



# BURJ KHALIFA

## The world's tallest building



At 163 stories, Burj Khalifa is almost double the height of the Willis Tower! It dominates the skyline of downtown Dubai, in the United Arab Emirates. In addition to reaching unprecedented heights, the super skyscraper boasts world records for most stories, longest elevator, and more. Its footprint is designed to resemble a flower—a really big flower!

### Washing windows half-a-mile in the sky

How do you wash more than 24,000 windows? Carefully and slowly! Horizontal tracks installed on several floors hold machinery for a team of workers to move up and down, cleaning as they go. A squeegee accidentally dropped from this height could be deadly to those below. As for shining the building's spire, that's done by daredevils dangling on ropes half-a-mile in the sky.



### BEYOND THE BLUEPRINTS

**BURJ KHALIFA**

DUBAI, UNITED ARAB EMIRATES

### The Science of Super Skyscrapers

Built to withstand height and heat

Burj Khalifa broke new ground in architecture and engineering by bundling smaller structures for efficient strength. Twice the Empire State Building's height, Burj Khalifa's tubular design required less steel. A pioneering Y-shaped buttressed core halts twisting in the wind.

### REAL

ARCHITECT: ADRIAN SMITH

HEIGHT: 2,722 FEET, 163 STORIES TALL

BUILT: JANUARY 6, 2004 –  
DECEMBER 30, 2009

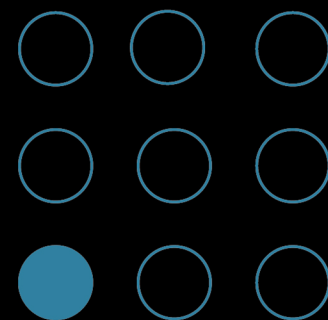
### LEGO® MODEL

DESIGN TIME: 45 HOURS

BUILD TIME: 60 HOURS

NUMBER OF LEGO BRICKS: 16,500

THIS IS THE ONLY MODEL WHERE  
ADAM HAS USED A MATHEMATICAL  
EXPRESSION TO VISUALIZE THE DESIGN.



# ONE WORLD TRADE CENTER

## Rebuilding and reaching for the sky



One World Trade Center opened on November 3, 2014, as the tallest building in the Western Hemisphere. Through its design, the building's architects and engineers sought to pay homage to the original World Trade Center, to convey resilience and to inspire hope.

### Navigating Wind, Water ... and a Railway

Sturdy and stoic

One World Trade Center pushes concrete, steel and glass to their limits. One of the sturdiest buildings ever constructed, the first 20 stories are windowless concrete. Underground, the foundation wends around train tunnels, and slurry walls prevent seepage from the Hudson River.



# GATEWAY ARCH

## Threshold to America's West



St. Louis, Missouri's Gateway Arch is the nation's tallest memorial; the world's tallest stainless steel monument; and part of the Jefferson National Expansion Memorial, which includes a museum, courthouse and park. Plans for the Arch began in the early 1930s. Work started in 1963, and the Arch was completed in 1965.

### Putting the Arch in Architecture

Complex engineering, streamlined design

Gateway Arch's catenary curve is an upside down version of the shape a chain makes when suspended from both ends. For sturdiness, the Arch's foundation is buried 20 feet into bedrock; legs are reinforced with double walls; and a stainless steel skin is filled with concrete.



# INTERNATIONAL SPACE STATION

## A home away from home



The International Space Station is a cutting-edge laboratory that's orbiting Earth. Now that's an engineering challenge! Aboard ISS, science, technology and human innovation are practiced in a way physically impossible on Earth. An international crew lives and works on ISS while orbiting Earth at the speed of 17,500 miles per hour.

### Some Assembly Required

Navigating spatial relationships in space

The ISS is modular, like LEGO®. The first piece, Russia's Zarya Control Module, was launched in 1998. A primary challenge of outer space construction is material delivery. Rockets can only be launched in a window of minutes each day to reach the orbiting destination at the right time.



# PING AN FINANCE CENTRE

## A tribute to growth



Photo credit: 见圳城长/weibo.com

Soaring above Shenzhen, this new super-skyscraper will be China's tallest. In just 35 years, the city's population has skyrocketed from 300,000 residents to more than 10 million, and the 115-story building will be a towering reflection of Shenzhen's rise.



