



# Engineering the Panama Canal

An Online Continuing Education Course for Engineers

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## Introduction

Life without engineers would be unimaginable; some may conclude it unlivable. Since the Babylonians constructed the first tower destroyed by the almighty, man has quested to impress the heavens and tame the world around them. Nothing so great embodies this quest since the Egyptians constructed the pyramids, like the Panama Canal.

How is the construction of the Panama Canal relevant today? The canal first opened in 1914. It has been in continuous operations for over 100 years. In a world of “replace it when it breaks,” the price tag it would require to build the Panama Canal today would be well over ten billion dollars. The lives lost building the gateway from the Atlantic to the Pacific would not be tolerated in the world today, with approximately 26,000 known lives lost; some historians say closer to 30,000.

Over 14,000 ships pass through the canal annually, with an average speed of about 5 knots; it would take 22 days to sail around South America. In stark contrast, it takes just around 8 to 10 hours to cross the Panama Canal. This time saving reduces carbon emissions from saved fuel. It also provides a means of commerce from the East to the West and is an economic money generator. Over 160 countries use this route as a primary shipping lane for goods and services.

Captain John Constantine piloted the SS Ancon, an American cargo and passenger ship, to become the first ship to officially transit the Panama Canal in 1914. Since that time, the canal aided the United States in becoming a world economic power.

Engineers will benefit from the rich history of this project, learn how to overcome obstacles, and see how engineers solve the world’s problems. The NASA space program of the 1970s spurred innovation and creation through engineering accomplishments; so too did the Panama Canal. Let’s walk through this journey together and learn critical thinking both as an engineer and a problem solver, and recount history as it unfolded.

*“Eliminate the impossible; whatever remains, however improbable, must be the truth?” Sherlock Holmes Quote – The Sign of Four, Sir Arthur Conan Doyle, February 1890 edition of Lippincott's Monthly Magazine*

## The Panama Canal

The Panama Canal is arguably one of the greatest feats of engineering in modern-day, even at over 118 years old. The total shipping distance is approximately 51 miles (82km) long. Ships pass through the entire distance in a range of 8-10 hours.

There are two pairs of locks on each side of the Panama Isthmus that raise marine vessels by gravity-fed locks about 85 feet (26m) above sea level. This water elevator for ships currently allows about 14,000 ships a year to pass through the system. Each set of three locks moves ships through the lock system with the use of rail cars located on each side that essentially tow the ships through the lock portion. Captains-pilots must relinquish temporary control of their ship to qualified pilots from the Panama Canal Authority in order to navigate through the system.

The largest ship in dimension and container cargo capacity ever to pass through the Panama Canal was the Neopanamax container ship Triton, built-in 2015. It boasts a TEU capacity of 14,424, a 20-row beam of 51.2 meters (168 feet), and 369 meters (1,211 feet) in length. A TEU or Twenty-foot Equivalent Unit is an exact unit of measurement used to determine cargo capacity for container ships and terminals. This measurement is derived from the dimensions of a 20ft standardized shipping container.

The enclosed map provides a layout and cross-sectional profile of the entire length of the canal. Without the locks, the canal would have taken an additional 5-10 years to build, and excavation would have had to remove another 85 feet in depth and a 700-foot-wide swath of material about forty miles in length. This would have been an additional 465.5 million cubic yards of spoils. This would have been in addition to the 268 million cubic yards the original canal with locks had removed. In contrast, the Suez Canal excavated approximately 20 million cubic yards of spoils.



Courtesy of Creative Commons, CC-BY-SA, Public Use Map

## Why Build the Panama Canal?

The Panama Canal was originally constructed to shorten the distance, cost, and time it took for ships to carry cargo between the Atlantic and the Pacific Oceans. Before the canal, ships would have to sail around the entire continent of South America, adding 22 days to the journey.

As with all government-backed endeavors, there were other benefits. The shortened travel time allowed the United States to deploy warships and supplies to almost anywhere in the world with speed. This allowed the United States to stretch its military might during both WWI and significantly more in WWII.



*Courtesy of US National Archives, Public Domain*

There is no doubt the canal still provides the US economy with a continuous commerce supply line. About 10% of all US cargo ships travel through the canal annually. Even with the increase in air commerce, the canal still provides economic advantages for goods to ship into and out of the canal.

In addition, like any advantage to commerce, the Panama Canal is a revenue generator for Panama. The canal charges an average freight of \$220,000 US dollars to use the lock and dam system. With approximately 14,000 ships passing through the gates annually, this equates to a net income of over \$3,000,000,000. Ships pay a toll, depending on the amount of cargo and ship size. This may sound pricey, but the fuel to sail 22 days around South America would burn up about 1,320,000 gallons of fuel. If you figure \$5/gallon average worldwide, this additional cost is roughly \$6,600,000 US dollars. Based on the alternative, freight shippers are more than happy to pay the toll.

Even though the canal, due to modern innovation, was a new way of transporting goods, a surge in air travel reduced dependence on the canal. There is no doubt it remains a powerful incentive for transporting goods from the Pacific to the Atlantic and back again.

Perhaps the least discussed the modernization of the Panama Canal is its contributions to “Green Energy” before green energy was even a forethought on any progressive liberal's mind. The canal boasted 1022 hydroelectric motors, generating 28,290 horsepower (approximately 22 megawatts). Green power from its hydroelectric dams, combined with the fuel savings of sailing around South America’s tip for thousands of ships annually, has had a huge impact on lowering emissions over the century.

The canal was built to expand commerce, increase security around the globe, provide economic revenue, and power both the dam and the surrounding communities. These same objectives have not changed in over one hundred years. As long as there is a world, the Panama Canal will remain a force and one of the greatest engineering accomplishments in the modern day.

The only threat to its existence currently is a Chinese backed plan to build the original route through Nicaragua. That route will be discussed later in this training module.

