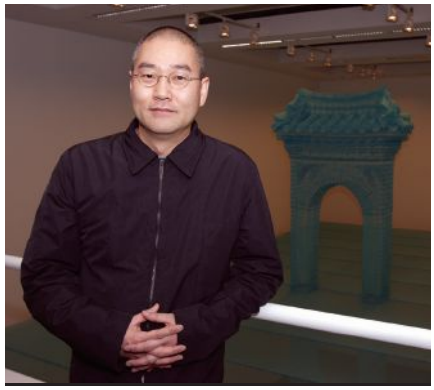
Engineering Brings Art and Architecture Together

Fallen Star Lands to Find Home Atop School Building

By **Jeffrey Saikali,** *Ohio Beta '96*

Standing on the grounds of the Jacobs School of Engineering on the University of California (UC) San Diego campus, the blend of massive buildings with natural scenery of grass and trees all looks quite normal for this technology-driven portion of a major university...with one exception. Atop the roof of Jacobs Hall (formerly Engineering Building I) is a single-room, light blue cottage known as Fallen Star. Equally striking is that the house appears to be hanging precariously in a distorted orientation as if it had randomly dropped from the sky as part of a children's fable.



Do Ho Suh

Yet, Fallen Star is no toy, and its position is intentional. It is a creation of Korean artist Do Ho Suh, inspired by aspects of his life when he emigrated from South Korea to the United States. Although Suh is not an engineer, engineering played a major role in bringing to life this piece that took seven years to plan.

Despite the differences between engineering and art, there are times when the two disciplines join forces. Furniture, bridges, and automobiles are examples of structures that each need to be strong, stable, and not unnecessarily weighted but also do well to have aesthetic appeal. That is, humans tend to appreciate when products are designed not purely for function but also with form in mind. Many commercial buildings are designed to accommodate function while bringing a measure of visual pleasure to the people who use them.

I interviewed Suh recently, during his visit to San Diego for the premiere of the documentary *Fallen Star: Finding Home*. Directed by Vera Brunner-Sung and Valerie Stadler, the film took five years to produce. It chronicles the design, development, and construction of Suh's landmark creation.

In my interview with him, Suh recounts growing up watching many different American television programs while in his native South Korea. He says this gave him a good sense of what life in America was like. Due to that informal exposure, Suh says he did not go through the overwhelming cultural shock that he might otherwise have experienced upon relocating to the United States in 1991.

Subtle Differences

Nonetheless, Suh did face discomfort with subtle differences in spatial organization of American society compared to that of South Korea. He cites the shapes of buildings, sizes of doors, and locations of door knobs as examples. Intending to stay indefinitely in the United States, he was compelled to adjust to these dissimilarities, and they caused him to think of dimension of personal space in ways that he had not previously considered. Since Providence, Rhode Island, was his first home city in the United States, the basic look of the Fallen Star

PHOTOS: Fallen Star sits atop Jacobs Hall, right, and is seen from its home on the roof of the 6th floor, below left. Credit: Fallen Star, 2012, Do Ho Suh, Stuart Collection, UC San Diego, Philipp Scholz Rittermann

cottage is a composite of homes in that area.

Home is a recurring topic in Suh's works. He describes it as a universal theme that artists can use in communicating with the general public. When he visited the UC San Diego campus in 2006 and was contemplating what to create for the Stuart Collection, it occurred to Suh that discomfort with geographic and cultural displacement are sensations that probably most of the thousands of students at UC San Diego also go through. He notes that these feelings can be provoked even when relocating within a country, since climate, accents, culture, and architecture have regional distinctions. A measure of jitter and social awkwardness are common for students as they settle into university life away from home. Suh expresses all these sensations by Fallen Star's intentionally non-level floor and tilted walls. They subject the visitor to significant uneasiness that takes time to accept.

