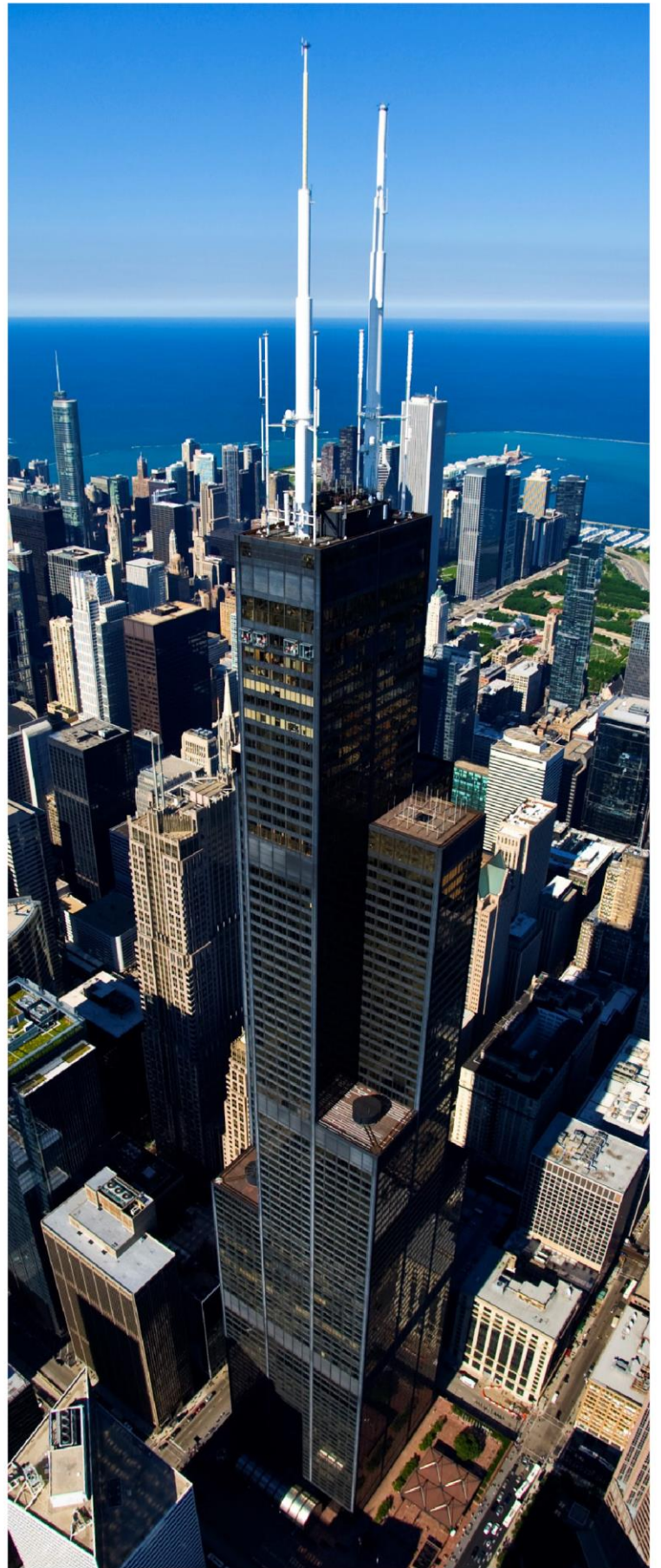


THE HOWS, WHATS, AND WOWS OF WILLIS TOWER

A GUIDE FOR TEACHERS



WELCOME TO SKYDECK CHICAGO AT WILLIS TOWER

There are enough impressive facts about the Willis Tower to make even the most worldly among us say, “Wow!” So many things at the Willis Tower can be described by a superlative: biggest, fastest, and longest. But there is more to the building than all these “wows”: 1,450 sky-scraping, cloud-bumping feet of glass and steel, 43,000 miles of telephone cable, 25,000 miles of plumbing, 4.56 million square feet of floor space and a view of four states.

Behind the “wows” are lots of “hows” and “whats” for you and your students to explore. In this guide you will be introduced to the building—its beginnings as the Sears Tower and its design, construction and place in the pantheon of skyscrapers. Its name was recently changed to the Willis Tower, proudly reflecting the name of the global insurance broker who makes the Tower its Chicago home. You will also learn about the Skydeck view of Chicago, a view unlike any other anywhere.

Included are other sections geared to the interests of your students and the needs of your curriculum, such as art, environmental efforts and our “city within a city.”

At the end are “Try This” activities and discussion questions that relate to each section. We have used several of them to create “Come Rain or Come Shine” field trip plans to adapt for all ages. Please choose among the activities to fit your students.

When you get back to your school, we hope your students will send us photos or write or create artwork about their experiences and share them with us (via email or the mailing address at the end of this guide).

One photo will be selected as the “Photo of the Day” and displayed on our Skydeck monitors for all to see. Artwork and writing will posted on bulletin boards in the lunchroom area. We would also love to have you and your students post you Skydeck Chicago photos to the Skydeck Chicago pages on [Facebook](#), [Instagram](#), and [Twitter](#).

As you get ready for your trip, please call us with any questions at (312) 875-9447. We aim to make your visit your best school trip ever.



A TOWER OF THE PEOPLE.

—Bruce Graham, lead architect, Sears Tower (now known as the Willis Tower)

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A SKYSCRAPER AMONG SKYSCRAPERS

Look at any photograph of Chicago and there it is: the Willis Tower. This building, formerly known as the Sears Tower, says Chicago in the same way the Eiffel Tower says Paris and the Empire State Building says New York.

The tallest building in the Midwest, the Willis Tower stands out from the rest of the city's skyline, even though Chicago includes some of the most spectacular architecture anywhere. As architecture critic Paul Goldberger put it a few years ago, "What brownstone has ever been the symbol of New York that the Empire State Building is, what lakefront park the icon that the Sears Tower has become?"

Yet if the Sears, Roebuck Co. had followed through on its initial thoughts for a new office building, the Willis Tower would have been less of, well, a tower. And the city would have lost its most recognizable landmark.

THE SKYSCRAPER THAT ALMOST WASN'T

Planning for new office space for the Sears, Roebuck Co. began in the late 1960s, when Sears was generating 1 percent of the annual value of all the goods and services produced in the nation, according to *The Sears Tower* by Craig and Katherine Doherty. A huge company needed a huge headquarters. The company figured it would need enough room for more than 13,000 Chicago-area employees to meet its projected growth through the end of the century.

After interviewing many architects, Sears hired Skidmore, Owings & Merrill, the architecture firm that recently had completed Chicago's John Hancock Center. The team included Bruce Graham as lead architect and Fazlur Khan as structural engineer, a man later called the "Einstein of Structural Engineering."



Photo credit: © Choose Chicago



Sears envisioned a building with enormous floors, some of which would be rented out to other businesses before Sears needed them for its own employees. Indeed, the first plan would have made the Sears “tower” 40 stories of 110,000 square feet each. This would have been just fine for Sears, but not for the other, much smaller businesses Sears had hoped would rent space.

Each new plan called for an increasingly vertical design, offering more floors with less space. When the building design finally called for 104 stories, someone suggested that only six more would create the world’s tallest building at 110 stories. Thus, a skyscraper among skyscrapers—and the icon of Chicago—was conceived.

WHERE DOES THE WILLIS TOWER RANK AMONG THE WORLD’S TALLEST BUILDINGS?

The Willis Tower is the second tallest building in both North America and the Western Hemisphere and #8 in the world. According to the Council on Tall Buildings and Urban Habitat, a building’s height can be measured in several different ways. The Willis Tower qualifies as the tallest building in the nation in:

- Height to highest occupied floor (1,431 ft.)
- Height to the top of the roof (1,450 ft.)

While the Willis Tower is no longer the tallest building in the world, it does have the one of the world’s longest elevator rides. You are whisked up 1,353 feet to the highest building observation deck in North America. Unless, of course, you want to quibble over that point with Toronto’s CN (Canadian National) Tower, which is not exactly a “building” but a 1,815-foot high “self-supporting structure.” Its observation deck is 1,465 feet off the ground.

THE FIRST “SEARS TOWER”

When business partners Richard Sears and Alvah Roebuck decided to build the first national headquarters for the Sears, Roebuck Co. in 1905, they looked to the skies.

The first “Sears tower” stood 12 stories high, overlooking the neighborhood around Homan and Arthington Roads in northwest Chicago. Originally designed as a water tower, the 250-foot-high structure in 1924 became a broadcasting studio for a Sears-owned radio station, WLS, whose call letters stood for “World’s Largest Store.” A year later, the company opened its first retail store in the brick complex adjacent to the tower. Sears Holdings, one of the nation’s largest retailers, continues to bear the famous name.



MY KIND OF TOWN, CHICAGO IS.

—Frank Sinatra



SKYLINE OF THE WORLD'S TALLEST BUILDINGS

SKYSCRAPERS



Burj Khalifa | Dubai, United Arab Emirates
Completed 2009 | 2,682 feet (818 meters) tall



Willis Tower | Chicago, United States
Completed 1973 | 1,730 feet (527.3 meters) tall



Taipei 101 | Taipei, Taiwan
Completed 2004 | 1,671 feet (509.2 meters) tall



Shanghai World Financial Center | Shanghai, China
Completed 2008 | 1,614 feet (492 meters) tall



Petronas Towers | Kuala Lumpur, Malaysia
Completed 1998 | 1,483 feet (451.9 meters) tall



Jin Mao Tower | Shanghai, China
Completed 1998 | 1,380 feet (420.5 meters) tall



2 International Finance Center | Hong Kong
Completed 2003 | 1,364 feet (415.8 meters) tall



CITIC Plaza | Guangzhou, China
Completed 1997 | 1,282 feet (391.1 meters) tall



Shun Hing Square | Shenzhen, China
Completed 1996 | 1,260 feet (384 meters) tall



Empire State Building | New York, United States
Completed 1931 | 1,472 feet (448.7 meters) tall

DESIGNING AND CONSTRUCTING THE WORLD'S TALLEST BUILDING

A THUMBNAIL HISTORY OF THE SKYSCRAPER

The first skyscrapers were built about a century ago. The growing businesses of America were driving the need for ever and ever larger buildings. But the only way to remain in the center of cities—near the rails, ports and customers that businesses needed—would be to grow up, and not out, in size.

