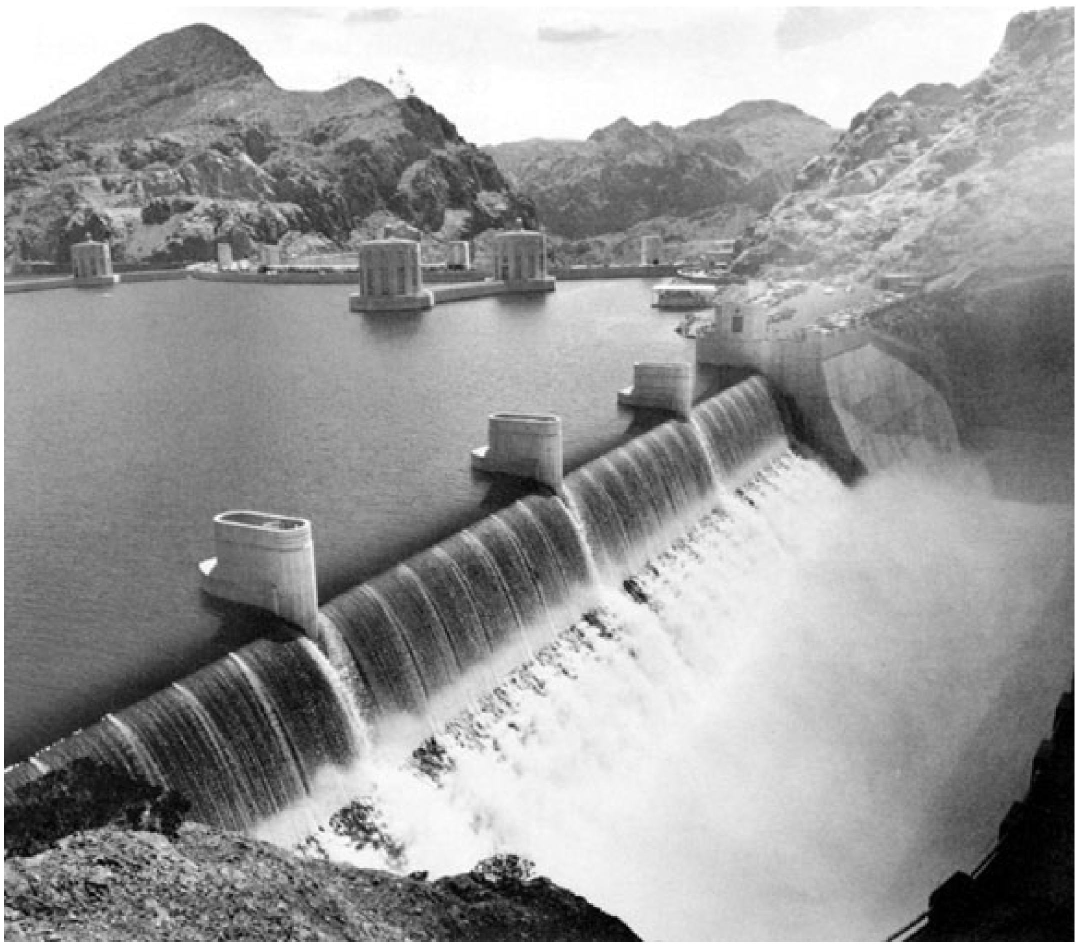
The Effects of Fluid Mechanics in Our Culture



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"THE FINAL VICTORY"

"THE people are full of rejoicing. The war for the Union has been their way, fought in their interest, sustained by their patriotism-a patriotism that has withheld neither property nor life.-let the people rejoice, then, in the final triumph, with a consciousness of their own strength, but especially with a conviction of the righteousness of their victory and a sense of overwhelming gratitude to the God of Battles. Their Hail Columbia is fitly accompanied by their Te Duems."

This is an excerpt from the April 22, 1865 issue of the Harper's Weekly newspaper. "The Final Victory" is referring the Union's victory over the Confederates in the Civil War. The Civil War was the deadliest war in American history, with an estimated toll of over 618,000 deaths. The astounding statistic is that only 213,000 of these deaths occurred on the battlefield. The remainder was caused by a much deadlier enemy. Two-thirds of the soldiers in the Civil War died from dysentery, malaria, small pox, pneumonia, and measles. The largest contributor to these diseases was the lack of sanitary water. Due to the absence of sanitation and waste facilities during the war, soldiers' waste water usually ended up in their "fresh" water supply, causing harmful infections and deadly diseases. Since then, America has developed highly efficient water supply systems that can offer clean, safe drinking water on tap to every home. We have developed systems to pump, screen, store, and treat ground and surface water for our use. These systems have given Americans a standard of living which revolves around the concept of fluid mechanics.

