



Purdue
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Extrapolations
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The Golden Gate Bridge:
A Purdue professor
designed it, and his
story is coming to light.
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CREDIT WHERE CREDIT WAS DUE



Charles Ellis, a Purdue civil engineering professor from 1934 to 1946, is finally being recognized as the true designer of the Golden Gate Bridge.

The promotion, conception, and construction of San Francisco's Golden Gate Bridge is maybe as much of an American story as you'll come across. It's loaded with fierce determination, blatant betrayal, and much bravado. Depression-era men would risk life and limb in the literal high-wire acts of raising the magnificent span, which was named one of the "Seven Wonders of the Modern World" by the American Society of Civil Engineers (ASCE) in 1994. But the story of the Golden Gate Bridge is also a history prime for revision.

The PBS documentary *Building Big: Bridges*, which aired in October 2000, as well as the work of writers like John van der Zee and Russ Cone, is helping to set the record straight that Charles Ellis was the original designer of the San Francisco landmark. The old story goes that Joseph Strauss, chief engineer and architect, "conceived and brought to form" the world's most famous bridge. A 27½-foot bronze statue of the smallish man (just over five feet in real life) shows him staring out over the Pacific Ocean with a set of plans in hand. It perpetuates a half-truth, and the falsehood lies in those very clutched plans. Strauss did indeed spend nearly two decades politicking for, promoting, and constructing the bridge that would connect San Francisco to northern California in 1937 and pave the way for a population and business explosion. But its design could not have sprung from his brow.

A "ponderous, ugly structure"

According to van der Zee, Strauss was ahead of his time in the ways of marketing and dealing with political boards. From as early as 1922, "Strauss kept turning up at chambers of com-

merce in northern California," van der Zee says. "He had a Chicago-based bridge-building firm, and he knew the ins and outs of the politics."

He knew little about suspension bridges. Strauss graduated from the University of Cincinnati in 1892, 13 years before the school offered engineering degrees. He was never a member of the American Society of Civil Engineers. Van der Zee refers to Strauss as the "drawbridge king." In *The Gate* he writes, "Of the more than 400 bridges that Strauss and his firm were associated with in his lifetime, probably 375 of them were of this basic bascule type."

The Golden Gate Strait is the meeting point between San Francisco Bay and the Pacific Ocean. Spanning it offered unique challenges. More than a mile wide at its shortest point, the strait is the outlet for seven different rivers. Its deepest point is 335 feet. An area of high winds and thick fog, the Golden Gate is also 12 miles from the San Andreas Fault, the epicenter of one of the largest earthquakes ever experienced in the continental United States, which shook San Francisco to its core in 1906. By the 1920s, no bridge had ever been attempted at the mouth of a major harbor.

Van der Zee describes Strauss's original design for the Golden Gate Bridge as "a ponderous, ugly structure of mixed parentage [part suspension span and part cantilever], based on erroneous survey information and precious little actual engineering. Strauss proudly patented his design and campaigned eight years for it."



Enter an engineering scholar

In 1922, Strauss hired Charles Alton Ellis, a professor of structural and bridge engineering at the University of Illinois. He had previously been the design engineer for the Dominion Bridge Company of Chicago and was also an assistant professor of structural engineering at the University of Michigan from 1912 to 1914. Strauss knew he had to bolster his staff because he lacked engineering credentials. With a \$1 million contract in hand from the Golden Gate Bridge District (which Strauss founded), Strauss agreed to have his design screened by a panel of experts in August of 1929. The panel, including Leon Moisseiff, a leading theorist and designer in the field of suspension bridges, quickly rejected Strauss's bulky design. Strauss soon gave Ellis the task of creating a new one. After several more meetings and an arrival at a Moisseiff-inspired bridge—a highly calibrated, lighter-weight, all-suspension span that would bend and flex with the elements—Ellis reportedly said, "Mr. Strauss gave me some pencils and a pad of paper and told me to go to work."

"In addition to being a civil engineer," van der Zee says, "Ellis was a classical scholar. He did translations from Greek in his spare time. Ellis

knew from his classical training the opportunity that this represented. The Golden Gate was one of the most dramatic meeting places of land and water in the world."

He writes that to Ellis the challenge must have suggested "the stories and legends that surrounded similar sites in the ancient world: such as the Dardanelles, bridged by Xerxes the Persian king, using a string of boats in 481 B.C., and by Alexander the Great, using the same method 150 years later."