Two innovations made the quest for the sky possible: the steel frame and the elevator. Making buildings with steel skeletons—or steel-reinforced concrete—to bear the weight made it possible to reach up beyond 15 or 20 stories. One of the last tall buildings with load-bearing walls was built in 1891, the 16-story Monadnock Building in Chicago. Its seven-foot-thick walls bore the weight of all the floors above. A building with load-bearing walls to handle the weight of a 60-story building would have to be so thick on the bottom floors that there would be no room for office space.

The perfection of the safety elevator by Elisha Otis made it much more appealing to build taller buildings. What seems at first consideration to be a luxury is a necessity. No one wants to climb steps to a 40th floor, much less to a 110th floor (more than 2,232 steps up!).



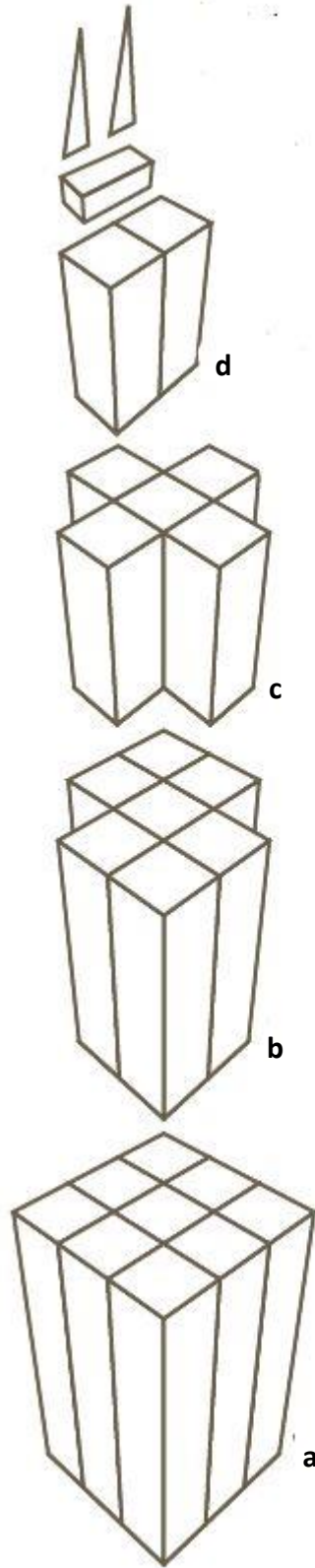
MEETING THE DESIGN CHALLENGES

The challenge of building the world's tallest building is contending with two forces of nature: gravity and wind. One, of course, is a vertical force and the other, horizontal.

The solution to both in the Sears Tower was an elegant design that had the serendipitous result of being cost-effective as well. Fazlur Khan, the structural engineer from Skidmore, Owings & Merrill, already had figured out how to build 100 stories at the John Hancock Center. For that building, he used a steel tube with exterior cross braces instead of the traditional steel skeleton of most skyscrapers.

But to go still higher and create a distinctive look for the Tower, Khan came up with a “bundled tube” design that handled both wind and gravity. At the ground level and on up to the 50th level, the building is nine tubes of rigid steel column-and-beam construction. Each measures 75 feet by 75 feet, yielding 50,000 square feet of space per floor. If you look at the side of the Tower at the ground level, each side is three tubes wide (see **a**).

At the 50th level, two of the tubes—on the northwest and southeast corners—end (see **b**). At the 66th floor, two more tubes—this time on the northeast and southwest corners—end (see **c**). The remaining five tubes—forming a plus sign with one in the middle and one on each side—stretch together to level 90, where three more tubes end. (see **d**). The last two reach the 109th floor. This is the floorplate you will experience when you visit the 99th and 103rd floor Skydecks. The 110th floor is a small penthouse structure housing one of the wash robots that helps keep the outside of the building clean.



Using the 75-foot tubes cut both the potential weight and cost of the building. If the Sears Tower had been built as a traditional skyscraper, the steel would have weighed about 50 pounds per square foot. The steel used in Khan's design weighs only 33 pounds per square foot. The overall weight of the steel frame, however, is still impressive: 76,000 tons, or enough to build more than 52,000 cars.

The variations in the tube heights disrupt the force of the wind. Interior cross braces on several floors also help stiffen the building to make it more windproof. Two models were tested in wind tunnels before the design was made final and construction began. The final building was designed to sway up to 6 inches in the strongest winds.

The final design also solved another problem facing the architects: how to allow tenants of different sizes to use the building efficiently until Sears was ready to occupy the whole building. The final design allowed Sears to take the larger, lower floors and lease the smaller, upper floors to tenants.

THE TOWER TAKES SHAPE

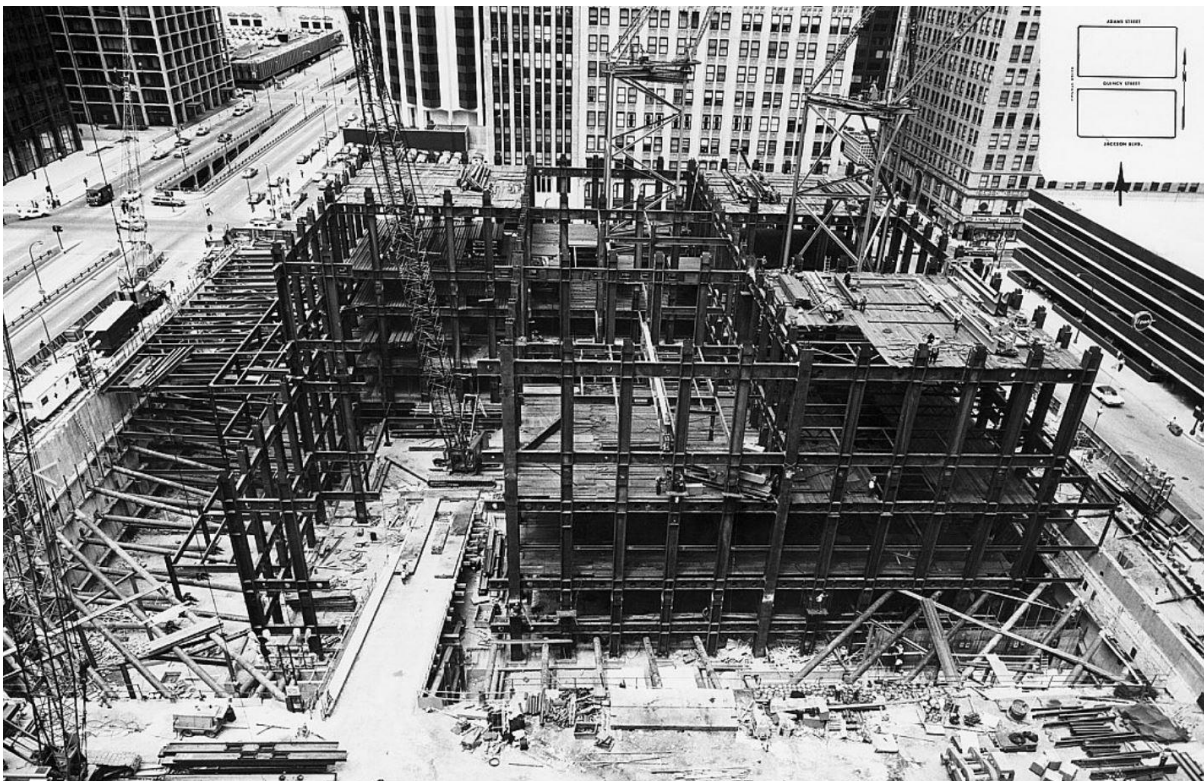
The Sears Tower took roughly three years and \$175 million to build. The builders broke ground in August 1970 and set the first section of steel for the bundled tubes in place in June 1971.

Starting with a hole 100 feet deep, builders laid the foundation of 200 circular caissons set into the bedrock. Prefabricated steel in 15-foot by 25-foot sections—called “Christmas trees”—were put into place, rising at a rate of about two floors a week. Four derrick cranes moved higher with each floor to lift the “Christmas trees” into position.

The builders put enough concrete into the building to make an eight-lane highway five miles long. Some 2 million cubic feet of concrete went into the foundation and all of the floor slabs. Special elevators were created to take the concrete mixed on site to heights above.

When it took too much time for workers on the upper floors to go down and eat their meals at ground level, special kitchens were created to feed them on two floors part way up. They endured temperatures up to 20 degrees colder at the top than at ground level. Practically the only thing that could stop construction was the wind, which blew so hard at the highest points that the workers could not even stand up, much less move across the beams.

By May 3, 1973, the last beam was put into place. It was signed by 12,000 construction workers, Sears employees and Chicagoans who wanted their names on the world’s tallest building, a title the Sears Tower would hold for 23 years.



SHE TOWERS SO HIGH!

—Sears Tower workers singing as they put the last beam in place

FROM THE GROUND UP

A Giant Footprint Is a First Step

Such a tall building needs a good-sized place to sit. How about three acres in downtown Chicago? Fifteen smaller buildings on two city blocks were razed for the Tower. And a section of Quincy Street—bought from the city of Chicago for \$2.7 million—was swallowed up. All of the real estate was in Sears' hands about nine months before ground was broken for construction to begin in the summer of 1970.

Underneath It All

Supporting the millions of square feet of floor area in the Willis Tower are deep concrete bedrock caissons. Each of the Tower's nine tubes extends down three levels where it is connected to circular foundation supports anchored in limestone bedrock. The foundation supports are all connected to a huge concrete raft that acts as the lowest basement floor. The 30-inch thick concrete wall around the concrete raft keeps the basement dry. Even when hundreds of building basements in the Chicago Loop flooded with Chicago River water in 1992, the Tower's basement stayed dry.

Tell Me a Story

A story, sometimes spelled storey, is the space between one floor and the next. The height of one story at the Willis Tower is 14 feet, but the average ceiling height on a typical office floor is about 8 feet, 8 inches. The rest is taken up by mechanicals such as heating, cooling and electrical systems.

The Willis Tower has 110 stories, with the first story being at the Franklin Street plaza level. Three more levels extend 48 feet underground below Franklin. Basement and attic floor levels usually are not considered to be stories.

On the Sides and at the Center

When you look at the Willis Tower, you notice the huge number of windows. Across the face of the entire building are 16,100 tinted windows and 28 acres of black aluminum panels (with the color chosen to hide the city's dirt). The building glows bronze at certain times of day, depending on how the sun hits it.