Common Theme

I recently visited the Museum of Contemporary Art San Diego in downtown San Diego. Consuming the relatively small museum's entire first floor for a special 15-week event were exhibits by Do Ho Suh. The many pieces on display included paintings, drawings, and sculptures. Unmistakable is that every one relates to a common theme: home. Most striking for me was Suh's piece titled *Apartment A, Unit 2, Corridor and Staircase, 348 West 22nd Street, New York, NY 10011, USA (detail)*, a life-size recreation of his former New York City apartment. Made entirely of translucent polyester fabric and stainless steel tubes, the set includes stoves, refrigerators, kitchen sinks, bathroom sinks, bathtubs, toilets, light switches, air conditioners, and fixtures, all of which are finely crafted in great detail. The circuit breaker boxes (also made of polyester and steel tubes) in "Apartment A..." include the kind of text you would expect to see in a home electrical apparatus of that kind. The many pieces on display at this exhibit confirm Suh's passion for incorporating notions of home and personal space in his artwork.

The UC San Diego main campus is the permanent home of the unique Stuart Collection, of which Fallen Star was the 18th addition. The ongoing program seeks artists who will contribute to its mission of "...enrich[ing] the cultural, intellectual, and scholarly life of the... campus and of the San Diego community by building and maintaining a unique collection of site-specific works by leading artists of our time." This includes artists whose backgrounds do not include public works. Collection representatives approached Suh because his notion of home is a topic associated with the university experience. Per normal practice of the Stuart Collection, project manager Mathieu Gregoire says that Suh was given no direction on what to create. Once an artistic design for Suh's piece was settled on, a feasibility study was conducted, and the project was presented to the UC San Diego chancellor for approval. When Jacobs Hall was proposed as the preferred building on top of which Fallen Star would be positioned, students, faculty, staff, and administrators of

Interior of the building. Credit: Fallen Star, 2012, Do Ho Suh, Stuart Collection, UC San Diego, Philipp Scholz Rittermann

the Jacobs School of Engineering (named for Joan and **Irwin M. Jacobs,** *New York Delta '56*) were welcoming.

Don Hodges, principal of Hodges & Hodges Architects, was the licensed architect for Fallen Star. J. John Walsh, president of Walsh SE, Inc., was its licensed structural engineer. In separate interviews with Hodges and Walsh, the technical details of Fallen Star's design and final positioning were explained.

Typically, the architect is the creative person who works with the client to generate a preliminary idea and design, and who decides on such things as how the system will be waterproofed, the sizes of doors and windows, and how they will function, what colors of paint will be used, and so on. The architect also assembles the team of structural engineers and construction personnel who will turn the vision into reality. Fallen Star was different in that the idea and conceptual design model were created by artist Suh. Nonetheless, the complicated nature of this project left plenty for Hodges to do.

Concrete Flooring

The design of Fallen Star calls for it to be cantilevered from the roof of Jacobs Hall, a structure with working faculty offices and laboratories. Had the cottage been constructed on the roof of Jacobs Hall, steel beams could have served as the foundation, anchored to the roof and cantilevered into space. However, this would have necessitated iron workers hanging from the top of the building, and that would have demanded sealing off a large area on ground as a safety measure. Altogether, that approach would have disrupted the daily lives of employees in Jacobs Hall and significantly raised the cost of the project.

Instead, it was decided to construct the house on the ground-level pedestrian walkways and grassy area that face Jacobs Hall and then lift it to the top of the building. The concrete foundation of the cottage runs around its perimeter and is about 18 inches wide and 18 inches deep. That, plus the concrete flooring accounts for the building's unusually great weight of about 70,000 pounds. The floor slab varies in thickness due to the 5-degree tilt of the floor, with the foundation about 18 inches at its thickest.

For the house to survive being raised six stories and cantilevering substantially, its foundation had to be far more robust than usual for a hypothetical single-room house of this size. This required an extra sturdy base, and it explains why the house was constructed on a concrete slab that is far thicker, stiffer, stronger, and bearing a greater reinforcement than usual for a house. The frame of the cottage needed to be abnormally stout. It consists of steel tube pieces, four to six inches in width and depth that are vertical, horizontal, and diagonal in a skeletal formation. Between these tubes are light gauge metal studs, placed every 16 inches on center that form the walls. (The interior is finished in drywall.) Besides adding stiffness, this framework allows the house to be made of non-combustible materials, which was mandatory for the fire-rating of Jacobs Hall.