BEYOND THE  
BLUEPRINTS

Photo credit: Ches Pope/flickr.com

### Designed for Peace and Safety

Engineering with efficiency in mind

Building aesthetics serve practical purposes, too. The sleek stainless steel façade resists salt corrosion. Columns provide visual interest and wind resistance. Located downtown, this transit-integrated building is a key to swift rail access within Shenzhen and throughout the heavily populated Pearl River Delta.

### Short Stories

Each Ping An floor is expected to take just four days to finish! Ping An's little sister, a 47-story building to the south that will be connected to the taller skyscraper at several levels, is slated for completion in 2018.

PING AN FINANCE CENTRE - SHENZHEN, GUANGDONG PROVINCE, CHINA

#### REAL

ARCHITECT: KOHN PEDERSEN FOX ASSOCIATES

HEIGHT: 1,065 FEET

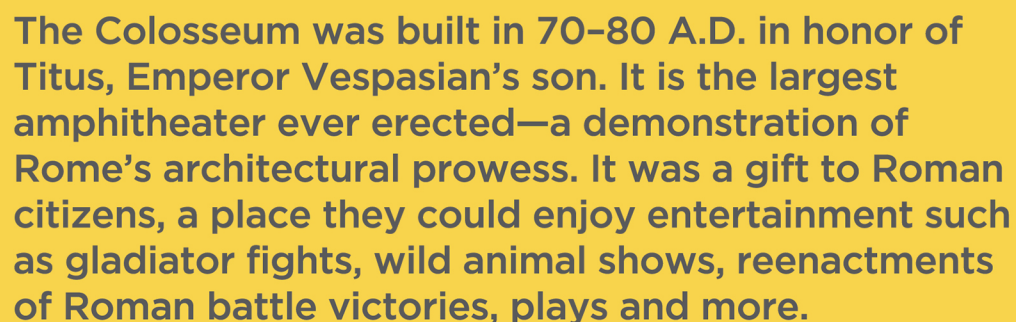
BUILT: 2010 - 2016

#### LEGO® MODEL

DESIGN TIME: 25 HOURS

BUILD TIME: 60 HOURS

NUMBER OF LEGO BRICKS: 20,250



In ancient Rome, the highest class had the lowest seats, closer to the center of the action. The emperor and his special guests lounged in VIP boxes. Like today's fans, most Roman plebeians enjoyed the action from the nosebleed seats.

# BEYOND THE BLUEPRINTS



Easy in, easy out

The Colosseum is an early example of function driving form. Eighty entrances, called vomitoria, were installed so people could evacuate quickly in an emergency. The emperor, of course, had his own entrance. Another functional feature was the underground hypogeum, a hub of passageways for human and animal performers.

REAL

LENGTH: 679 FEET

WIDTH: 512 FEET

HEIGHT: 160 FEET

BUILT: 70 - 80 A.D.

## LEGO® MODEL

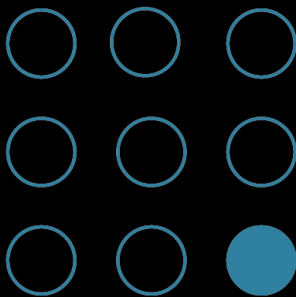
DESIGN TIME: 120 HOURS

BUILD TIME: 75 HOURS

NUMBER OF LEGO BRICKS: 22,500

TO GET THE OVAL SHAPE JUST RIGHT, THE STRUCTURE WAS REDESIGNED OVER A DOZEN TIMES.





# AMERICAN EAGLE ROLLER COASTER

## World-class wood



Photo credit: Six Flags Great America

When the American Eagle roller coaster opened at Six Flags Great America in 1981, it was the world's tallest wooden coaster. It had the longest drop and record-breaking speeds. It's still respected as one of the country's best wooden coasters.

### Designing Thrills

Where engineering and physics come to play

Speed, mass, gravity, friction, centrifugal and centripetal forces, and other scientific principles guide engineers in the design of roller coasters. It's how they determine the height of the drops, type of loops, rider position (standing, sitting, hanging upside-down) and other fun factors.

### AMERICAN EAGLE ROLLER COASTER - GURNEE, IL, USA

### American Eagle by the Numbers

Construction of this great coaster took more than 20,000 hours, 9,000 gallons of paint and more than a million feet of lumber.