These windows and panels make up the curtain wall, or exterior, of the building. At the center of the bundle of tubes are the elevator banks, washrooms and areas on each floor for the plumbing, electrical wires and heating and cooling apparatus. The people working in the offices need the best views.

Over Your Head

At the very top of the building are 287-foot antennas with airline warning strobe lights that flash 40 times a minute. Visible to pilots over great distances, the lamps are changed about every 18 months by a climber who scales the antenna towers. New digital antennas were recently installed for Chicago's major television stations so they could offer high definition TV.

In the past, the antenna towers also have served as lightning rods, with grounding cables running from the top down to the ground, where electrical energy is safely dissipated. More recently, the antennas have featured a spiked circular lightning deterrent system, which prevents static electricity from building up and being discharged as lightning.



FROM THE BEGINNINGS OF THE SEARS TOWER TO TODAY'S WILLIS TOWER

- 1886** Richard Sears sells watches by mail order.
- 1887** Sears hires Alvah Roebuck to repair the watches he sells.
- 1893** Sears and Roebuck become partners and move to Chicago.
- 1906** Sears and Roebuck move to Homan and Arthington Roads on Chicago's northwest side, where the first Sears Tower — a water tower — is a neighborhood landmark.
- 1925** Sears and Roebuck open their first retail store there.
- 1969** The world's largest retailer, Sears, Roebuck Co., purchases 3 acres of land to create a new headquarters.
- 1970** Design of Sears Tower is unveiled in July. Ground is broken for the Sears Tower in August.
- 1971** First steel is erected in June.
- 1973** Last steel is put into place in May. First Sears employees move into the Tower in September.
- 1982** Public areas are renovated. New antenna sections are added to make present total Sears Tower height of 1,730 feet.
- 1988** Sears moves out of the building.
- 1990** Lobbies and public areas are renovated. The Skydeck pavilion is created.
- 1994** Aldrich, Eastman, and Waltch become owners of the Sears Tower.
- 2000** The 103rd floor Skydeck is renovated. It now provides not only a great view, but also a fabulous overview of Chicago's history.
- 2004** The Tower is purchased by 233 S. Wacker Drive LLC, a real estate group formed to buy the building.
- 2007** U.S. Equities Realty becomes the building's exclusive leasing and management company.
- 2009** All of the Skydeck entry areas are revitalized to bring the city of Chicago to life even before people take the trip to the 103rd floor. There are exciting new interactive exhibits about Chicago favorites, from the museums to sports (and don't forget the hot dogs and deep dish). The 103rd floor Skydeck gets an exciting new feature—The Ledge—that lets you stand 4.3 feet away from the side of the building on a 1.5-inch glass floor high above Wacker Drive and look below, above, front and side to side. It's like you are in a bubble floating 103 stories high above the bustle below. The building is named the Willis Tower after the Willis Group, a London-based global insurance broker.



ART AND ARTISTRY AT WILLIS TOWER

OUR FRONT DOOR

The public areas of the Willis Tower, redesigned by Chicago architects DeStefano and Partners in the 1980s, draw your attention to the construction of the building.

The beams and columns of the tube at the Wacker Drive front entrance are clad in lavishly decorated brushed and polished stainless steel. Italian Travertine marble creates a rich yet neutral backdrop. The elevators are polished so shiny that they are mirrors.

Inset into the large red granite floor tiles are stainless steel medallions of varying sizes. The medallions are representations of the construction of the building. See for yourself!

In the warm months, planters are filled with flowering plants both inside the lobby and out. The red granite plaza outside features seasonal outdoor seating and is often filled with people enjoying the sunshine, listening to the summer concert series or picking up fresh produce from the farmers market. In December, an enormous decorated evergreen tree graces the Wacker Drive lobby.

The Skydeck entrance pavilion off of Jackson Boulevard is a light-filled area that beckons to the thousands of visitors who stop by every day. You may even see the 20-foot-high Willis Tower built entirely from LEGO® bricks by our visitors (see page 27 for details).

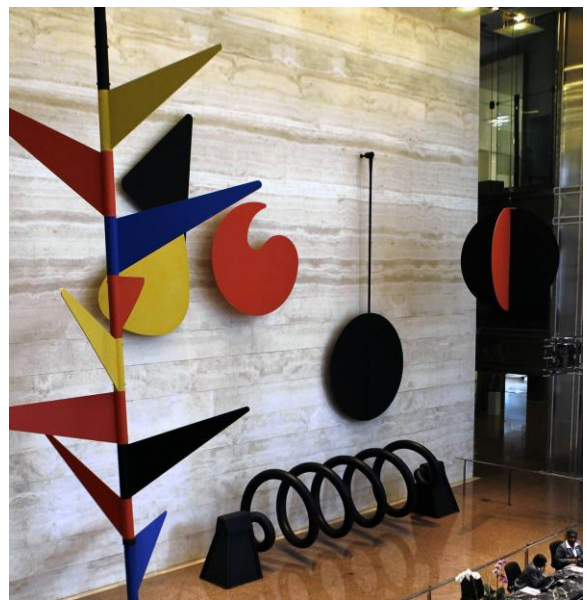
OUR “INDOOR UNIVERSE” BY ALEXANDER CALDER

The whole “Universe” is contained in the lobby of the Willis Tower.

Enter the building from Wacker Drive and you step down into the four-story atrium at the center of which is “Universe,” a kinetic sculpture designed by Alexander Calder (1898-1974), a noted American sculptor.

This massive sculpture features seven elements, each of which is driven by its own motor at its own speed. In red, yellow, blue and black are three flowers, a spine, a helix, the sun and a pendulum.

The total composition weighs 16,000 pounds and stretches 55 feet wide and 33 feet high. It was prefabricated in a foundry in France before being brought to this country for installation in 1974 in the Willis Tower lobby. Calder, an engineering draftsman before he became an artist, flipped the switch himself to begin the movement of the sculpture.



OUR CITY WITHIN A CITY

THE VERTICAL VILLAGE

With more than 4.5 million square feet of space, the Willis Tower is a “vertical village.”

Imagine a city the size of 78 football fields, including the end zones, and you have an idea of how large the Tower’s space is. The only larger office building in the world is the Pentagon, the U.S. military’s headquarters just outside Washington, D.C.

More than 25,000 people a day come through the doors on their way to work or to visit the Skydeck or one of the many businesses in the building. While the Willis Tower is home to many different kinds of businesses, it has been especially attractive to companies in insurance (including the namesake Willis Group), health care, law and accounting. It is also the home to United Airlines, where thousands of their employees come to work every day.

With hundreds of thousands of pieces of mail coming in each year, the Willis Tower has its own U.S. Post Office. There are numerous restaurants, from a coffee shop to fine dining. You can handle just about all of your day-to-day needs, such as getting breakfast, lunch and dinner, working out, doing your banking, getting a haircut and buying a gift or book or other sundries. And you can visit your doctor, chiropractor, broker or lawyer. All without going outside!

DOWN UNDER

The first lower level of the Willis Tower is where all of the “stuff”—the mail, the furniture, the equipment, the food for the restaurants, you name it—comes into the building.

Fifteen loading and unloading bays handle all the vehicles bringing material to and from the building. Trucks and delivery vehicles enter from Lower Wacker Drive, which runs underneath South Wacker Drive, just in front of the building. Some 200 cars can be parked underneath the building at one time.



Photo by Daniel Schwen

SHOW ME ANOTHER CITY... SO PROUD TO BE ALIVE

—Carl Sandburg, poet, “Chicago”



13

THE WORLD FROM THE TOP

EVERYTHING IS AT YOUR FEET

On a clear day, you can see up to 50 miles from the top of the Skydeck into four states: Illinois, Indiana, Michigan and Wisconsin. The lake sparkles to the east, and the roads in and out of Chicago are filled with travelers. Nightfall brings a different glittering view to the Skydeck, and everything seems closer. There's no better view anywhere.

South

Peer south and enjoy views of some of Chicago's favorite attractions—from historic Soldier Field to the Field Museum and the Museum of Science and Industry. On a clear day, you may even spy the smokestacks around the bend of Lake Michigan that mark the industrial city of Gary in neighboring Indiana.

Look for:

- The Field Museum
- Soldier Field
- The Museum of Science and Industry
- McCormick Place Convention Center
- Hyde Park

East

Look east and feast your eyes on the stunning view of one of the world's largest freshwater lakes, Lake Michigan. The land along this truly great lake is home to beautiful parks and cultural attractions, including Millennium and Grant parks, the Shedd Aquarium, and the Adler Planetarium. Due east, across the water you just might see the shore of Michigan.

Look for:

- Navy Pier
- Millennium Park
- Buckingham Fountain
- Shedd Aquarium
- Adler Planetarium
- Aon Center
- Grant Park
- Northerly Island

North

To the north, you will see many of the other notable skyscrapers that help make up Chicago's iconic skyline. You also will see the Chicago River, Lincoln Park Zoo and world-famous Wrigley Field. Look to the horizon and you will start to see how the city's growth has bridged the border to blend with the cities of southern Wisconsin.

Look for:

- Wrigley Field
- Lincoln Park Zoo
- Merchandise Mart
- John Hancock Center
- Water Tower Place

West

Looking west, you will see the constant air traffic of O'Hare and Midway airports. The west side of the city is also home to renowned University of Illinois' Chicago campus, the United Center, Oprah's Harpo Studios and historic Little Italy and Greektown. But the true highlights of the western view are the spectacular sunsets and The Ledge with its unbelievable views straight down 1,353 feet.

Look for:

- Midway Airport
- Little Italy
- Greektown
- United Center
- O'Hare Airport
- University of Illinois Chicago Pavilion
- Harpo Studios



HOW MANY DIFFERENT LANGUAGES DO YOU HEAR?

The Skydeck draws 1.6 million visitors a year, many from around the world. Listen as you take the elevator and walk around the Skydeck. How many different languages do you hear being spoken? If you're at the Skydeck on a big tour day, you'll think the United Nations has moved to Chicago.

WALKING ON AIR: THE LEDGE

The Skydeck's newest view surrounds you: above, below, to the sides and right in front of you. The Ledge boxes extend 4.3 feet from the Tower itself and stand 1,353 feet above Wacker Drive. Look between your feet and see the people walking below. Look straight down the Chicago River. There is nothing like it anywhere. Exhilarating, exciting, and scary—all at once.

