

*Tour en Fer*

Most cities have their peculiar and singular architectural or engineering structures, and Cincinnati is no exception. Now, we are all familiar with the Queen City's most prominent structures. Unfortunately, the Roebling Bridge belongs to the Commonwealth of Kentucky; our tallest buildings can't compare to New York's or Chicago's; and our Union Terminal reflects the city's procrastination in constructing a central railroad station. Still, we do have our own not-so-well-known curiosities.

Up I-75, about half way to Dayton was the Solid Rock Church's "King of Kings" statue, known to many disbelievers as either "Touchdown Jesus" or "Jesus in the Quicksand." To those with lingering memories of state fairs, its off-white coloring suggested a blue ribbon entry in the butter-carving competition. This massive sculpture which rose from the grounds in front of the non-denominational Solid Rock evangelical church, with its arms uplifted, burned after being struck by lightning a few years ago. Its replacement, a 52-foot full-figured Jesus, considered to be fireproof, is perhaps less imposing, but still represents either an awesome religious icon or a tasteless example of man's hubris.

Reversing our direction, just south of the Ohio River sits the world's smallest chapel. At least that was the claim made in "Ripley's Believe It or Not" some years ago. Officially called the Monte Casino Chapel, this 6' by 9' stone structure was built in 1878 by monks of the Benedictine monastery in Covington. After the monks departed the region, the chapel was restored and moved to the then-new Thomas More College campus, where it is open for personal meditation . . . and Munchkin weddings.

A very different architectural structure is the well-known Loveland castle, the brainchild of one Harry Andrews. Andrews, who was declared dead from spiral meningitis during the First World War, returned to the United States—very much alive—with a profound dislike of modern warfare and an overly romantic understanding of medieval life. In the early 1920s he organized a Boy Scout troop, and out of this came an organization called The Knights of the Golden Trail. Harry Andrews soon became Sir Harry Andrew. The knighthood was self-imposed and no doubt Queen Elizabeth remains unaware of this particular branch of the lesser nobility.

Having absorbed the early Boy Scout emphasis on developing manly character, Andrews often took his boys hiking and camping along the banks of the Little Miami River. So often, in fact, that they constructed two stone shelters to house their gear, and from this modest beginning rose the great castle-like structure called Chateau Laroche, the eventual product of several generations of local boys. Andrews, a graduate of Colgate University, died in 1981, at the age of ninety-one, but the castle and the Knights of the Golden Trail remain.

Just a few miles north of Chateau Laroche sits a fourth local curiosity, the centerpiece of King's Island. I am speaking, of course, of the Ohio version of the Eiffel Tower. Why this was deemed a fitting symbol for an amusement park remains a mystery to me, although no doubt it seemed logical at the time as part of the original "International Street," an area of kitschy European restaurants and shops. This replica, approximately one-third the size of the original, continues to serve as the amusement park's own iconic image.

All of this is a somewhat round-about way to get to my topic this evening. For centuries, cities around the world often have been recognized by unique physical structures. Rome has its coliseum; Sidney, its Opera House. The onion-topped Saint Basil's Cathedral identifies

Moscow; Rio is instantly known by the imposing statue of Christ the Redeemer; and London has its bridge . . . except that the London Bridge is now in Arizona. Oh, well, it has other bridges, along with Big Ben and, more recently, a huge Ferris wheel. One could place the Empire State Building in the same category, although it has to compete with too many other New York skyscrapers. As for Paris, nothing represents that city, or for that matter France itself, so well as the great iron tower constructed for the World's Fair of 1889. Indeed, the Eiffel Tower may be the world's penultimate urban image. But this brief tour led me to the realization that I knew more about Sir Harry Andrews than I did about the designer of the great tower, Gustav Eiffel.

