers' Association, Mexico



Complex curved balustrades for Ford Mexico supplied by Cristacurva.

Arquitectura Prodesarrollo of Mexico City designed freestanding laminated glass stairs and a stunning, large and impressive curved laminated glass balustrade, both incorporating DuPont® Butacite® PVB, that form an interior design centerpiece at the prestigious Ford Dealers' Association building in Mexico City. The association represents the interests of the country's 200 Ford dealers.

Glazing specialist firm Klyp was responsible for engineering and installing the staircase. Klyp's general manager, architect Pedro De La Peza commented: "Impact and strength tests devised to test the strength of the

laminated glass stairway construction included having three men with a joint weight of 240 kg (529 lb) jumping on the stairs, all at the same time, and dropping a 100 kg (220 lb) bag down onto the stairs from a height of one metre." The stairs are 20 cm (8 in) in width and fixed by metal clips at the edges. The laminated glass construction is 6 mm + 12 mm + 6 mm (0.2 in + 0.5 in + 0.2 in) with two Butacite® PVB interlayers, each of 0.76 mm (30 mil). De La Peza confirmed that the stairs and balustrades passed the strength and impact tests with no problem.

The visually-striking, point-fixed, protective balustrades, consisting of large, 1.2 m (3.9 ft) tall x 1.8 m (5.9 ft) wide panels, are drama-

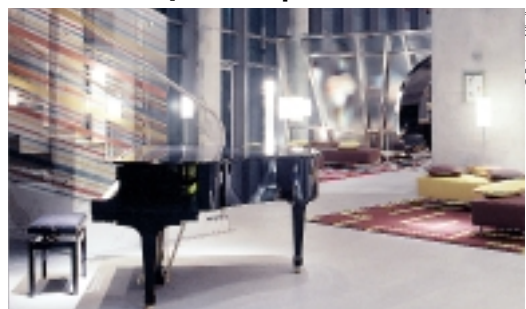
tically curved to a two-metre radius at the top of the stairway. The glass consists of three lites of 10 mm clear laminated tempered glass, held together by two Butacite® interlayers of 1.52 mm (60 mil) each. The balustrade / handrails continuing down the stairway, which are made of flat laminated glass, are of a 6 mm + 6 mm (0.2 in + 0.2 in) fully tempered, laminated construction incorporating a 0.76 mm (30 mil) Butacite® interlayer. Javier Sanchez Gil, sales manager at laminator Cristacurva, said: "It was quite a significant challenge to laminate these very complex curved and flat tempered pieces of glass. These are state-of-the-art balustrades; our comprehensive testing showed that they are incredibly tough but look weightless, almost invisible."

## 'Blue Heaven' hotel interior signed Adam D. Tihany has rainbow balustrade in SentryGlas® Expressions™

'Blue Heaven', the new Radisson SAS Hotel in Frankfurt (opening: November 2005) was designed by three famous hospitality designers: building architect John Seifert (London); interior designer Matteo Thun (Milano), and restaurant and hospitality designer Adam D. Tihany (New York), who designed the ground floor. Tihany Design designed a seemingly transparent glass stairway that is a centerpiece of the lobby space. Colorful, rainbow-like stripes are designed into the laminated safety glass balustrades of the stairway thanks to Tihany Design's use of DuPont® SentryGlas® Expressions™ technology. Adam D. Tihany said: "One of the goals of the glass balustrade

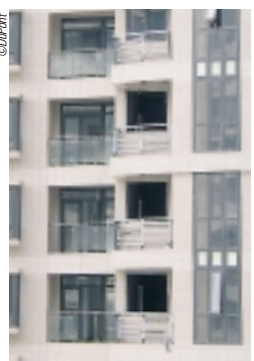
with SentryGlas® Expressions™ was to make the lobby crossing more interesting for hotel guests. The colorful pattern in SentryGlas® Expressions™ was custom-designed in our studios. The pattern allows a significant portion of clear glass to remain transparent, letting through maximum natural daylight." Use of DuPont's decorative glass technology enabled Tihany to design in a large portion of clear glass to the balustrade, which was an important requirement, while also using three colors all on one PVB interlayer. Alternative technologies would have required a different PVB interlayer for each color, leading to a significantly thicker, heavier and more complicated laminated glass construction.

Tihany continued: "The light coming through the rainbow balustrade creates quite a magical experience... the colorful ambience adds to the feeling of luxury and uniqueness we wanted to create for privileged hotel guests on the staircase in Blue Heaven." The laminator for the balustrade glass was Flachglas Wernberg GmbH. Flachglas's Josef Failer said: "The SentryGlas® Expressions™ decorative glass construction, which we have trademarked Sigla Motiv®, is made of 8 mm + 8 mm (0.3 + 0.3 in) clear laminated tempered glass with a 1.52 mm (60 mil) interlayer of SentryGlas® Expressions™."



Designer Adam D. Tihany chose SentryGlas® Expressions™ technology for the laminated glass balustrades of his rainbow staircase in the lobby of 'Blue Heaven', the new SAS Hotel in Frankfurt (2005).

## New Shanghai Gubei residential apartments have laminated glass balcony balustrades



A prestigious new downtown residential complex in Shanghai has balcony balustrades of laminated glass with Butacite® PVB.

A prestigious new, 24-floor high residential complex in downtown Shanghai (completion early 2006) uses over 4,200 m<sup>2</sup> (45,200 ft<sup>2</sup>) of laminated safety glass with Butacite® for its balcony balustrades, which are 1.2 m (4 ft) in height.

The Shanghai Gubei residential complex was designed by architects from the well-known Shanghai Tongji University Design Institute. The laminator is Shanghai Xu Feng Glass Co. Ltd. Shanghai Tongji project architect Ms Wang Chin Ling told Laminated Glass News: "The design intent was to realize a bright new form for the building, both from the inside

and from the outside. This was achieved thanks to the use of the laminated glass balustrades, which look great due to their simple and smart aesthetic form. The minimally-supported, bolt-fixed system we selected offers clear, wide-angle views for the residents of Shanghai Gubei; this was a major design goal. The laminated glass balcony balustrades are also highly functional, providing optimal safety for residents and passers-by alike, even in a post-breakage situation. Furthermore, the use of laminated glass for these balcony balustrades is required by the national building codes."

## Architects install laminated balustrades at Changi Airport, Singapore

Architects, Engineers and Planners RSP of Singapore worked with laminator Singapore Safety Glass (SSG) to replace all the tempered glass balustrades of Singapore's Changi International Airport's Terminal 2 with laminated safety glass balustrades using 0.76 mm (30 mil) Butacite® PVB during a major renovation of the terminal in 2005. RSP project architect Colin Chan said: "Laminated safety glass is now used extensively throughout Terminal 2 - not only for the new safety glass balustrades but throughout the facades, glass ceilings, glass partitions and shop fronts. As well as safety, acoustic control was a major driver in the upgrade. The laminated glass installations look particularly attractive at night when the airport is illuminated." DuPont Asia Pacific Glass Laminating



Laminated glass balustrades with Butacite® PVB interlayer for Changi Airport, Singapore.

Solutions Architectural Director Phil Davies commented that Singapore is moving to replace vertical tempered glazing with laminated glass throughout the public housing sector, including balustrades and shower screens, and that the switch from tempered to laminated balustrades in Changi Airport's Terminal 2 could be viewed as part of a growing trend in that country.

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