The inspiration for The Ledge came from the hundreds of forehead prints visitors left behind on Skydeck windows every week. From the memorable scene in the movie "Ferris Bueller's Day Off" to curious children going right up to the window, visitors are constantly trying to catch a glimpse below. Now they have a unique and unobstructed view of the city.

The Chicago office of Skidmore, Owings and Merrill, the building's original designers, drew up the innovative plans for this architectural and engineering achievement. The Ledge is designed so that the fully enclosed glass boxes rest between conveyor belts. The boxes retract into the building, allowing easy access for cleaning and maintenance.

Experts in international structural glass design, Halcrow Yolles, fully designed and detailed all the glass and steel components. Beginning with the architect's original concept, the engineers took the design one step further by eliminating all perimeter structural steel at the sides and along the floor of the glass enclosures and creating a near-invisible support system.

MTH Industries, the Chicago-based 120-year old glass and architectural metal contractor that installed Cloud Gate in Millennium Park, installed The Ledge's glass panels. Each glass box is comprised of three layers of glass laminated into one seamless unit. The low-iron, clear glass is fully tempered and heat-soaked for durability. In addition, the motorized system that projects and retracts the boxes from the building utilizes steel LinearBeams. The result is both beauty and strength.



HOW IT ALL WORKS: SAFETY, SYSTEMS AND MAINTENANCE

THE COMMAND CENTER

The Willis Tower is fully automated. A command center helps the building engineers and security staffers keep watch over the building. A huge bank of screens relays images from cameras located in all the public areas of the building. Another set of screens monitors all of the systems that keep the building heated and cooled, the water running and the electricity humming.

Command center staff can tell the temperature of each floor and the electricity being used as well as which elevators are in use and where they're going. All of the images and data are recorded. Office workers who want the temperature a little cooler or a little warmer can just call the command center for assistance.

SAFETY AT THE WILLIS TOWER

Safety is top priority at the Willis Tower. Every system has been designed for the safety of the people who work in and visit the building.

Security personnel are on duty 24 hours a day, monitoring the building in the command center and patrolling the public areas. Guards are posted at the loading docks, the public areas, the Skydeck and throughout the building.

The Willis Tower was the first building to have automatic sprinklers covering every square foot of space. In addition, all of the steel is fireproofed. Advanced smoke detectors on every floor can pinpoint the source of any smoke and alert a computer in the command center that activates the exhaust system for that area and reduces the flow of air that might fuel a fire. There also are fire pumping stations at many levels and four stairwells for use in case of fire.

While earthquakes are unlikely in the Chicago area, the Willis Tower is capable of resisting significant earthquake forces. The closely spaced columns built to withstand high winds also would give the building great strength in an earthquake.

If there were a power failure, two diesel generators would provide emergency power for the elevators and lights. (The building has never experienced a blackout in its entire history.) There is a public address system throughout the building and hotlines to both police and fire stations.

Even the sidewalks are heated to keep snow and ice from building up and posing a hazard to passersby and people heading into the building.'

PEOPLE AND PLACES

Keeping a building of this size running smoothly takes a lot of machinery and an army of people working around the clock. The building employs a platoon of security guards, 99 full-time housekeepers, 28 maintenance engineers, six electricians, six technicians, five elevator technicians, three carpenters and a locksmith. Contractors also are used for special jobs.

Each floor has some machines and equipment, but the major pieces are housed in "physical plants" on seven floors. These floors feature electrical substations, water- and air-handling equipment and elevator motors. In addition, some of these floors feature cross bracing for the tubes. You will notice some of these floors from the outside, as some of them have louvers (or slotted covers) instead of windows.



ELECTRICITY, PLUMBING, AND PHONE LINES

The power for the Willis Tower comes through a 13,200-volt substation. Some 2,000 miles of cable—enough to reach from Chicago to Los Angeles—carry enough electricity throughout the building to serve a town of about 35,000 people. Eight o'clock means lights out for the building, except where tenants are still working and the cleaning crews are doing their jobs.

Turning off the lights is important when the building's electrical bill is millions of dollars a year. No wonder: the building features some 145,000 light fixtures and other electrical installations!

Fitting restrooms throughout the building took 25,000 miles of plumbing. There are 992 toilets. When you wash your hands, you are using one of 796 washroom faucets in the building.

The phones required 43,000 miles of telephone cable, enough to circle the globe one and three-quarters times.



ALL THE UPS AND DOWNS

One-hundred-and-four elevators carry people and freight up and down the Willis Tower. Fourteen double-deck units carry passengers nonstop to the 33rd-34th floor or the 66th-67th floor sky lobbies, which are transfer points for the single-deck elevators. These single-deck elevators travel a maximum of eight floors so that riders don't have to wait while an elevator stops at dozens of places.

The two Skydeck elevators are among the world's fastest elevators, traveling at a speed of 1,800 feet per minute. Your ears will pop as they adjust to the changing air pressure during your speedy trip. You also will be treated to an elevator presentation that tells you when you achieve the altitude of other world icons, such as the St. Louis Gateway Arch and the Eiffel Tower, on your way to Skydeck.

When you're riding an elevator, just about the last thing you're thinking about is the wind outside. At the Willis Tower, a wind of 60 miles per hour can make the top of the building sway a little; it was designed to sway about 6 inches. While you would not even notice that, the small amount of sway could jam an elevator. To accommodate the sway, the speed of the longest elevators is reduced.'

Six freight elevators also serve the building, in addition to 14 escalators that help people reach the lower mezzanine levels and floors and the two-story sky lobbies.

KEEPING COOL AND STAYING WARM

Each day heat builds up inside the skin of the Willis Tower. Sunlight pours in the windows (despite their tinting); computers and other electrical equipment generate heat; and all those warm people help push the temperature up.

A sophisticated air-handling system cools, filters and circulates air throughout the building. The air comes in and out of each floor through ceiling vents.

Sometimes heat is needed on the shady side of the building. Or perimeter heating is needed all over on cold winter days. At the direction of the command center, air can be filtered and exchanged between the warm and cool areas of the building or electric boilers can supply heat throughout the offices on the perimeter.

On the main mechanical floor are enormous chillers. These large refrigerator units cool water to chill the air and pump it to major physical plant areas throughout the building, where it is then circulated to each floor. Four large cooling towers three stories high on the 106th-109th levels take water already used by the chillers and cool it down using fans as the water runs down the inside of each tower. The work of the chillers and cooling towers is monitored by the command center.

WASHING THE OUTSIDE

Six automatic window robots clean the outside of the building eight times a year.

This system, unique to the Willis Tower, uses machines on tracks on the outside of the building. Moving down in its track, each machine cleans about 45 feet a minute, first spraying the building with water and detergent, then brushing the windows and aluminum panels to remove the dirt, and finally vacuuming up the dirty water. The machine then cleans and filters the water to repeat the process on another stretch of wall.

The 5,000-pound wash robots are located in roundhouses on rails on the roof setbacks when they are not moving down the sides of the building. Two are at level 50, two at level 66, one at level 90 and one in the penthouse at level 110. Each has to clean a face of the building clear down to just above street level.

The all-glass enclosures that make up The Ledges on the 103rd floor were built to retract into the building so the cleaning robots can do their job. You can see the rails when you look back at the side of the building while standing on The Ledge.

Down on the ground, a special small-scale “street sweeper” machine is used to clean the plaza areas.



ENVIRONMENTAL EFFORTS AT WILLIS TOWER

REDUCING, REUSING, AND RECYCLING

Who knew that the true color of the Willis Tower was green? The Willis Tower not only is an innovator in promoting green practices among its tenants, but also stands as a leader among tall buildings in increasing energy and water efficiency and reducing waste.

Over the past 20 years, the Tower has reduced annual electricity consumption by 34 percent by installing enhanced lighting systems and controls and adopting special conservation practices. The building saves 10 million gallons of water, or the equivalent of 156,448 bathtubs full, each year by relying on reduced water-flow fixtures. These successes are spurring the building to look into certification as a LEED (Leader in Energy and Environmental Design) building and explore renewable energy resources, such as solar and wind power. One day there might be “green roofs” covered with vegetation (the tallest green roof in the nation, anyone?) to conserve energy.

THE SHRINKING CARBON FOOTPRINT

The Willis Tower has reduced its carbon emissions by 51 million pounds a year since 1987. That’s the equivalent of planting 4.4 million trees or taking 4.418 cars off the road each year.

The Tower began its recycling program in June 1993 by recycling 241 tons of paper. Today the building recycles 445 tons a year—enough to save more than 3,500 trees annually. Some 12 tons of office electronics, such as computers and printers, are recycled each year.

Being a green leader is not just about making the planet safe—it’s about caring for the people in the building. The Willis Tower implemented green cleaning programs to reduce the use of harsh chemicals. The building offers incentives for people to ride their bikes to work, such as providing shower and changing facilities and indoor bike parking. Tenants who drive hybrid vehicles may park at a reduced fee. If people have an off-site meeting or just want to take a spin up to Millennium Park, they can hop on loaner bikes provided by the building during biking season.

Ongoing education of all the people in the building has contributed to the success of the recycling and source reduction program at the Willis Tower. Each different kind of business in the Willis Tower tailors the program to meet its needs.

The maintenance crew collects trash and recyclables daily, emptying the trash into compactors on the lower level and sorting recyclables into special bins for carting away to be recycled.



HOW THE WILLIS TOWER REDUCES WASTE

- Using reduced-flow faucets and water fixtures
- Using long-life, energy-efficient light bulbs and electrical fixtures with timers and controls
- Double-sided copying
- Reusing laser printer and copier toner cartridges
- Sending email rather than printed memos
- Replacing disposable with reusable items (such as coffee mugs for foam cups)
- Using renewable, refillable or returnable containers
- Donating or recycling surplus office materials

WHAT'S RECYCLED AT THE WILLIS TOWER

- Paper
- Cardboard and chipboard
- Aluminum
- Plastic (#1 PET and #2 HDPE)
- Glass
- Aluminum and copper wiring
- Electrical components from computers and other electronics
- Batteries

WHAT'S THROWN AWAY AT THE WILLIS TOWER

- Food products
- Food containers, utensils and wrappers
- Any waste paper contaminated by food or liquid

A NEW KIND OF HEAT EXCHANGE

The Willis Tower has a unique heat-salvage system that takes heat from the electrical transformers in the basement levels and uses it to heat water for the rest of the Tower. This “by-product” heat is enough to create hot water for the equivalent of 1,000 homes. This exchange saves energy.