Eiffel's great-great-grandfather emigrated from Germany to France early in the eighteenth century, where he changed the family name to Eiffel from Boenickhausen, the region in Germany from which they had come. This was a fortunate decision on his part for who would want to visit the Boenickhausen Tower. After two generations of upward economic mobility, Gustav's father left the ranks of the petit bourgeoisie to join the ranks of Napoleon's army, and after Waterloo he was assigned to the barracks at Dijon. Here, he married the daughter of a prosperous merchant, and Gustav was born in 1832. After a normal provincial boyhood, he attended the Central School of Arts and Manufactures in Paris, where he studied chemical engineering and graduated in 1855. He aspired to a position in his mother's brother's vinegar distillery, but his uncle, a staunch republican, violently disagreed with Gustav's parents' Bonapartist views, and that ended Gustave's future in vinegar. Left to his own resources, he took a position with a company that designed railroads. Hired initially as the assistant and private secretary to the company director, he eventually was placed in charge of research. In 1858, he was part of a team sent to build a cast iron railroad bridge across the Garonne River in

Bordeaux. After several engineers quit the project, Eiffel found himself in charge. The company's officers quickly learned what a valuable asset they had.

During the 1860s he developed a formula for determining the elasticity of wrought-iron, a formula that allowed him to do away with the costly trial-and-error method so commonly used, and in 1867 he used his formula to construct Machinery Hall at the Paris Exposition of that year. This structure, a 1,600 by 1,266 foot iron-framed ellipse was the largest structure of its day, exceeding the size of London's Crystal Palace, built sixteen years earlier for the first world's fair. In France, this was considered a great victory over the despised English.

The second half of the nineteenth-century might well be called the "age of engineering." Iron replaced masonry. Steam power replaced animals. Height, speed and distance records were established and then re-established. James Eads built his great bridge across the Mississippi; the Roeblings built their suspension bridges over the Ohio and then the East River; and Eiffel's Machinery Hall pushed his name to the forefront of French engineering. Victoria's Prince Albert had caught the essence of the era when he wryly commented that, "If we want any work done of an unusual character and send for an architect, he hesitates, debates, trifles; we send for an engineer and *he does it.*" Eiffel, himself, while looking at bad designs, on occasion was heard to mutter, "Stupid as an architect."

Between 1867 and 1886, the newly-formed Eiffel and Company constructed, in France alone, 42 railroad bridges. Because suspension bridges were still considered dangerous--and the tragic collapse of Scotland's Tay Bridge in 1878 underlined that concern--Eiffel's trademark became the trussed arch which he had used for the Bordeaux bridge and later to such good effect for bridges at Oporto, Portugal, and over the Truyère River in eastern France, the latter a four

hundred foot high “monster” that took five years to complete. His work also included the train station in Pest, Hungary, numerous bridges in Indochina, the framework for the Bon Marché department store in Paris, various structures in South America, and the skeletal support for the Statue of Liberty.

His work on the Statue of Liberty must have reinforced his views about poor design. The sculptor Frederic Bartholdi had designed the statue, a 151 foot tall Amazon, with an upraised arm that itself was 42 feet long and 12 feet thick. The head was to be 17 feet from chin to cranium, and an index finger to extend eight feet. It was to be, and remains, the tallest human figure in the world. Unfortunately, Bartholdi had not a clue how this massive sculpture could be supported, particularly with the tricky winds of New York harbor. He turned to Monsieur Eiffel. Eiffel chose to construct an interior iron skeleton for the hollow lady, and for the inherently weak arm holding the torch, he used iron beams to support it and then extended them across the back to the left side, thus creating a practical counter balance. It was Eiffel who also suggested that “Liberty” be clad in a protective sheaf of copper attached to his iron framework. The final product is more engineer than artist.