From 1929 to 1930, Ellis was the man in charge. Ellis oversaw the test borings of the bridge towers, the surveying, and the siting. He had to find the solid footing on the northern Marin County shoreline on which to build. Because the bridge had to allow for the passage of any ship, the constructed steel towers would have to be the largest ever. A pier, with dimensions the size of a football field, had to be plotted in the open sea for one tower. Ellis considered all of it in his calculations. With the preliminary test borings completed, Ellis left San Francisco and returned to Chicago to work on the design and estimate. The proposed budget for construction was \$35 million, which would be collected in taxes and tolls.

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"Ellis implemented Moisseiff's theory," van der Zee says. "His design involved 11½ volumes of pre-computer higher mathematics, all done by one guy with a circular slide rule and a hand-crank adding machine."

"These computations and design, enhanced by the art deco architectural treatment of the San Francisco architect Irving Morrow," writes van der Zee, "are at the heart of the bridge's uniqueness."

Given such a massive undertaking, Ellis wanted to be doubly sure of the design. His work pace didn't sit well with Strauss. Later, in a January 4, 1933, letter to George T. Cameron, the publisher of the *San Francisco Chronicle* and board chairman of the Bridge District who van der Zee says was at the time "having difficulties with Strauss," Ellis explained his involvement with both the design and the man in question. He writes, "I had tried many times to convince Mr. Strauss that a year would be necessary to do this work properly.... Mr. Strauss, however, insisted that the work must and could be done in three or four months, inasmuch as he would write the report in San Francisco while I was making the design and estimate in Chicago."

Still, working 12- to 14-hour days, Ellis was able to present his preliminary plans to bridge consultants at a June 12, 1930, Chicago meeting. While his plans were well received, Strauss's report came under fire from the directors in San Francisco. Ellis knew nothing of what resided in Strauss's report, just as Strauss knew little of Ellis's preliminary design. He writes, "Mr. Strauss, however, arrived at the erroneous conclusion that the dissatisfaction on the part of the directors was traceable to me."

"It was at this time," Ellis continued, "that I first felt Mr. Strauss's displeasure. It was understood that when the preliminary plans were delivered, I should remain in San Francisco and give technological advice during the bond campaign. But when he realized that the directors were coming to me for information and advice, he instructed me to return to Chicago at once."

Strauss may have been further irritated that Ellis made the keynote address about the theory behind the forthcoming bridge at the first West Coast meeting of the National Academy of Sciences in Berkeley in September of 1930.

In November of the same year, the Golden Gate Bridge was given the go-ahead by voters, who approved the necessary bond issue by the largest margin of victory in the city's history.

Strauss, however, sent for Clifford Paine, one of Ellis's former students whom Ellis had brought into the organization. According to Ellis's papers, Paine, who "had had absolutely no connection whatever with the work or any other work of the suspension type," was put in charge of the job without explanation to Ellis. Construction of the Golden Gate Bridge would begin (and end) without Ellis.

On December 5, 1931, Ellis left his office at the Strauss Engineering Corporation for the final time. Ordered by Strauss to start his vacation immediately, he would be fired three days before completing it. Strauss cited that "the structure was nothing unusual and did not require all the time, study, and expense which [Ellis] thought necessary for it."

While implementing his design with only minute changes, Strauss tried to erase Ellis from ever being involved in the process. Van der Zee likens the scenario to "what happened to old Bolsheviks under Stalin. He became a non-person. The dozen copies of the engineer's report, which credited Ellis with overseeing the design, were recalled by Strauss and (with the exception of Strauss's own copy, now in Cone's hands) have since disappeared. All mention of Ellis vanished from bridge promotional and historical material." The name of Charles Ellis has never appeared on the Golden Gate Bridge, and a spokesperson for the Bridge District says (still), "We have no current plans to honor Charles Ellis."