OUR FINE FEATHERED HUNTERS

Peregrine falcons, who were introduced to the city many years ago to control the pigeon population, regularly utilize perches at the Willis Tower to hunt.

While the birds make their nests at lower levels on other nearby buildings, they rely on the Willis Tower to look for prey. They sit up at the 66th and 90th levels, which are set back from the rest of the building, to hunt. Upon spotting their prey, they will swoop down, catch it and bring it back up to the same spot to eat it. Sometimes the falcons will hover on the updrafts along the building, seemingly making no effort to stay afloat many stories above the street.

SWEET HOME CHICAGO!

—Robert Johnson, composer (and many blues singers, including the Blues Brothers, in the 1980 movie of the same name)

20



ACTIVITIES AND QUESTIONS FOR STUDENTS

Indicates an activity is appropriate for:

E

Elementary school students

M

Middle school students

H

High School students

A SKYSCRAPER AMONG SKYSCRAPERS

E FIND: SPOT THE WILLIS TOWER ON YOUR WAY INTO CHICAGO

Look for the Willis Tower as you drive closer to Chicago. How far away are you when you first spot the Tower? Ask the bus driver to clock the distance and have your students use roadway mile signs to estimate.

On a clear day, the airline safety strobe lights on top of the Tower can be seen from as far away as Milwaukee, Wisc., Joliet, Ill., and Michigan City, Ind. We've also been told that the antenna towers can be seen from Holland, Mich. The lights atop the antenna towers are focused on the horizon, so they are not as easy to see on the ground as they are from the air. The lights blink 40 times a minute, shining 200,000 candelas during the day and 1,000 candelas at night.

Try the same activity on your way home.

DESIGNING AND CONSTRUCTING THE WILLIS TOWER

E SOLVE: WHAT PROBLEMS MUST YOU SOLVE TO BUILD A TOWER THIS HIGH?

M Ask your students to assume the role of architects and engineers given the assignment of creating the world's tallest building, which the Willis Tower was when it was built as the Sears Tower.

What would they have to consider? What questions would they ask the Sears, Roebuck Co.? What problems would they have to solve? What challenges might they face 10 years after construction? You could role-play this question, with several students acting as the Sears executives and others playing the role of the architects and engineers. Students could use blocks, building bricks or the computer to "construct" their creations.

E CALCULATE: HOW MANY "YOU'S" WOULD HAVE TO BE STACKED HEAD TO TOE TO EQUAL THE HEIGHT OF THE WILLIS TOWER?

The Willis Tower is 1,450 feet (442 meters) to the roof. How many of you could stand head to toe next to the Tower and touch the roof?

ART AND ARTISTRY AT THE WILLIS TOWER

E DISCUSS: WHAT DO THE SHAPES MEAN?

Take your students to look at the "Universe" sculpture in the Wacker Drive atrium. Let them study it a while before you ask any questions. Have them look away when they tell you what is most memorable about it. Does it make them feel anything in particular? What do the shapes mean to them? Why might Calder have chosen them? What does "universe" mean here? Why might he have chosen the colors he did? Why do they think the sculpture is here in the midst of a busy office building? What kind of music, if any, seems to fit this sculpture?

E DESIGN: MAKE YOUR OWN "UNIVERSE" SCULPTURE

When you're back in the classroom, have students make mobiles of their own, using the shapes Calder used or ones of their own design. Required materials would be fishing line or thin string, a hole punch, scissors, construction paper, and items to serve as supports for holding the dangling shapes (such as hangers, dowels, chop sticks or twigs). What would they call their masterpieces?



OUR CITY WITHIN A CITY

E CONSIDER: WHAT BUSINESSES WOULD YOU INCLUDE IN THE WILLIS TOWER?

Ask your students what businesses they would like to see at the Willis Tower. Check the businesses in the concourse and lower levels (just around either corner from the Skydeck lobby).

What is the “city within a city” missing, if anything? Where should your students’ businesses be located? Who would their customers be? If you’re not from Chicago, would those same businesses fit in your hometown? Why or why not?

Ask them to draw their business operations and describe them. At your school, you could create a bulletin board with their businesses located on the floors they choose. The computer game, Sim Tower, lets them choose businesses for their Tower (see page 33 for details).

THE WORLD FROM THE TOP

E CHALLENGE: WALK OUT ON THE LEDGE

M Ask your students to describe in one word how they would feel being in a clear bubble high atop the city looking at the ground 1,353 feet below them. If you do this ahead of time, have them write it down. Once you’re on the Skydeck, recruit volunteers to walk out on The Ledge and give a different one-word answer. What changed? Who can come up with the best word to describe the experience? You also can ask them to write paragraph or short poem about what they felt being out there.

M DOCUMENT: TRY TO CREATE A COLLABORATIVE PANORAMIC VIEW

Have your students take digital photos of the scenery, either using a regular digital camera or a cell phone camera, overlapping the photos to create a customized panoramic view of the city. Each student could be responsible for a portion. When you get back to school, you can overlap them using photo software or by printing them out and taping them over each other on the wall. Email the finished product to us, and it may be selected as the Photo of the Day for display on our Skydeck monitors.

E DISCUSS: WHAT WOULD IT BE LIKE TO “FLY BLIND?”

Head up to the Skydeck when visibility is low to give students an idea of what it must be like to be pilots who “fly blind” with only instruments to guide them. How would they feel doing this? What are the clues that your students can find to orient themselves? How could compasses help? What other information would they need to fly safely?

E CREATE: MAKE YOUR OWN SOUVENIR

Make your own souvenir of the Willis Tower by doing a “rubbing” of the steel medallions in the first floor lobbies. The medallions are inlaid in the granite floors. Can your students tell what the design represents? Use a crayon or the side of a soft pencil on paper placed over the design. Rub lightly and you will have the design to take home with you.



M

HOW IT ALL WORKS: SAFETY, SYSTEMS, AND MAINTENANCE

CALCULATE: HOW LONG IS YOUR ELEVATOR RIDE?

The Willis Skydeck elevators travel 1,800 feet per minute. You get on the elevator on the second lower level, which is 28 feet below the ground floor from which the height of the building is measured. The observation deck is 1,353 feet high. How many feet did you travel? And how long was your elevator ride? Time your trips. Were the times what you predicted?

E

ENVIRONMENTAL EFFORTS AT THE WILLIS TOWER

M

CHALLENGE: HELP THE ENVIRONMENT AT YOUR SCHOOL

If you don't already have a program to recycle and help cut down on waste in your school, your students can start one. Call your local town or city government and ask what programs are already in place in your community. See how your school can fit in.

Start with a brainstorm among your students. Ask them to name something they can do that corresponds to each letter of the alphabet (A is for recycling aluminum cans, B is for avoiding bottled water in favor of drinking tap water....). Make "reduce, reuse, recycle" the first thing they see in the morning—and keep it top of mind during the day. Your students can urge their friends to bring their lunch to school in reusable containers. Your art projects could involve scrap materials used in new ways. You can even have the class calculate and trade representative carbon credits for walking, riding a bike, taking a bus or driving to school. The options endless.

A source for helpful information in the Chicago area is Keep Chicago Beautiful, Inc. (KCB), which offers seminars for teachers on waste management and recycling, and programs for children and community groups. For information, call (312) 984-0448 or visit their site: <http://www.kcb.org>.



PROBLEM SOLVING BY SUBJECT AREA

PHYSICS

Given: The Willis Tower is 443m tall.

- 1) Strong winds can apply a significant enough force to tall skyscrapers to set them into a back-and-forth motion. The amplitudes of these motions are greater at the higher floors and barely observable for the lower floors. It is said that one can even observe the vibrational motion of the Willis Tower on a windy day. As the Willis Tower vibrates back and forth, it makes about 8.6 vibrations in 60 seconds. Determine the frequency and the period of vibration of the Willis Tower.
a) Frequency: 0.14 Hz.; Period: 7.0 s
- 2) Joe wants to set the world's stair climbing record and runs all the way to the roof of the tower. If Joe's average upward speed is 0.60 m/s, how long will it take Joe to climb from street level to the roof of the Willis Tower?
a) 738.3 seconds
- 3) Suppose Joe drops a feather from the top of the building. What would the feather's velocity be at a point 221 m above the ground? Neglect air resistance.
a) -66.0 m/sec
- 4) The express elevator in the tower averages a speed of 1800 ft./min in its climb to the 101st floor, 1,340 feet above ground and just two floors below The Skydeck. Assuming a total load of 1.0×10^3 kg, what average power must the lifting motor supply? Answer must be in Watts (W) and horsepower (hp). Use SI units.
a) 9×10^4 W and 120 hp
- 5) The Skydeck in the Willis Tower is on the 103rd floor. The Skydeck elevator leaves the lobby and accelerates upward with a constant acceleration of 0.80 m/s^2 until it reaches a maximum velocity of 18.2 miles/hr. Then it travels at its maximum velocity until it passes the 94th floor, 1,263 feet above the lobby. How long does the elevator take to accelerate to its maximum velocity?
a) 10.16 sec.
- 6) The Skydeck in the Willis Tower is on the 103rd floor. The Skydeck elevator leaves the lobby and accelerates upward with a constant acceleration of 0.80 m/s^2 until it reaches a maximum velocity of 18.2 miles/hr. Then it travels at its maximum velocity until it passes the 94th floor, 1,263 feet above the lobby. How high above the lobby is the elevator just as it gets to its maximum velocity?
a) 41.29 m
- 7) The Skydeck in the Willis Tower is on the 103rd floor. The Skydeck elevator leaves the lobby and accelerates upward with a constant acceleration of 0.80 m/s^2 until it reaches a maximum velocity of 18.2 miles/hr. Then it travels at its maximum velocity until it passes the 94th floor, 1,263 feet above the lobby. How many seconds after it leaves the lobby does the elevator pass the 94th floor?
a) 52.5 sec.



MIDDLE SCHOOL SCIENCE

- 1) Catherine's weight is 45 kg. She recently learned in science class that your weight depends on where you are—for example, on Earth or on the moon—because your weight is impacted by how hard gravity is pulling on your body. Catherine decides to see how her weight would change as she rides up and down in the elevator at the Willis Tower.
 - a) What do you think happened when the elevator started to go up from the ground floor to the 103rd floor?
 - b) What happened as the elevator slowed down as it reached the 103rd floor?
 - c) What happened when the elevator started going back down to the ground floor from the 103rd floor?