### BEYOND THE BLUEPRINTS



Photo credit: Six Flags Great America

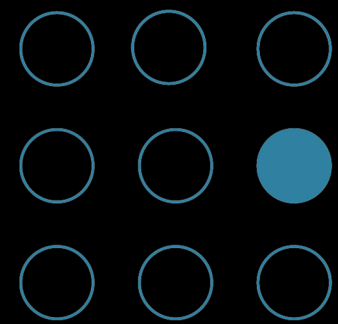
#### REAL

ARCHITECT: INTAMIN AMUSEMENT RIDES  
DISTANCE: 9,300 FEET OF TRACK  
BUILT: 1981  
THE FIRST DROP IS 147 FEET AS THE TRACK DIVES BELOW GROUND LEVEL

#### LEGO® MODEL

DESIGN TIME: 55 HOURS  
BUILD TIME: 70 HOURS  
NUMBER OF LEGO BRICKS: 14,500  
PART OF ADAM'S RESEARCH INCLUDED WALKING UP TO THE TOP OF THE COASTER'S LIFT HILL.





# PALACE OF FINE ARTS

A fair to remember...

Museum of Science and Industry

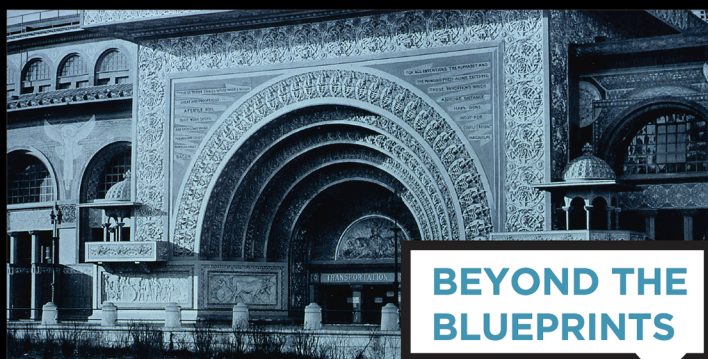


The 1893 World's Columbian Exposition played a pivotal role in Chicago's architectural story. Of the more than 200 Exposition buildings which comprised the expansive "White City" fairgrounds, only one—the Palace of Fine Arts—survived. Since 1933, it has been home to the world-famous Museum of Science and Industry.

## The White City: Form OVER Function

Bold scale. Fleeting beauty.

The memory of the Great Chicago Fire frightened contributors sending priceless artworks. To assuage them, the Palace of Fine Arts was built with a fireproof brick substructure. After the Fair closed, most of the buildings were destroyed by fire, but the Palace of Fine Arts survived.



## BEYOND THE BLUEPRINTS

## Bold designs of the Columbian Exposition

Most of the Columbian Exposition buildings were painted white and reflected a neoclassical style. Louis Sullivan's modern Transportation Building was a notable exception, featuring an unforgettable golden door. The Fair's Manufactures and Liberal Arts building was, at the time, the largest building the world.

## PALACE OF FINE ARTS - CHICAGO, IL, USA

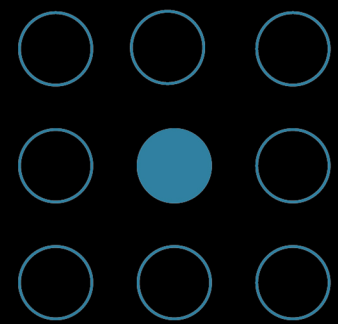
### REAL

ARCHITECT: CHARLES ATWOOD  
BUILT: 1893  
LENGTH: 500 FEET  
WIDTH: 320 FEET  
CENTRAL ROTUNDA HEIGHT: 125 FEET

### LEGO® MODEL

DESIGN TIME: 41 HOURS  
BUILD TIME: 187 HOURS  
NUMBER OF LEGO BRICKS: 18,500  
THIS IS THE FIRST TIME ADAM HAS USED ONLY WHITE BRICKS IN A MODEL.





# CINDERELLA'S CASTLE

Dreams do come true!

Walt Disney World®



Photo credit: The Walt Disney Archives

This enchanted residence is the theme park's most-recognized icon. It was designed by Herbert Dickens Ryman, a Disney artist and close friend of Walt Disney. His inspiration for Cinderella's Castle came from eight architectural masterpieces—châteaux, fortresses, churches and real castles—from all over Europe.

## A Feat of Imagineering

Brawn beneath beauty

As Cinderella knows, looks can be deceiving. Her castle appears to be brick, but most of the exterior is gypsum plaster. Steel-framed construction and a 10-inch-thick concrete wall lie beneath the ornate façade. Central Florida is home to hurricanes, so the princess's residence can withstand 100 mph winds.

## Tall tales

Forced perspective makes Cinderella's Castle look bigger than it is. Upper-level windows and bricks are smaller than those on the lower levels so they appear further up and away.