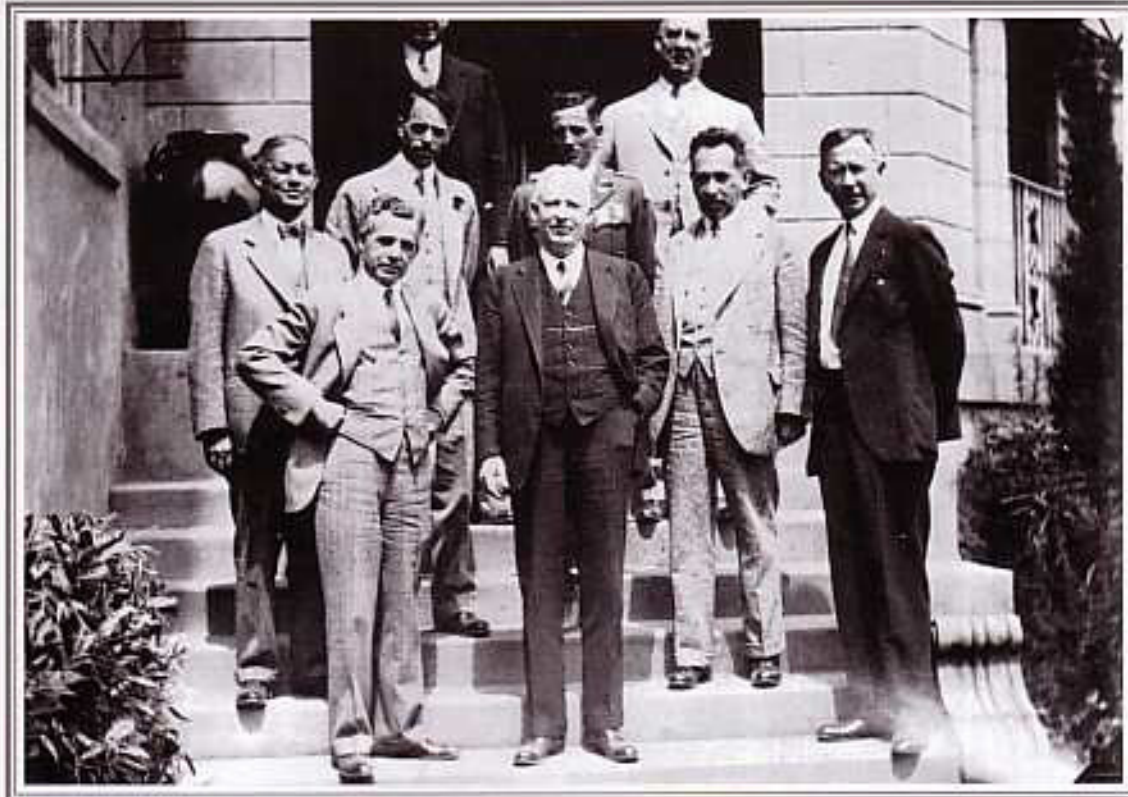
Purdue's gain

Charles Ellis didn't make much of a fuss over his dismissal. Van der Zee writes, "A man with little desire for the limelight, Ellis would seem to have had the ideal temperament for academic life, with its deferred satisfactions, peer appreciation, and sense of private rather than public achievement."

It was 1934 before he arrived back at academia. Purdue students, like Charles Pankow (BSCE '46), mostly remember the quietly refined professor with high white collars and the Woodrow Wilson glasses. He never said much about his experiences with Strauss and the bridge. "He was a rather self-effacing guy," says Lewis McCammon (BSCE '41, MSCE '48, PhD '51). "He always kept a picture over his desk of the Golden Gate Bridge. He never bragged much about it, but if anyone ever brought it up, he said, 'I designed every stick of steel on that bridge.'"

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THE STARTING NINE: The first meeting of the engineering board on August 27, 1929, at the Alta Mira Hotel in Sausalito, California, included Joseph Strauss (hands on hips), an Army officer, three Golden Gate Bridge District officials, and four consulting engineers, including Charles Ellis (far right) and Leon Moisseiff (just left of Ellis). The panel quickly rejected Strauss's bulky bridge design, and Ellis was soon given the task of creating a new one. He reportedly said, "Mr. Strauss gave me some pencils and a pad of paper and told me to go to work."



MAN ABOUT CAMPUS: Known for his impeccable dress, gentle manner, and scholarly pursuits, Charles Ellis poses for a photograph in Purdue's 1939 *Debris*.



FOND FAREWELL:
In 1946, colleagues surround Ellis and his wife at his Purdue retirement dinner.

Students remember the droll professor that they called "Uncle Charley" (but only behind his back), who encouraged students to find their own answers in the classroom and would periodically sneak off to take in a baseball practice.

Fred Apsey (BSCE '41) worked on calculations in Ellis's class after the Tacoma Narrows Bridge in Washington buckled and went down in 40-mile-per-hour winds on November 7, 1940. Van der Zee says it was the "most spectacular failure in suspension bridge history." Having built it on the same theory as the Golden Gate, engineers panicked and asked Ellis for the double-check.

"The Tacoma Narrows Bridge was too narrow," Apsey says. "Ellis couldn't understand how under-designed the support structure was." Ellis's Golden Gate Bridge design would hold up.

Did Apsey detect a grudge with Strauss? "He wasn't that kind of a person," Apsey says. "Ellis never let me believe that he was bitter about it. He was more proud of the fact that he designed the thing and it was working."