Have students watch [this video](#).

- 2) Weight is the force of gravity on your body, meaning weight = mass x acceleration. What would your weight be as the Willis Tower elevator reaches an acceleration of 8 m/sec?
- 3) Catherine realizes that as she is standing on the scale and as the elevator starts to drop, her body briefly stays at rest (a body at rest tends to stay at rest, while a body in motion tends to stay in motion). It almost feels as if her body is hovering lightly on the scale for a brief moment as the elevator starts to drop. She sees that as this happens, her weight on the scale drops. Why is this?

SOCIAL STUDIES

Use the information on [this site](#) and [this site](#) to build your lesson plan. Then discuss the questions below with your students.

- 1) How did the Sears, Roebuck Company help revitalize the downtown Chicago Loop area?
- 2) The construction of the Sears Tower revitalized a neighborhood characterized by abandoned rail yards, vandalized homes and building, and flophouses.
 - a) What are the potential outcomes on the neighborhood of constructing such a large tower with so many people visiting it each day?
 - b) How do you think it affected other neighborhoods in Chicago?
 - c) Why do you think the collapse of the rail industry—which was such a large part of the South Loop up until the 1960s—allowed the Sears Tower to flourish in the location?
- 3) How do you think it affected other businesses in the area? What businesses do you think were affected?
- 4) Would it be realistic in the current year to expect zoning laws to be changed for a specific company? If so, which companies do you think would be considered?
- 5) The Sears Tower stood as the world's tallest building for 24 years.
 - a) What kinds of things need to be considered before attempting to build the tallest building in the world?
 - b) What kinds of things might allow one to build the tallest building (e.g., technology, new construction materials, etc.)?
 - c) Do you think a building having the title of World's Tallest Building is important? Why or why not? What is the potential impact?



YOU AND THE VIEW

LANDMARKS TO LOCATE DURING THE DAYTIME

E FIND: CHECK OFF EACH LANDMARK AS YOU FIND IT AND CIRCLE THE DIRECTION IN WHICH YOU ARE LOOKING

M (N =North, E = East, S= South and W = West).

H

- ☐ Two parks named after presidents

N E S W

N E S W

- ☐ Another work of art by Alexander Calder

N E S W

- ☐ Two train stations

N E S W

N E S W

- ☐ A theater that's a curly ribbon of metal in Millennium Park

N E S W

- ☐ A high-altitude statue of the "Goddess of Grain"

N E S W

- ☐ Four sports arenas

N E S W

N E S W

N E S W

N E S W

- ☐ A newcomer to the skyline named after Donald Trump

N E S W

- ☐ A glass tower with a green roof

N E S W

- ☐ Four museums

N E S W

N E S W

N E S W

N E S W

- ☐ A lighthouse near Navy Pier

N E S W

- ☐ Two churches

N E S W

N E S W

- ☐ A concert venue where an airport once stood

N E S W

- ☐ Twin cylindrical buildings

N E S W

- ☐ Two buildings with unusual shapes on top (triangle, diamond, circle, etc.)

N E S W

N E S W

- ☐ Your favorite building from up high

N E S W

- ☐ A roof top swimming pool (There's more than one!)

N E S W



YOU AND THE VIEW

LANDMARKS TO LOCATE DURING THE NIGHTTIME

E FIND: CHECK OFF EACH LANDMARK AS YOU FIND IT AND CIRCLE THE DIRECTION IN WHICH YOU ARE LOOKING
(N =North, E = East, S= South and W = West)

M

H

☐ The baseball fields of University of Illinois – Chicago

N E S W

☐ A large Ferris wheel

N E S W

☐ The John Hancock Center

N E S W

☐ The Water Tower, which survived the Great Chicago Fire (hint: it's not labeled on your map but you can find it near the Hancock Center!)

N E S W

☐ The traffic cloverleaf ("spaghetti bowl") that connects Chicago's Dan Ryan and Kennedy expressways

N E S W

☐ Merchandise Mart

N E S W

☐ United Center

N E S W

☐ McCormick Place

N E S W

☐ A building with lighted, castle-like "turrets"

N E S W

☐ The building that looks like New York City's Chrysler Building (Two Prudential Plaza)

N E S W



Photo credit: © Choose Chicago

I SPY FROM THE SKY

LANDMARKS FOR YOUNGER EYES TO LOCATE

E FIND: CHECK OFF EACH LANDMARK AS YOU FIND IT AND DRAW A PICTURE OF YOUR FAVORITE ONE.

- | | |
|--|---|
| <input type="checkbox"/> Lake Michigan, which seems to stretch from here to eternity | <input type="checkbox"/> The Chicago River with boats floating up and down |
| <input type="checkbox"/> Millennium Park, with a curly metal theater | <input type="checkbox"/> Soldier Field, where the Chicago Bears play football |
| <input type="checkbox"/> The Water Tower, which survived the Great Chicago Fire | <input type="checkbox"/> Midway Airport, with planes flying in and out |
| <input type="checkbox"/> Wrigley Field, where the Chicago Cubs play baseball | <input type="checkbox"/> The Hancock Building, with its famous black steel X marks on the sides |
| <input type="checkbox"/> The Field Museum, where Sue the dinosaur rules | <input type="checkbox"/> U.S. Cellular Field, where the Chicago White Sox play baseball |
| <input type="checkbox"/> Grant Park, home to President Obama's Presidential Election Victory Party | <input type="checkbox"/> The Metropolitan Correctional Facility, tall triangle shaped jail with a basketball court on top |

Draw a picture of your favorite landmark in the space below.



INDOOR SCAVENGER HUNT

LOOK, LISTEN, AND INTERACT!

M ENJOY THE MUSEUM OF CHICAGO ON THE LOWER LEVEL BEFORE GOING UP TO THE SKYDECK.
CAN YOU ANSWER ALL OF THESE QUESTIONS ON YOUR INDOOR SCAVENGER HUNT?

1. Take a photo with the world's largest 103.
2. Who signed the football on the wall? _____
3. How many photos do you see of basketball great Michael Jordan? _____
a. Bonus: What is his jersey number? _____
4. Find at least two Tyrannosaurus Rex dinosaurs (hint: there are three total).
Where were they? _____
5. Who said, "Less is more"? _____
6. How many films have been made in Chicago? Name one. _____
7. How many images of Cloudgate, the "Bean", do you see? _____
8. How long are the artificial vines that the Lincoln Park Zoo's great apes eat? ____ ft.
9. Where is the Jin Mao Tower located? _____ How tall is it? ____ meters
10. How many Oprahs tall is the Willis Tower? _____
11. How many languages are spoken at the Skydeck on a given day? _____



Photo credit: © Skydeck Chicago/Willis Tower

COME RAIN OR SHINE!

FIELD TRIP PLANS IN INCLEMENT WEATHER

Here are three great trips for you and your students. Even if visibility at the Skydeck is down to zero, there's still plenty to do at the Nation's Tallest School.

START EVERY TRIP THIS WAY:

Focus your students on the trip by allowing them to choose (as individuals, pairs or teams) the names of Chicago landmarks. Depending on the grade and capabilities of your class, ask them to do research on the history and stats of the buildings and what the buildings are used for today. Perhaps they can build "their" buildings out of paper, cardboard, sugar cubes or found objects from nature, such as seeds, stones, twigs, etc. Get inspiration for re-creating Chicago in found natural objects by looking at photos of the Chicago Botanic Garden's Wonderland Express that operates during the holiday season: <http://www.chicagobotanic.org/wonderland/about.php>

They'll be more engaged in your trip if they have a building they "own" as you all look out on the city from the Skydeck. They can photograph "their" building from there. Once you're back in school after your trip, they can present their buildings to each other and you can re-create the city with everyone's photos.

FIELD TRIP PLANS ON A SUNNY DAY

Supplies you will need: paper, crayons or pencils, and enough copies of the "Find This Outside: Landmarks to Locate by Day" for each student or team of students (print this before you leave).

Prepare your students before your trip with a discussion about how to determine the tallest buildings in the world. Should a building be judged by the number of occupied floors? The height of the "architectural top," including spires but not communication antennas? The height to the top of the highest roof?

Or the height from the sidewalk to the highest tip (either a spire or an antenna)? These questions have been debated by the Council on Tall Buildings and Urban Habitat:

<http://www.ctbuh.org/HighRiseInfo/TallestDatabase/Criteria/tabid/446/Default.aspx>

What do your students think?

You also can do role-playing about the design and construction of the Willis Tower. Your students might use wooden blocks or plastic building bricks, or even the computer, to create their own designs.

ON THE DAY OF YOUR TRIP:

- Find the Willis Tower antennas on your way into town
- Use the map to locate the appropriate parking area and enter the Skydeck from Jackson Blvd.
- Check out the 20 foot replica of the Willis Tower, created by LEGO® architecture artist Adam Reed Tucker. He led teams of Skydeck visitors (just like you!) in building the replica out of 50,000 LEGO® bricks over two days in September 2008
- Take the elevator down to the lower level and engage with the many interactive exhibits on Chicago's sports, art, music, pop culture, architecture, attractions, and people
- Enjoy the nine minute long educational film "Reaching for the Skies" in the theater
- Ascend to the 103rd floor in the high-speed elevators while learning how your height compares to other world-famous structures along the way
- Enjoy the breathtaking panoramic views
- Dare to stand out on The Ledge, the glass boxes that extend 4.3 feet outside the building
- Create your class's custom panoramic photo
- Find the landmarks on the list or play "I Spy from the Sky"

MAKE BIG PLANS. AIM HIGH IN HOPE AND WORK.

—Daniel Burnham, architect and planner of Chicago



- Descend from the Skydeck in the elevators, timing how fast the ride is
- Exit from the Skydeck pavilion on Jackson Blvd. and turn right to go around to the front entrance of the Willis Tower (on Wacker Dr.)
- Enter and note the construction of the building, and observe and discuss Calder's "Universe"
- Return to your school and have your students share their experience with us. Email us your photos for a chance to be displayed as our Photo of the Day on the Skydeck monitors

FIELD TRIP PLANS ON A CLEAR EVENING

Supplies you will need: paper, crayons, or pencils, and enough copies of "You and the View: Landmarks to Locate at Nighttime" for each student or team of students (print this before you leave).