As with many other life forms, humans need clean water to survive. The application of fluid mechanics plays a major role in our culture because it provides us with purified water to supply our everyday needs. We began utilizing fluid mechanics in our favor early in our civilization through wells. Wells have been in existence for so long that they've been cited in early writings, such as the Christian Bible. They are made by constructing holes deep enough to reach ground water in the water table. Ground water is naturally stored below the earth's surface through rain and snow fall that has seeped through soil and is naturally filtered. The continuous collection of this water forms a level known as the water table. As we've learned from the study of piezometers in fluid statics, the height of fluid in a column is directly proportional to the pressure of the surrounding fluid to which it is attached. Naturally, water table levels fluctuate with the amount of precipitation in the area, causing water levels in the well to follow. This simple concept is what powers the benefits of the well. There are three types of wells: dug wells, driven wells, and drilled wells. Dug wells were used in early civilizations and had diameters large enough only to conform to muscle-powered digging. They were difficult to dig using only shovels, so they only ranged from 10 to 30 feet in depth. Being so shallow, dug wells were easily contaminated. These wells were usually lined with stone or brick to prevent collapse. In America, early dug wells usually had the beloved design of the tilted roof to prevent external contamination and a pulley with a rope tie to a bucket to obtain water. They are very rarely used for their purpose in today's society and now serve a decorative design to older homes.

Driven wells are most common in rural areas. They're attached to an end that can be driven into the ground, reaching a depth of about 50 feet to pass the water table. Although they are deeper than dug wells, they are still relatively shallow and possess a moderate risk of contamination. Drilled wells are the most modern form of wells. They are drilled by heavy machinery, which can reach depths between 100 to 400 feet, penetrating bedrock to reach a water source. These wells are typically cased with steel or PVC with the addition of a "surface seal" to prevent contamination. They can be used for water, oil, or other natural resources needed in large supply. Although wells provide a relatively reliable supply of fresh water, they simply could not meet the demand of the growing population; this is where pumps came into play.

In our knowledge of fluid mechanics, we know that a fluid will move freely from areas of high pressure to areas of a lower pressure. Pumps add energy to a system by creating this difference in pressure. Early pumps were manual and hand driven. They were typically attached to a well or well-like structure which was tapped in the water table. The pumping motion then drew the water up to ground level, creating a flow. Classic pumps such as these are remembered in the story of Helen Keller, when water from a pump broke the communication barrier for the famous deafblind American author. More innovative applications of pumps in American history came with the development of the water-pumping windmill, or windpump. The windpump furthered the concept of the pump by expanding it to a larger scale. The large wind turbine was attached to a crankshaft that converted rotary motion to a pumping motion, which drew water from the water table. This invention was a major factor in providing farmers and ranchers with water to utilize lands in America which were naturally arid. In addition, they supplied steam locomotives with

water to operate across the country, therefore playing a major role in the development of the rail transport system of the U.S. Windpumps still stand in America only as an unused remembrance of early technology; however, windmills are still constructed in remote areas of western America as a source of electric energy. In fact, the construction and restoration of windmills are on a rise due to the rise energy prices and cost of repairing and replacing electric pumps. Today, most water is not pure enough to simply pump it from the ground and put it to use. Due to over population in certain areas, depletion of natural resources, and many other factors, raw water is usually contaminated and unsafe for human consumption if it is not treated. Consequently, we have to resort to alternative means to obtain and purify groundwater for our use.

The process in which we obtain safe water today is through water purification and complex piping systems. About 90 percent of Americans get their water from public drinking systems. Public drinking systems basically consist of three steps: purification, storage, and delivery. Water is purified through a series of events which removes aggregates and bacteria from the supply. It is first pumped from an aquifer and screened for large debris. Water is then stored for a number of days in a reservoir to allow natural biological purification to occur. Over the next few days, it will go through a series of filtration and disinfection processes to ensure the quality is acceptable. After purification, water is sent to a storage tower, which is constructed higher above ground than the houses it serves. These towers are usually large enough to supply a community's water needs. There is also a chlorination device attached to ensure contamination does not occur during storage. This tank is designed to use the principles of fluid mechanics to provide delivery. Since the tanks are significantly high from ground level, the water inside creates hydrostatic pressure. It is the same concept of well usage, but the results are much greater due to the higher elevation. The pressure in a storage tank is so high, that water is delivered nearly instantly to a household when the pressure is released (i.e. a faucet is opened). These are the designs behind our luxury of running water, sanitation, and a vindicated water supply.

These applications of fluid mechanics have provided us with a constantly progressing method of delivering clean, safe water to our households, industries, and other special needs. We have used these principles to derive more efficient systems of delivery each time the demand increases. We've improved from dangerous contamination, to simple wells, then to pumps as our first source of flow, to our complex, highly efficient systems we use today. Although these are remarkable and relevant applications of fluid mechanics, they are only a small portion of the numerous functions. We use fluid mechanics in construction, aircraft design, boat and ship design, oil manufacturing and delivery, vehicle design, and many more aspects of world culture. With advanced study, fluid mechanics can also provide an understanding for extremely complex systems, which cannot be analyzed using only an equation. An introductory knowledge of fluid mechanics will help you understand the basis of your everyday livelihood.

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