Massive buildings, soaring bridges, the Statue of Liberty, all of this made Gustave Eiffel the logical person to construct a tower that would be the centerpiece of the Paris Exposition of 1889. World’s Fairs, of course, had been around since 1851 when Great Britain, pushed by Prince Albert, conceived of the idea of holding a great exhibition to showcase industrial advances around the world, many of which, of course, reflected Great Britain’s place as the world’s leading industrial nation. The Crystal Palace exhibition, as it was dubbed, was a great success. Not to be upstaged by a nation of shopkeepers, France held its first Exposition Universelle in 1855, to be held on the Champs de Mars. London countered seven years later with its second

industrial exhibition. Paris again responded, in 1867. Eventually Vienna and Philadelphia joined the mix. But 1889 was a special year for France. The country wanted to celebrate the 100<sup>th</sup> anniversary of its revolution, and a fair would allow the none-too-stable Third Republic to strengthen its position against clamoring Bonapartists and leftover Communards. It was also an opportunity to show the world that France had cast off its humiliating defeat by Prussia in 1870 and was once again the leading nation on the continent. This was to be the opening of France's "La Belle Èpoque."

Eiffel was not the first to envision a colossal tower. As early as 1833, a British railroad engineer had suggested erecting a one-thousand-foot cast-iron tower in London, situated on a one-hundred-foot-wide masonry base, with the tower gradually narrowing at the top to ten feet and surmounted by a large statue. The project was never attempted and later engineers found the design fatally flawed. Nevertheless, the 1000-foot tower became something of an obsession on both sides of the Atlantic, although some considered it unachievable, like climbing Mt. Everest or running the 4-minute mile in the next century. Two American engineers wanted to attempt such a tower for the Philadelphia Centennial Exposition in 1876, but their plans remained on the drawing board. By 1889, man's loftiest achievement remained the all-masonry, 555-foot Washington Monument, completed in 1884 after a gestation period of 36 years.

As soon as the French government announced plans for its third exposition, with a dramatic centerpiece, two of Eiffel's engineers began planning a thousand-foot tower. Indeed, even before the required specifications were released, Eiffel had published a general description of this plan, a plan much admired by Edouard Lockroy, minister of commerce and industry and the guiding force behind the Exposition, and there is considerable evidence that the official specifications were largely based on Eiffel's preliminary work. Thus, it should have come as no

surprise when Eiffel received the contract. Of course, controversy followed immediately. Competitors claimed foul, although many of their designs ignored the required specifications or were completely unrealizable. One entrant envisioned a tower with a gigantic water sprinkling system that would alleviate any future summer droughts. Another displayed a large guillotine to evoke the event being honored. Jules Bourdais, architect of the famed Trocadéro Palace designed an all-granite tower with a huge electric searchlight at the top, surrounded by parabolic mirrors, which would banish night from every corner of Paris.

More importantly, France saw itself as the center of culture, and the art world resisted the concept that industrial materials and processes could result in an appropriate aesthetic symbol for the nation. One of the first criticisms came from the editor of the architectural journal, *La Construction Moderne*. He denounced Eiffel's plan as "an inartistic . . . scaffolding of crossbars and angled iron" with a "hideously unfinished" look. Others denounced it as "a useless and monstrous" tower. Forty-seven of France's best known and most powerful artists and intellectuals published a joint letter which described the proposed tower as a dishonor to Paris. "For the next twenty years we will see cast over the entire city . . . cast like a spot of ink, the odious shadow of the odious column of bolted metal." Although many of these critics eventually changed their minds, the writer Guy de Maupassant retained his dislike. Some years later, when asked why he so frequently ate in one of the tower's restaurants, he famously responded that it was the only place in Paris where he didn't have to look at it.

The slings and arrows of aesthetic criticism proved to be only the beginning of Eiffel's worries. A new line of attack soon surfaced. In June, 1886, a virulent screed titled *The Jewish Question* accused the engineer through his German ancestors of being Jewish and it labeled the proposed tower as "*une tour juivre*." Coming just eight years before the infamous Dreyfus Affair, Eiffel

felt called upon to defend himself in the republican paper *Le Temps*, by firmly stating that he was born of French Catholic parents. And he didn't even have to show his birth certificate. After parrying this surprising allegation, Eiffel was anxious to get started in order to meet the Exposition's opening deadline, but more serious problems quickly surfaced.