## BEYOND THE BLUEPRINTS

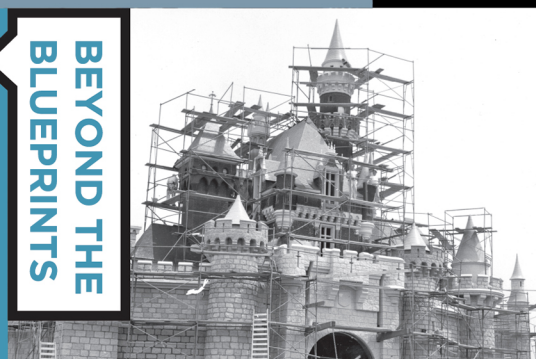


Photo credit: The Walt Disney Archives

## CINDERELLA'S CASTLE, FANTASYLAND, USA

### REAL

ARCHITECT: WALT DISNEY IMAGINEERING  
BUILT: 1970 - 1971  
HEIGHT: 189 FEET

### LEGO® MODEL

DESIGN TIME: 145 HOURS  
BUILD TIME: 230 HOURS  
NUMBER OF LEGO BRICKS: 36,000  
ALMOST EVERY LEGO® BUILDING TECHNIQUE IN ADAM'S REPERTOIRE HAS BEEN USED IN THE CASTLE.

# GOLDEN GATE BRIDGE

Engineered to brave the elements



After the 1849 California Gold Rush, forecasters predicted Marin County would become hot property if the San Francisco Bay could easily be crossed. The Golden Gate Bridge opened in 1937, then the longest suspension bridge in the world.

## Mastering Suspension

A bridge to withstand wind and earthquakes  
Thought to be impossible to build, each of the bridge's cables comprises hundreds of wires, anchored for support. A deck truss prevents too much sway, but cables can move up to 27 feet to accommodate winds.

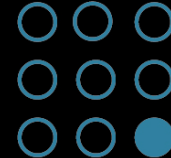


Courtesy of Golden Gate Bridge, Highway and Transportation District

BEYOND THE  
BLUEPRINTS

## Serious About Safety

Chief Engineer Joseph Strauss was an early hard hat advocate, and the Golden Gate Bridge was the first construction site to mandate their use. He also debuted the first safety net: it ran beneath the length of the bridge's primary cable, 10 feet wide at each end. At the time, it was the largest and most expensive safety feature ever used on a construction site. Ultimately, this net saved the lives of 19 workers, who became known as the "Halfway-to-Hell Club."



## GOLDEN GATE BRIDGE - SAN FRANCISCO, CALIFORNIA, USA

### REAL

ARCHITECTS: JOSEPH STRAUSS, IRVING MORROW  
AND CHARLES ELLIS

LENGTH: 4,200 FEET

BUILT: JANUARY 5, 1933 - APRIL 19, 1937

### LEGO® MODEL

DESIGN TIME: 215 HOURS

BUILD TIME: 260 HOURS

NUMBER OF LEGO BRICKS: 64,500

AT 60 FEET, THIS MODEL IS SO LONG IT  
COULD NOT BE FULLY ASSEMBLED UNTIL  
IT ARRIVED AT MSI.



## ONE WORLD TRADE CENTER - NEW YORK, NY, USA

### REAL

ARCHITECT: DAVID CHILDS

BUILT: APRIL 2006 - JULY 2013

SIZE: 1,776 FEET, A TRIBUTE TO THE YEAR THE DECLARATION OF INDEPENDENCE WAS SIGNED.

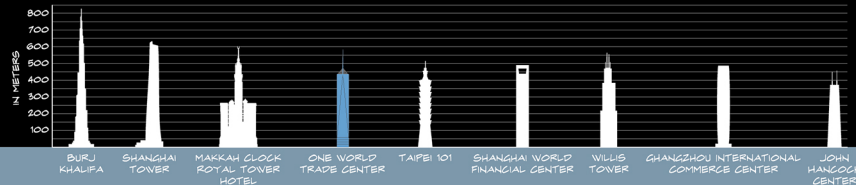
### LEGO® MODEL

DESIGN TIME: 15 HOURS

BUILD TIME: 45 HOURS

NUMBER OF LEGO BRICKS: 25,500

THIS MODEL IS COMPLETELY HOLLOW, WITH NO INTERNAL STRUCTURE OR INTERIOR SUPPORTS.