As you would for a daytime trip, prepare your students before your trip with a discussion about how to determine the tallest buildings in the world. Should a building be judged by the number of occupied floors? The height of the "architectural top," including spires but not communication antennas? The height to the top of the highest roof? Or the height from the sidewalk to the highest tip (either a spire or an antenna)? These questions have been debated by the Council on Tall Buildings and Urban Habitat:

<http://www.ctbuh.org/HighRiseInfo/TallestDatabase/Criteria/tabid/446/Default.aspx>

What do your students think?

You also can have your students role-play as they discuss the design and construction of the Willis Tower. Your students might use wooden blocks or plastic building bricks (or the computer) to create their own designs.

ON THE DAY OF YOUR TRIP:

- Find the Willis Tower antennas on your way into town
- Use the map to locate the appropriate parking area and enter the Skydeck from Jackson Blvd.
- Check out the 20 foot replica of the Willis Tower, created by LEGO® architecture artist Adam Reed Tucker. He led teams of Skydeck visitors (just like you!) in building the replica out of 50,000 LEGO® bricks over two days in September 2008
- Take the elevator down to the lower level and engage with the many interactive exhibits on Chicago's sports, art, music, pop culture, architecture, attractions, and people
- Enjoy the nine minute long educational film "Reaching for the Skies" in the theater
- Ascend to the 103rd floor in the high-speed elevators while learning how your height compares to other world-famous structures along the way
- Enjoy the breathtaking, panoramic nighttime views
- Dare to stand out on The Ledge, the glass boxes that extend 4.3 feet outside the building
- Create your class's custom panoramic photo
- Find the landmarks on the list or play "I Spy from the Sky"
- Descend from the Skydeck in the elevators, timing how fast the ride is
- Exit from the Skydeck pavilion on Jackson Blvd. and turn right to go around to the front entrance of the Willis Tower (on Wacker Dr.)
- Enter and note the construction of the building, and observe and discuss Calder's "Universe"
- Return to your school and have your students share their experience with us. Email us your photos for a chance to be displayed as our Photo of the Day on the Skydeck monitors



FIELD TRIP PLANS FOR A RAINY DAY/

RAINY EVENING

Supplies you will need: paper, crayons or pencils, and enough copies of the “Indoor Scavenger Hunt: Look, Listen, and Interact!” for each student or team of students (print this before you leave).

Prepare your students before your trip with a discussion about how to determine the tallest buildings in the world. Should a building be judged by the number of occupied floors? The height of the “architectural top,” including spires but not communication antennas? The height to the top of the highest roof? Or the height from the sidewalk to the highest tip (either a spire or an antenna)? These questions have been debated by the Council on Tall Buildings and Urban Habitat:

<http://www.ctbuh.org/HighRiseInfo/TallestDatabase/Criteria/tabid/446/Default.aspx>

What do your students think?

You also can have your students role-play as they discuss the design and construction of the Willis Tower. Your students might use wooden blocks or plastic building bricks (or the computer) to create their own designs.

ON THE DAY OF YOUR TRIP:

- See if you can find the Willis Tower antennas on your way into town—they may be shrouded in clouds!
- Use the map to locate the appropriate parking area and enter the Skydeck from Jackson Blvd.
- Check out the 20 foot replica of the Willis Tower, created by LEGO® architecture artist Adam Reed Tucker. He led teams of Skydeck visitors (just like you!) in building the replica out of 50,000 LEGO® bricks over two days in September 2008

- Take the elevator down to the lower level and engage with the many interactive exhibits on Chicago’s sports, art, music, pop culture, architecture, attractions, and people
- Begin the “Indoor Scavenger Hunt: Look, Listen, and Interact!”
- Enjoy the nine minute long educational film “Reaching for the Skies” in the theater
- Ascend to the 103rd floor in the high-speed elevators while learning how your height compares to other world-famous structures along the way
- See if Mother Nature will let you see the tops of the Trump Tower, John Hancock Center, and any others that may peek through the clouds
- Talk about what it would be like to be a pilot in zero visibility
- Dare to stand out on The Ledge, the glass boxes that extend 4.3 feet outside the building
- Create your class’s custom panoramic photo
- Find the landmarks on the list or play “I Spy from the Sky”
- Descend from the Skydeck in the elevators, timing how fast the ride is
- Exit from the Skydeck pavilion on Jackson Blvd. and turn right to go around to the front entrance of the Willis Tower (on Wacker Dr.)
- Enter and note the construction of the building, and observe and discuss Calder’s “Universe”
- Return to your school and have your students share their experience with us. Email us your photos for a chance to be displayed as our Photo of the Day on the Skydeck monitors



FOR MORE INFORMATION: AN ANNOTATED BIBLIOGRAPHY

The following resources are available through public libraries or online. Some also may be purchased through the Skydeck store. Please call for availability: (312) 993-3716.

BOOKS

Adams, Robert. *Buildings: How They Work*. New York: Sterling Publishing Co., Inc., 1995. Offers an overview of building through the ages and the technology that has changed where people live and work.

Bennett, David. *Skyscrapers, Form & Function*. New York: Simon & Schuster, 1995. A glossy, beautifully photographed, oversized book geared to adults and older students. Includes a 24-hour diary of life at the Sears Tower and large foldout of the building. Covers the development of skyscrapers over the years. Includes an excellent bibliography of sources for advanced students.

Curlee, Lynn. *Skyscraper*. New York: Atheneum Books for Young Readers, Simon & Shuster, 2007. Gorgeous illustrations propel the older student along. It closes with illustrations of the "Tribute of Light" marking the Twin Towers of the World Trade Center and the Freedom Tower that will stand in their place. "To build well is an act of peace," architect Kevin Roche is quoted as saying at the book's conclusion.

Doherty, Craig A., and Doherty, Katherine M. *The Sears Tower*. Woodbridge, CT: Blackbirch Press, Inc., 1995. Children's book on the history of the Sears Tower and how it was designed and built. Includes glossary, chronology, and suggestions for further reading and full library source notes.

Gibbons, Gail. *Up Goes the Skyscraper!* New York: Macmillan Publishing Co., 1986. A very simple and clear illustrated children's book about the building of a skyscraper. Key words are in boldface. Older children might like it for its clarity about the building process.

Giblin, James Cross. *The Skyscraper Book*. New York: Thomas Y. Crowell Junior Books, 1981. Book for older elementary and middle-school students on the development of skyscrapers. Offers interesting anecdotes about what inspired early developers. Includes "Fabulous Facts" about skyscrapers and architectural terms. Excellent bibliography.

Goldberg, Paul. *The Skyscraper*. New York: Alfred Knopf, 1981. An adult-reading-level book that comments on the "greatest of American building forms, the skyscraper." Compares New York and Chicago rivalry in designs and forms of skyscrapers. Abundant in photos and illustrations.

Huxtable, Ada Louise. *The Tall Building Artistically Reconsidered: The Search for a Skyscraper Style*. New York: Pantheon Books, 1982. A discussion of skyscrapers as products of art, business, and politics in the past and the future. For adults or sophisticated students.

Ingoglia, Gina. *The Big Book of Real Skyscrapers*. New York: Grosset & Dunlap, 1989. Illustrated children's book on the history, structure and building of skyscrapers. Includes an excellent glossary.

Macaulay, David. *Unbuilding*. Boston: Houghton Mifflin Co., 1980. A fantasy dismantling of the Empire State Building, revealing how it is made. With wonderful detailed illustrations.

Macaulay, David. *Building Big*. Boston: Houghton Mifflin Co., 2000. Companion to the video originally shown on PBS. Illustrated in fine detail for all ages, showing skyscrapers as a building marvel.

Masengarb, Jennifer, and Kinsner, Jean. *Schoolyards to Skylines: Teaching with Chicago's Amazing Architecture*. Chicago: Chicago Architecture Foundation: 2002. This 500-page loose-leaf-bound resource books offers a K-8 curriculum aligned to Illinois State Goals and Chicago Academic Standards and adaptable nationwide. Uses architecture as a way to teach social sciences, science, mathematics, language arts, and fine arts.



Nash, Paul. *Super Structures*. Ada, OK: Garrett Educational Corporation, 1989. A children's book that considers the Sears Tower among other tall or large world structures, such as the Great Temple of Abu Simbel, the Sydney Opera House and the Great Buddha of Nara. Photographs with short descriptions.

Peet, Creighton. *The First Book of Skyscrapers*. New York: Franklin Watts, Inc., 1964. Children's book with photos. Dated, but offers a thorough look at the basics of building a huge structure.

Pridmore, Jay. *Sears Tower, A Building Book from the Chicago Architectural Foundation*. Rohnert Park, CA: Pomegranate Communications, Inc., 2002. Devotes its 64 pages to our favorite building, calling it "the spiritual center of twentieth-century American architecture." Perfect for older students interested in the art and science of the building.

Pridmore, Jay, and Larson, George A. *Chicago Architecture and Design*. New York: Harry N. Abrams, Inc., 2005. Provides an overview of Chicago architecture for teachers and other adults. Beautiful photos.

Roza, Greg. *A Kid's Guide to Incredible Technology, The Incredible Story of Skyscrapers*. New York: PowerKids Press, 2004. Offers good basic information with lots of facts and figures and a glossary. Directs the reader to up-to-date links online.

Severance, John B. *Skyscrapers: How America Grew Up*. New York: Holiday House, 2000. Starts by noting the Great Pyramid of Cheops in Egypt could have been the first skyscraper with its height of 50 stories. Provides great storytelling about innovation in building for middle-graders.

Terranova, Antonino. *Skyscrapers*. Vercelli, Italy: Barnes & Noble Books with arrangement with White Star, 2003. Oversized, emphasizing stunning architectural photography. Provides a world tour for older students and adults.

The Learning Channel. *Super Structures of the World: Skyscrapers*. Farmington Hills, MI. Asks if Frank Lloyd Wright's idea of building a mile-high building today might not be the "futuristic folly" it was in his time. Color photos. Includes a chapter on the World Trade Center and the attacks on Sept. 11, 2001.

Wilson, Forrest. *Architecture: A Book of Projects for Young Adults*. New York: Van Nostrand Reinhold Co., 1968. Offers 33 projects for older students to build to test ways of designing and building structures. Illustrated.

Yunker, Richard. *On Site: The Construction of a High-Rise*. New York: Thomas Y. Crowell, 1980. Covers construction of tall buildings at six different Chicago sites. Photographs show roles of workers and sequence of events. Lots of detail about how teamwork produces a building.