Eiffel estimated the cost of the tower at five million francs, or about forty million dollars in today's currency. The government had originally implied that it would pick up the entire cost, but now fiscally conservative politicians backpedaled, and finally it was determined that the government would underwrite only one and one-half million francs, or just 30% of the estimated cost. This left Eiffel with the personal responsibility to raise the rest. To attract investors, he was permitted to keep the tower in place for 20 years and retain all the profits from entry fees and restaurant concessions during that period.

While politicians debated the financing, the Comtesse de Poix, who lived on the boulevard that ran alongside the Champs de Mars, filed a law suit to block construction, claiming that the tower was not only a menace to her house but "that it will block up for many years the most agreeable part of the Champs de Mars . . . in which [I have] been accustomed to take [my] daily exercise." There was also concern that the iron tower would function as a giant lightning rod and draw dangerous storms to the area. With weeks turning into months of dithering, Eiffel contemplated dropping the entire project. Finally, in a bold move, he accepted personal liability for any damage to neighboring homes if the tower should fall. However, nothing was resolved concerning the Comtesse's exercise regimen.

On January 28, 1887, some eight months after receiving the bid, Eiffel and Co. broke ground. From this time on, his problems would be engineering ones, not political or personal. His

original plans had been drawn with the idea that the tower would sit more or less in the center of the Champs de Mars, but opposition from the army, which used the area for training exercises, pushed the tower to the very edge of the Seine River. Two of the foundations for the legs would now be on the unstable alluvial soil along the Left Bank. This required not only deeper excavation but the need to use compressed air inside sunken caissons to protect workers from water seepage while they removed the soil. By the end of June, however, the great masonry foundations had been completed and the iron tower could now start its ascent. Since even a very small deviation from the horizontal plane could throw off the tower's balance, Eiffel designed an ingenious system for fine-tuning. In the base of each leg, where they joined the foundation, he installed four hydraulic jacks which would permit minute adjustments as the iron beams moved upward to the first platform.

During these early months, Eiffel and Co. had been busy manufacturing the thousands of iron beams that would make up the actual tower. Each of the 18,000 pieces was designed separately, numbered, and holes, calculated to within one-tenth of a millimeter, drilled for the rivets. According to *The Atlantic Monthly*, this required a total of over 7 million holes. Steam-powered cranes traveled up and down the framework hoisting the beams for installation, and like a gigantic Erector set the tower moved upward. By mid-October, Parisians out for a stroll could see the four legs stretching up some 92 feet; five months later the tower approached 200 feet. The world had never seen anything like it.

By March 26, 1888, the first platform was securely in place. To celebrate the occasion and to curry favor with the press, in July Eiffel invited eighty of the city's most influential journalists to a banquet to be served on the first platform. Wearing a formal frock coat and top hat, Eiffel led his guests up the stairs to the platform where they all dined off trestle tables, almost 200 feet in

the air. Above them, they could see and hear workmen riveting the spidery latticework that would lead to the second platform. Below them lay the sprawling city, a view previously seen by only a few intrepid balloonists. Already the tower was the tallest structure in Paris, eclipsing the dome of Les Invalides. On July 14, Bastille Day, a fantastic display of fireworks illuminated the rising giant. By now, no one doubted that the great tower would be finished.

At this point, a problem that had been bothering Eiffel for some time had to be addressed. How were the curious masses going to reach the top of the tower? Elevators, of course, but no one had yet designed elevators for such an unusual structure. The simple solution was to run a shaft up through the middle of the tower, but to Eiffel this would spoil the symmetry and simplicity of the tower's elegant profile. Instead, he devised a plan for three sets of elevators, each set requiring different specifications, and he employed a French engineer named Backmann to design them. However, just twelve months before the Exposition's scheduled opening, Backmann was still struggling with plans. To reach the first platform from the ground was not a problem. The width of the legs and the slight degree of curvature meant that a straight track could be employed. To safely and swiftly carry passengers to the second platform, however, proved much more difficult. Here, the curvature was much greater and presented a serious challenge in a time when most elevators ran on hydraulic pressure. Then, of course, there was the need to reach the top platform, which would have to be done in two stages. To complicate the matter, the government required that all elevators be built by French companies.