Constructing the truth

As a boy growing up in San Francisco, Russ Cone once marveled to his father, Russell G. Cone, the supervising engineer during the construction of the bridge, about what a designer Joseph Strauss must have been. The elder Cone confided in his son that Strauss had almost nothing to do with the Golden Gate's design. He had Strauss's original engineer's report with Ellis's signature on it at home. The report gives Ellis's credentials and

says that he was in charge of the design. The younger Cone would grow up to pen a story in the *San Francisco Examiner* about the controversy, but it didn't stir up much.

John van der Zee could daydream in high school geometry class, and gaze out at the Golden Gate Bridge where the architectural treatment seemingly changed by the way the light bounced off the mountains and the bridge's orange vermilion paint. Years later, an editor at Simon and Schuster suggested a book about the Golden Gate Bridge for its 50th anniversary in 1987. It was then that van der Zee found Cone. "I got very lucky," he says, "and researched and wrote the book in 18 months."

It wasn't until after the publication of van der Zee's book, *The Gate*, in 1986 that Lewis McCammon came forward with all of the Ellis's papers (now at Purdue), including letters, telegrams, engineering drawings with Ellis's signature on every page, and photographs. In 1992, they pitched it all to the Golden Gate Bridge District and suggested naming the arch on the San Francisco side after Ellis, which he, of course, also designed. Van der Zee says the Bridge District wanted to wait for findings from a historical research committee of the ASCE. The committee concluded that Ellis had indeed designed the bridge, but the Bridge District claimed not to be in a celebratory mood about it. Ellis was shut out again.

Does any of it matter? Strauss and Ellis are both long dead. There's no disputing that Strauss spearheaded a plan to get the bridge built. And

Ellis seemed more concerned with the work than the applause. Van der Zee thinks it matters. "The Golden Gate Bridge represents a profound reconciliation between technological progress and nature," he says. "That's why it hits people at this profound level. They think, 'God, it is possible to make something of useful everyday function that doesn't destroy nature or tramp on, but can complement, or even enhance it.' And you have to honor that the way it was done. Not the way some press release said it was done, or a collection of anecdotes. If we fail to honor the way the bridge was built as it really happened, we will lose the capacity to ever do it again."

For now we're left with a truth to build on. What was long known in the circles of academia is now accessible to anyone. For anyone who seriously studies the story of the Golden Gate Bridge can conjure up the image of the stately engineer Charles Ellis calculating how to span the magnificent strait. Because that's the straight story. ♦

—William Meiners

What Makes the Golden Gate Bridge a Worldly Wonder?

The answer could be found in the numbers.

In 1994, the American Society of Civil Engineers named the Golden Gate Bridge—along with the Hoover Dam, Interstate Highway System, Kennedy Space Center, Panama Canal, Trans-Alaska Pipeline, and World Trade Center—one of the "Seven Wonders of the Modern World." Beyond its breathtaking beauty and design, consider some of the following numbers that could help elicit such a claim for San Franciscans.

- **3 closures:** Gusting winds of 69, 70, and 75 miles an hour have closed the bridge on just three occasions (1951, 1982, and 1983). The bridge suffered no structural damage.
- **4 years of construction:** The bridge was built between 1933 and 1937. On May 27, 1937, the Golden Gate Bridge opened to pedestrians, and a day later, traffic.
- **11 construction deaths:** Until the year of its completion, only one man had died—an amazing feat attributable to Strauss and Cone's strict safety measures. But 10 died on February 17, 1937, when a section of a scaffold carrying a dozen men fell through the safety net suspended below the bridge.
- **19 saved by the net:** On a separate occasion, 19 men fell into the safety net and became known as the "Halfway to Hell Club."
- **1,000+ suicides:** The combination of beauty and a "no doubt about it" on impact make the Golden Gate Bridge the world's most popular suicide site.
- **4,200-foot-long suspension span:** At the time (and until 1964), it was the longest in the world. The Golden Gate Bridge now ranks seventh among spans.
- **600,000 rivets** (approximately) in each tower.



ERROR OF OMISSION: Charles Ellis always thought that his name appeared somewhere on the Bridge Plate of the Golden Gate. Apparently, he never returned to San Francisco to verify it.

For more information:

• *The Gate: The True Story of the Design and Construction of the Golden Gate Bridge*, John van der Zee, Simon and Schuster, 1986. His book, now in paperback, is available at www.barnesandnoble.com

• "The Case of the Missing Engineer," John van der Zee and Russ Cone, *San Francisco Examiner Image*, May 31, 1992. Reprinted by the American Society of Civil Engineers.

• *Building Big: Bridges*, PBS. To order call WGBH Boston Video at 1-800-949-8670 ext. 498.

• www.goldengatebridge.org