VIDEOS ON DVD/VHS

Building Big with David Macaulay: Skyscrapers. Boston: WGBH Science Unit and Production Group, Inc., 2000. (DVD/VHS.) An engaging tour of world's tallest buildings, from Gothic cathedrals to the Eiffel Tower to the Empire State Building to Petronas Towers and more. David Macaulay, the author of *The Way Things Work*, gives this video its sparkle. Suitable for later elementary grades. Comes with an activity guide for making a paper skyscraper with two sheets of newspaper. Check out the companion book mentioned in this guide as well as this Web site with activities: <http://www.pbs.org/wgbh/buildingbig/skyscraper/>

How Do They Build Skyscrapers? Popular Mechanics for Kids, Hearst Corp. Troy, MI: Anchor Bay Entertainment, 1996. (VHS only.) A good overview of building a "baby skyscraper" of 20 stories. Features "Pop," a workman character in all of the Popular Mechanics videos talking with a preadolescent boy. Good for elementary to middle-school students. Your students' favorite sequences will be the buildings



Skyscraper. The History Channel. New York: A&E Television Networks, 2006. (DVD.) Explores the use of the following tools used to create skyscrapers: the foundation drill rig, the tower crane, the impact wrench, the power trowel and the total station. Looks at construction of Chicago's Trump International Hotel and Tower, among others.

Modern Marvels: The Sears Tower. The History Channel. New York: A&E Television Networks, 2007. (DVD.) Explores the history of the building from its conception in the late 1960s through its construction and the various changes it has seen throughout the years. Offers facts and interviews with original architects and engineers as well as current staff.

ONLINE RESOURCES

Skydeck Chicago

<http://www.theskydeck.com>

Be sure to check out our pages on [Facebook.com](https://www.facebook.com) and on Instagram, and don't forget to follow us on Twitter by going to twitter.com.

Willis Tower/Sears Tower

<http://www.som.com/content.cfm/searstower>

This page on the Web site of Skidmore, Owings & Merrill, LLP, the architecture firm that designed the Sears Tower, offers key facts, awards received, and a small image gallery.

<http://www.flickr.com/photos/tags/skydeck/>

<http://www.flickr.com/photos/tags/willistower/>

<http://www.flickr.com/photos/tags/searstower/>

Searching Flickr, a free, public photo sharing service, for images tagged with "skydeck," "willistower" or "searstower" yields thousands of photos uploaded by different users. This is a great way to view the building from many different perspectives, locations and times of day. You can also search on Pinterest in the same way, and don't forget to visit our Pinterest page at <https://www.pinterest.com/skydeckchicago/>.

http://en.wikipedia.org/wiki/Willis_Tower

The Willis Tower Wikipedia page offers a wealth of up-to-date information including history, future plans, and other tidbits on the Willis Tower.

<http://us.factory.lego.com/gallery/buildinginstructions/Sears%20Tower.aspx>

The Lego site provides step-by-step instructions on how to construct the Willis Tower using LEGO® bricks. LEGO® also makes a Sears Tower model kit as part of its Architecture series. It was designed by LEGO® Architecture artist Adam Reed Tucker who also built the 20-foot replica in the Willis Tower lobby. You can purchase it in the Skydeck stores or by visiting the Skydeck merchandise section of the Skydeck Web site at <http://www.theskydeck.com>.

<http://www.searstower.org/articles.html>

Features news clippings from throughout the building's history.

Chicago Architecture

<http://www.architecture.org>

The Chicago Architecture Foundation's Web site offers information on architectural tours around the city, lectures, exhibitions, symposiums and other programs and events. It provides dozens of links to other architecture-related sites. View sample lessons from its *Schoolyards to Skylines* teacher resource guide (covered above in the book section).

<http://www.chicagoarchitecture.info>

Provides information and photographs of roughly 1,000 buildings around Chicago. Each building's page offers a place where visitors can leave comments and rate the buildings. The site also features an interactive map populated with the location of each building in the database.

<http://www.wttw.com/main.taf?p=1,53>

WTTW's televised documentary tour of our city's magnificent lakefront is called "Chicago's Lakefront." Watch the videos by Geoffrey Baer online.



<http://www.ci.chi.il.us/Landmarks/Tours/Tours.html>

Features virtual tours of many Chicago historic landmarks including tall buildings, residential structures, parks, etc. Also offers historic image galleries of the buildings cited.

<http://www.chicagoarchitecturetoday.com/building-directory.htm>

Offers a pictorial directory of Chicago's buildings, links to articles about architecture around the city, an extensive glossary of architecture terms and more.

<http://encyclopedia.chicagohistory.org/>

Encyclopedia of Chicago, supported by the Chicago History Museum, the Newberry Library and Northwestern University, offers historical photos of Chicago and its architecture.

<http://en.wikipedia.org/wiki/ArchitectureofChicago>

Provides a brief history of architecture around Chicago as well as a timeline and links to notable buildings

Tall Buildings

<http://skyscraperpage.com/>

Features information and detailed diagrams and illustrations comparing skyscrapers and their respective cities.

<http://www.skyscrapernews.com/>

Regularly publishes news stories on tall buildings around the world.

<http://www.moma.org/interactives/exhibitions/2004/tallbuildings/>

Though the exhibit was quite a few years ago, this microsite presents relevant information on design issues that architects and engineers must take into account when designing super-tall structures.

<http://www.ctbuh.org/>

The Council on Tall Buildings and Urban Habitat maintains databases of the world's tallest buildings, including images, presentations, videos and audio. This group sets the criteria for defining and measuring tall structures.

http://en.wikipedia.org/wiki/List_of_tallest_buildings_and_structures_in_the_world Provides lists of the world's tallest structures.

<http://www.emporis.com/en/>

Provides an extensive searchable database of buildings around the world.

<http://www.GreatBuildings.com/gbc.html>

Provides a searchable database of buildings.

Software

LEGO® provides a free software program called LEGO® Digital Designer that allows you to build 3D models using virtual LEGO® bricks. It is a simple program and is easy to use. After a model is built, you can order the bricks directly from LEGO® as a kit to build in real life. You can also share your model online with other users. Find more information and a link to download here: <http://ldd.lego.com/>

Have your students try SimTower. This computer game, first created by Maxis in 1995 and now available free online (just do an online search for it) allows your students to create mixed-use tall buildings, solving many of the problems that real designers and building managers do. The program prompts designers to add features, such as a recycling program and restaurants. They also might try the somewhat more challenging Yoot Tower published by Sega in 1999. Students can choose and name their businesses. Again, search for a free download online.



MORE ABOUT YOUR TRIP

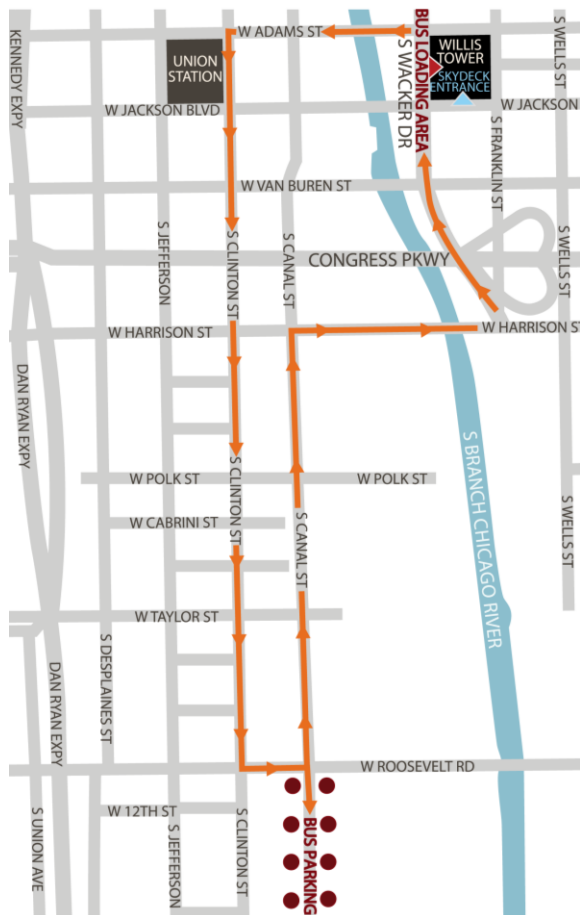
GETTING HERE

It's easy to find us at 233 South Wacker Drive in Chicago. Just visit the directions pages on our website which are tailored to the direction you are coming from. <http://www.theskydeck.com>

BUS AND AUTOMOBILE PARKING

Buses may unload and load on South Wacker Drive in front of the building, with bus parking located at 1200 S Canal Street (Roosevelt & Canal). Per City of Chicago Ordinance the driver **MUST** remain with the vehicle to use the free parking.

Self-parking for the Skydeck is at Tower Self Park, 211 West Adam Street. Please enter the garage on Adams, Franklin, or Wells. For more information, call (312) 782-5570.



ENTERING THE SKYDECK

You will enter the Skydeck pavilion off of Jackson Boulevard between South Wacker Drive and Franklin Street, where you will be directed to an elevator down to the start of your Skydeck adventure.

ACCESSIBILITY

The Willis Tower and Skydeck Chicago are fully accessible. Please use automated doors next to the revolving doors at the Skydeck entrance on Jackson Boulevard.

MEALS & SNACKS

Your group may arrange for meals on weekdays or for seating for brown bag lunches or snacks by calling (312) 875-9447. We have a lunchroom with plenty of tables and seating that is free of charge to reserve. Food is not permitted in the Skydeck areas.

NUMBERS TO KNOW

For school group reservations, call group sales during regular business hours at 1-877-SKY-DECK (759-3325) or (312) 875-9447 or email sales@theskydeck.com. Special rates are available for groups of 20 or more. You will need to present your tax-exemption certificate.

HOURS

The Skydeck is open seven days a week, 365 days a year.

From October through March, the Skydeck is open from 10 a.m. until 8 p.m., with the last ticket being sold at 7:30 p.m. From April through September, the Skydeck is open from 9 a.m. until 10 PM, with the last ticket being sold at 9:30 p.m.



FOR SCHOOL GROUP RESERVATIONS OR MORE INFORMATION:

Call: 1-877-SKY-DECK (759-3325) toll-free or (312) 875-9447

Email: sales@theskydeck.com



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