Jacobs Hall is in the highest class of fire rating (Type 1) available in California's Building Standards Code. Its construction is free of flammable materials, and it is highly robust with very thick cast-in-place walls, columns, and roof. The exterior of Fallen Star has fire-retardant-treated plywood to act as sheathing and a nailer for the PVC-siding. The siding and trim members (painted light blue) that look like wood are actually flame-graded PVC to resist exposure to open flame. The roof consists of composition shingles that are also fire-resistant. Inside the cottage are fire sprinklers to provide it with protection comparable to that inside Jacobs Hall.

Despite the overall sturdiness of Jacobs Hall, retrofitting was necessary. According to Walsh, the typical roof of a house or commercial building can handle loads of 20 pounds per square foot, but the roof of this building needed to manage loads of up to 100 pounds per square foot due to the tremendous weight that the cottage, its accompanying landscaping (including grass, a flower garden, and special lightweight soil), and visitors would add.

Fallen Star rests on a 6-story projection off the 7-story Jacobs Hall so that the 6th-floor projection's roof aligns with the 7th floor of the rest of the building. The roof of this projected portion was thickened by casting an 8-inch-thick slab of reinforced concrete bonded to the existing concrete. Additionally, six 1¼-inch diameter post-tension rods flank the sides of cast in-place concrete beams that are about 2 feet wide and 2 feet deep and run from side to side in Jacobs Hall. Each rod was tensioned to 60,000 pounds. Thus, each beam had an additional 120,000 pounds of compression on it, which caused the

PHOTOS: Fallen Star sits on its special base at it is readied for the crane, bottom, is lifted to the roof of the 6th floor, center, and is lowered onto its supports. Credit: Fallen Star, 2012, Do Ho Suh, Stuart Collection, UC San Diego

roof of Jacobs Hall to rise briefly while hydraulic jacks were tensioning the rods. They settled back down when the added load from the soil and cottage were put in place.

The roof was not originally intended for visitor access. Thus, a door had to be added to the 7th floor of Jacobs Hall to provide access to the open roof of the adjacent 6th-floor projection. That door opens over a 6-inch-wide seismic separation joint which needed to be waterproofed. A pliable waterproofing drain and metal drain were added to let visitors walk smoothly from the interior of the 7th floor to the exterior on the roof of the 6th floor. Since the soil in the landscape on the roof is irrigated to support plant life, another technical challenge was waterproofing. The entire roof and up the parapets had to be treated with waterproofing materials suitable for being buried. Aesthetically pleasing waterproof joints were needed. Metal sheets protect the waterproofing membrane system.

The process of retrofitting Jacobs Hall for the added load took about one year. Fortunately, ample over-design in the original building meant that no seismic retrofit of it was necessary.

Fallen Star was constructed on the grounds of UC San Diego's engineering school in 2011 over about five months. Translating the design of the cottage from a model to something the contractor could build was difficult. Hodges

created an x-y-z coordinate system with the origin at the southwest corner of the cottage's roof. From there, the contractor was given sketches showing other points of the structure in three-dimensional space including the tops of footings, bottoms of footings, roof peak-lines, and the roof peak. The contractor then had to use story poles and string to find these points in space in order to construct the framework and foundation.

On Tuesday, November 15, 2011, hundreds of spectators watched as a crane raised Fallen Star 100 feet from ground level to the roof of the 6th floor of Jacobs Hall. The lift had to work on the first attempt both due to the cost of crane rental and the potential risk of structural damage that raising any complex structure can introduce. The filmmaking team for the *Fallen Star: Finding Home* documentary were on site for the event. Numerous cameras were positioned in various places on ground and nearby structures. Remotely operated cameras inside the cottage during the lift captured close-up views of the raised cottage then being slowly lowered over approximately a dozen 1-inch diameter vertical threaded bars (on the roof and walls of Jacobs Hall) with all bars simultaneously perfectly passing through each of their complementary 3-inch diameter holes in the floor of the cottage. (Even prior to bolting those rods to the floor, the cottage was stable, says Walsh, because its center of mass lies over the main building, not empty space.) Also, on the roof of Jacobs Hall at the inner edge of the building, where the low edge of the cottage meets the roof, are steel plate embedments that were installed when the reinforced concrete topping was placed.