A French company installed a somewhat noisy, but reliable articulated chain-link operation to carry passengers from the ground to the first platform. For the two-part third stage, the primary obstacle was the sheer distance to be covered—525 feet. Blackmann was dismissed and Léon Édoux, who had installed a successful 230-foot elevator in the Trocadéro Palace, neatly solved

the problem. He used two cars, running simultaneously. As the lower car began its ascent from the second platform to the interim transfer point, the second car would descend from the top. They would counterbalance each other, with the help of hydraulic pressure brought from a holding tank at the top of the tower.

But it was the elevators in the middle, those that would connect the first platform to the second, which continued to baffle Eiffel. When bids went out, no French company even responded, only the Paris branch of the American Otis Brothers and Company submitted a design. After a second call for bids, the government reluctantly waived its rules and gave the contract to Otis. Otis had gained a strong reputation in the United States for the safety of his equipment, and he had perfected elevators that moved by cables from the top, with the energy provided by water pressure that moved large pistons. A safety system involved strong leaf springs that forced brake shoes to grip the rails, slowly bringing the car to a halt. In Europe most elevators used a system similar to cog railroads, a system that was both noisy and limited the speed of elevator movement. But Eiffel didn't trust the Otis method. After all, both his reputation and his financial liability hung in the balance.

Although the Otis Company installed its elevators, the situation was not finally resolved until three weeks after the Exposition opened when Otis's chief engineer came to Paris to demonstrate with a test run. He loaded approximately 7,000 pounds of lead in the cabin; secured the elevator with thick ropes; and then disconnected the steel cables. In front of thousands of spectators, two workmen, armed with axes, then walked up the narrow spiral stairs to the second platform. With both Eiffel's and American manufacturing prestige at stake, the signal was given. The ropes were cut and the fifteen-ton Otis cabin began to fall, but then as the brake shoes grabbed, it gradually slowed, swaying gently, and stopped just thirty feet above the first platform. When

Eiffel inspected the cabin, he noted that “not a pane of glass . . . had been broken or cracked.”

The next day the elevators were made available to the public.

When the exposition opened on May 6, 1889, many of the exhibits were not yet ready, including the much anticipated tower, which was still receiving a handsome coat of bronze-red paint. Nine days later, and with the elevators not yet tested, some 12,000 people became the first visitors to walk through it, although the great majority of them, after climbing the 350 steps to the first platform, chose to forgo the 380 step climb to the second platform. If Eiffel felt uncomfortable about the delayed elevators, he did not show it. This was his day. Congratulatory telegrams came from around the world. French newspapers touted his skill, his fortitude, his attention to detail, and even many of the tower’s early doubters now came around. The four restaurants on the first platform became the most popular places in Paris for dining, especially during soft summer evenings when the daily fireworks went off.

For the next five months Eiffel was the toast of Paris. Honored at frequent banquets and praised around the world, he modestly accepted various awards in the name of French engineering. He received foreign decorations ranging from the Austrian Order of the Iron Crown to the Japanese Imperial Order of the Rising Sun, and French President Carnot awarded him the rank of officer in the Legion of Honor. Although most European monarchies had chosen not to set up their own exhibit halls because of the fair’s association with the French Revolution, many “royals’ could not stay away, and Eiffel was happy to escort them personally up his tower. The future Nicholas II of Russia and the former Queen Isabella II of Spain made their appearances. So did the Prince and Princess of Wales, the Duke of Edinburgh and King George of Greece. Russia’s Grand Duke Michael showed up in resplendent uniform. The King of Senegal, the Shah of Iran, and the Kediye of Egypt arrived, surrounded by their many retainers. Even the German ambassador

came, although unannounced and hoping to avoid publicity. But Eiffel spotted him . . . and then gleefully notified the press.