### Securing Scaffolding, Stairwells and More

Safety features are abundant in One World Trade Center. During construction, a four-story scaffolding cage kept workers, tools and materials from falling. It was the first structure of its kind ever used in New York City. Inside the building, stairwells are pressurized to keep out smoke in the event of a fire, and emergency personnel have specially designated stairwells for swift access.

### BEYOND THE BLUEPRINTS

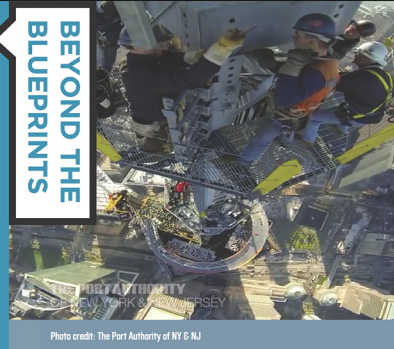


Photo credit: The Port Authority of NY & NJ

## GATEWAY ARCH - ST. LOUIS, MO, USA

### REAL

ARCHITECT: EERO SAARINEN

WIDTH AND HEIGHT: EQUAL AT 630 FEET

BUILT: FEBRUARY 12, 1963 - OCTOBER 28, 1965

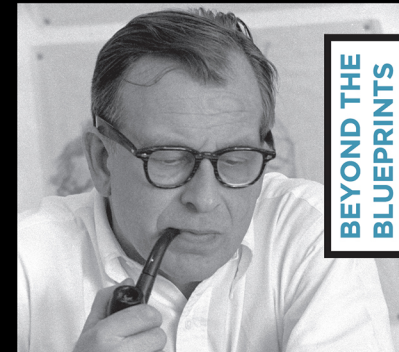
### LEGO® MODEL

DESIGN TIME: 25 HOURS

BUILD TIME: 30 HOURS

NUMBER OF LEGO BRICKS: 7,500

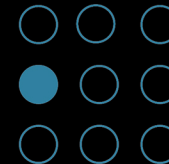
THE MODEL IS SELF-SUPPORTING, EVEN WITHOUT THE TOP SECTIONS IN PLACE.



### BEYOND THE BLUEPRINTS

#### Designer Genes

Gateway Arch's architect Eero Saarinen was selected through an anonymous competition. He and his father Eliel Saarinen submitted separate entries. Eliel was incorrectly informed he was a finalist, and the family celebrated with champagne. A few hours later, when the mistake was corrected and the family was told Eero's design would advance, the elder Saarinen broke open a second bottle of champagne to toast his son.





## INTERNATIONAL SPACE STATION - ORBITING BETWEEN 247 AND 265 MILES ABOVE EARTH

### REAL

LENGTH: 239 FEET

WIDTH: 356 FEET

SPEED: 17,500 MPH

ORBIT: 1998 - PRESENT

### LEGO® MODEL

DESIGN TIME: 30 HOURS

BUILD TIME: 25 HOURS

NUMBER OF LEGO BRICKS: 2,500

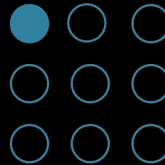
THE SOLAR PANELS WERE CREATED FROM GOLD BARS CULLED FROM HARRY POTTER LEGO® SETS.

### Nations united by science

ISS is an engineering marvel and more. It's a one-of-a-kind research platform, enabling studies that can take place nowhere else. Some examples: determining microgravity's long-term effect on the human body and gathering Earth data from a unique vantage point. The space station is a testament to international cooperation - sixty-eight countries have been involved in ISS research.



BEYOND THE  
BLUEPRINTS





Designing buildings that resist the wind.

In blustery places, architects and engineers find ways to defy the wind. They test their structural designs in a wind tunnel like this one. Using scale models, they can predict and plan for a strong building that's kind to its occupants and its neighbors.

## wild wind



## beat the wind

Build a wind resistant structure.

- STEP 1: THINK ABOUT SHAPES AND SIZES TO CONSTRUCT A STRUCTURE THAT CAN WITHSTAND THE FORCE OF WIND.
- STEP 2: CREATE YOUR STRUCTURE AND CLOSE THE DOORS.
- STEP 3: PRESS BUTTON TO START THE FLOW OF WIND.
- STEP 4: ASSESS YOUR STRUCTURE'S OUTCOME AND TRY AGAIN.

WHAT TO DO



## wild wind

Designing buildings that resist the wind.

In blustery places, architects and engineers find ways to defy the wind. They test their structural designs in a wind tunnel like this one. Using scale models, they can predict and plan for a strong building that's kind to its occupants and its neighbors.