Securely Fastened

While the crane was still holding the cottage in place, a workman welded the plates along the exterior wall of the house on the Jacobs Hall side. The anchor rods and welded embedded plates are the two ways in which the cottage was securely fastened to the existing building. The lift of Fallen Star, positioning it on top of the building, and affixing it to the structure were all successful.

Fallen Star was designed to withstand winds of up to 100 miles per hour. Walsh says the return period for an earthquake at this site is 475 years.

The internal four walls of Fallen Star are either parallel or perpendicular to each other. That might be where its normality ends. A chandelier is the interior's only true vertical. The cottage is both rotated and tilted relative to ground, and the floor is yet at a different angle. The floor of the cottage sits at a 5-degree angle from the flat roof of Jacobs Hall, and the cottage itself is built at another 10-degree angle. The distance from underside of the peak of the roof of the corner down to the floor is different for all four corners. The low point is at the northwest corner. Albeit with some initial difficulty, visitors are able to stand and walk on the floor because it is only sloped at 5 degrees. Some pieces of furniture are not rectified and sit on the floor space; other pieces are rectified to the angle of the cottage. The latter includes a bookcase and an armoire, both of which are at walls. The bases of these are lopped off at a skew angle. When you look around, you see two conflicting geometries. The floor is not the same level as the cottage. Then, when you look outside the windows, the whole world appears to be tilted relative to the cottage. ("Some people will have to resort to Dramamine to tolerate this kind of challenging geometry," says Hodges.) To say that it is disorienting to stand inside Fallen Star is an understatement, and yet that is the whole point of this creative work. These effects are Suh's way of using art to reflect the discomfort people feel when displaced from home.

"Life Changing Experience"

Fallen Star is decorated as a living room with sofas, a coffee table, end tables, and small desks. The décor is a mix of past and present such as books from half a century ago, a DVD player, and a flat-screen television. On the walls are amateur photographs of artist Suh, present and past deans of the Jacobs School in their childhoods, and other people affiliated with the project.

Architect Hodges calls Fallen Star, "One of the most thrilling, exciting, satisfying projects I've ever worked on and fun as well!" Engineer Walsh says, "We all knew that we were creating something special [with Fallen Star], and something that hadn't been done before...It was an exciting time in my life." Stuart Collection director Mary Beebe says, "It was an amazing and life changing experience to help Do Ho [Suh] fulfill this dream."

When asked about the idea of engineers collaborating with professionals from non-engineering disciplines, mechanical engineer and current UC San Diego dean of engineering **Albert P. Pisano,** Ph.D., *New York Alpha '76,* said, "We actively encourage it through the interdisciplinary nature of our research and education...At the undergraduate level, we are particularly proud of our new EnVision Arts and Engineering Maker Studio. It's a joint facility we built with the Division of Arts and Humanities at UC San Diego. We've already had 400 students work there. And better, we've already had classes in which engineers and art majors work together on art/engineering pieces!"

As for the Stuart Collection of permanent outdoor art that enlivens the UC San Diego campus, chancellor and electrical and computer engineer Pradeep K. Khosla says, "These public artworks beautify our campus artistically and intellectually, and lead us to a greater understanding of our environment and humankind."

Jeffrey Saikali holds a Bachelor of Science in Mechanical Engineering from the University of Cincinnati (cum laude), a Certificate in International Engineering (focus: Japan), a Professional Practice Achievement Certificate, and a Master of Science in Mechanical Engineering (focus: rigid-body dynamics) from the University of California, Los Angeles. His past engineering work involved research into heart assist devices and later with positioning of mobile robots.