At the height of his reputation and just 57 years old, Eiffel had no premonition that the tower would be his last work. Less than four years later he was a criminal defendant in a Paris courtroom desperately trying to hold on to his reputation. Paralleling the great Exposition Universelle, French engineers had undertaken to construct a canal across the Central America, a project that, when completed, would secure for the nation much wealth and admiration. The original plan, designed by Ferdinand de Lesseps, the designer of the Suez Canal, called for a sea-level canal without any locks. When this plan was unveiled, Gustave Eiffel had opposed it, believing it to be unfeasible. By 1887, and some \$280 million dollars later, Eiffel's fears had come true. Still, when de Lesseps turned to him for help, he could not resist. He quickly designed a plan for a series of locks and started their construction, but it was too little, too late. Just months before the opening of the World's Fair, work on the locks ground to a halt. The Panama Company filed for bankruptcy and thousands of investors wanted to know how their money had vanished in the jungles of Panama. The ensuing investigation revealed the unworkable original plan, several years of waste and mismanagement, and the use of almost \$5 million dollars in bribes to members of the National Assembly and members of the press. Along with the company officers, Eiffel found himself on trial for fraud. Although he had been only a contractor and had had nothing to do with either the financial or management side, the fact that he had profited by over \$6 million dollars on his lock contract made him a culprit in the eyes of the public. In the highly-charged political atmosphere the judge pronounced him guilty of misusing funds and sentenced him to two years in prison. A week after he entered prison, a

higher court voided his guilty verdict on a technicality, and a later investigation by the Legion of Honor found him innocent of all charges. Still, the damage to his reputation was done.

Eiffel retired from active engineering, and even had his name removed from his company.

However, his personal wealth allowed him to experiment with a subject that had long interested him— weather. The Eiffel Tower already contained a weather station that monitored wind speed and direction, temperature, humidity, and precipitation. Over the next quarter century Eiffel set up some 25 such weather stations all across the country, published daily weather information, produced a weather atlas, and established the foundation of meteorology in France. Always cognizant of the power of wind, he worked daily in his office at the top of the tower and, ever the meticulous researcher, experimented with air resistance by dropping objects of various shapes and measuring the time it took them to reach the ground. Eventually he constructed a large wind tunnel at the base of the tower and conducted experiments based on his early recognition of the importance of aerodynamics. His published observations furthered developments in both aircraft lift and in the design of efficient propellers. In 1913 the Smithsonian Institution awarded him its prestigious Langley Gold medal.

With the development of radio, Eiffel eventually persuaded the French military to install a telegraphy unit at the top of the tower, which it did but only because Eiffel agreed to pay for it. In the meantime, his twenty-year lease on the tower would soon expire. Although it had remained as the part of the Paris Exposition of 1900, there were many who happily contemplated its removal, including, no doubt, the Comtesse de Poix . In the usual way of governments, a committee was established in 1903 to explore the issue, and it concluded that the combination of scientific experiments and anticipated adverse foreign opinion justified doing nothing at that time. In 1906, just three years before his lease would end, the City of Paris grudgingly granted

an extension to 1915. “Since it is there, let it stay a little longer,” seemed to be the Gallic attitude. Eiffel’s worries about the future of his tower ended when the French War Department finally installed a radio antenna on it which could receive messages from as far away as North Africa. In 1914 the tower proved its military value when its receiver captured a radio message that the German army bearing down on Paris had run out of food for its horses. This convinced the French General Staff to launch a counterattack at the Marne River. Paris was saved and the tower was then closed to the public for the duration of the war. But the war had saved it from the scrap heap.

When peace again reigned over Europe, the eighty-six year-old Eiffel took great pleasure in noting that once again thousands ascended its heights each year . . . and it was still the tallest man-made structure in the world. When he died in 1923, at the age of 91, his only lament was that the tower led people to think that it was his only work. Six years later, the Chrysler Building, which topped out at 1,046 feet, finally exceeded the height of Eiffel’s *Tour en Fer*. No doubt, Eiffel himself would have discreetly smiled at the fact that it took forty years for a structure to surpass his namesake; and he would have taken just as much pleasure in knowing that it had become his country’s most recognizable symbol. There is no way to know what he would think of its King’s Island offspring.

Robert C. Vitz

The Literary Club

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