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Terminal of the Future

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INTRODUCTION

At the turn of the 20th century, there were just over 8,000 automobiles in the United States. By 1910 that number had grown to nearly 500,000. Today there are over 285 million motor vehicles on the road.

The transition from the horse-drawn carriage to the automobile is an amazing story that didn't just happen overnight. By many accounts, it took over fifty years for Americans to replace their trusted horses with the new and unfamiliar technology. Horses had been mankind's dependable transportation for thousands of years, and many Americans believed that automobiles were unsafe.

But our country's cities were growing, and city planners envisioned a horseless future. Horses required vast amounts of feed, an overnight stable, and then there was the problem of disposing of their copious waste. Automobiles, by comparison, could be fueled with an easily stored liquid energy product called gasoline, could be parked on the street overnight, and their waste products wafted away harmlessly into the air. True, gasoline was poisonous, could be explosive if stored incorrectly, and little was known at the time about pollution; but in spite of these drawbacks, the automobile seemed an attractive alternative to managing millions of pounds of horse manure each day.

The invention of the gasoline-engine automobile is attributed to German Karl Benz, who in 1888 developed the three-wheeled Benz Patent Motorwagen. In 1893, American Charles Duryea began manufacturing standard four-wheeled automobiles that he called the Horseless Carriage. To permanently put the horse out to pasture though, the automobile had to be safe and practical; it had to be something that appealed to Americans and that they could afford to own. Anticipating this need, Henry Ford designed and built the Model T in Detroit Michigan. The first Model T rolled off the Ford assembly line on October 1, 1908, and the world was forever changed.

HAY TO GASOLINE – THE CHANGING ENERGY MARKET-PLACE

By the 1920s, horses were a rare sight on the streets of America's cities, and automobiles had become commonplace. So, too, the gasoline to fuel these automobiles needed to become as ubiquitous as hay. In comparison to hay, however, gasoline was much more difficult to produce and bring to market.

Gasoline had been around since 1859 when Edwin Drake built the first refinery to distill kerosene from Pennsylvania crude oil. Until the advent of the automobile, gasoline was considered a waste product with no practical use. With automobile sales booming in the 1920s, demand for gasoline increased and new refineries sprang up around the country. Almost one hundred years later, in 2019, there were 135 refineries in the United States producing 389.5 million gallons of gasoline each day.

Refining gasoline from crude oil was only the first step. Gasoline also needed to be safely transported from the refineries to the Americans who wanted to drive their new cars. To accomplish this feat, a network of pipelines to transport, bulk terminals to store, and gasoline stations to dispense needed to be constructed.

The first gasoline station in the United States was opened in 1905 near St Louis, Missouri. Before filling stations existed, gasoline was sold at pharmacies, blacksmith shops, and hardware and general stores. In 1920 there were about 15,000 gasoline stations in the United States, today there are over 150,000 gasoline stations and around 1,300 gasoline bulk storage terminals across the country.

Photo courtesy of iStock/steinphoto
With Long Beach, California in the background, aerial view of oil and gasoline storage and refinery.

BOOMS AND BUSTS

During the latter half of the 20th century, the economy of the United States became increasingly dependent on the free flow of petroleum. This dependence manifested for a number of reasons, but the primary reason is that most Americans thought of automobiles as a necessity to maintaining their standard of living. It should come as no surprise then that America consumes more gasoline per capita than does any other country in the world.

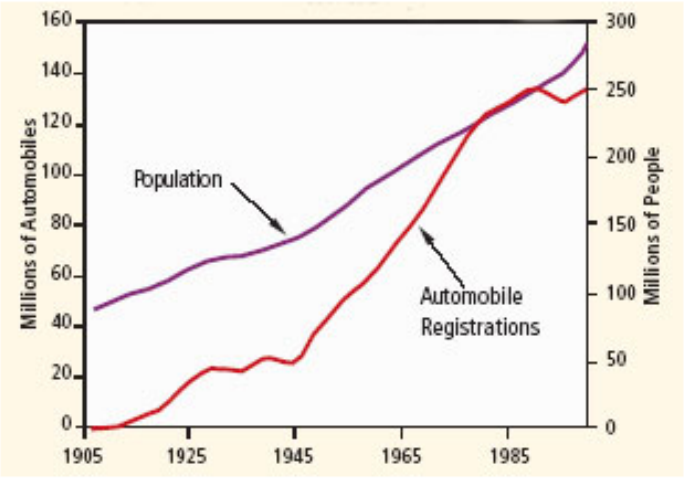

Figure 1 courtesy of FHWA.dot.gov
Automobile registrations increase through time, eventually matching the population growth trend in the early 1980s.

America's thirst for gasoline is an economic reality. In general, the relationship between supply and demand governs pricing in commodity markets in all of the world's economies. In a very simplified sense, the rule is that if demand for something is high and supply is short, the marketplace will quickly push prices higher until an equilibrium is attained. This balancing act between supply and demand is referred to as "elasticity". Interestingly, crude oil and its products do not follow this economic principle – in fact, crude oil and its products are considered somewhat "inelastic" commodities. Even though prices may change over time, inelastic commodities don't often reach an equilibrium point between supply and demand. This is true for several reasons, most notably because supply (crude oil production, refining, transportation, and storage) cannot adapt rapidly to major shifts in demand. In the oil business, the seemingly constant surging of supply and demand, and the corresponding wild swings in prices for raw materials and commodities leads to the booms and busts with which the world has become so familiar.

Typically, the oil boom and bust cycle starts when there is abundant crude available for refining into products like gasoline. A steady, reliable supply of crude oil keeps prices low. Low crude oil prices translate into low gasoline prices; and when gasoline prices are low, Americans hit the road. More driving results in an increase in demand for gasoline and a corresponding increase in prices. When prices are high, oil companies have more cash to invest in crude oil production to meet the expected future demand. Unfortunately, when prices get too high motorists reduce consumption, and gasoline demand declines. When demand drops off sharply, prices slump. If prices slump for long enough, crude oil production is cut back.

Photo courtesy of iStock/MicroStockHub

This cycle has repeated

itself numerous times over the decades. From 2010 to 2014 an oil boom resulted in historically high crude prices over $100 per barrel. A bust followed in 2014-2015 when, among other things, U.S. oil production caused a glut in the supply of crude oil.

Because driving their cars is so important to them, Americans expect their leaders to keep gasoline affordable and plentiful. Those drivers who are old enough to remember it learned a painful lesson during the Arab oil embargo in 1973 when prices skyrocketed and filling stations ran dry. In 2008, motorists did not flinch at price increases until soaring crude prices pushed gasoline prices above $4.00 per gallon.

Oil busts can be caused by either an oversupply of crude oil, a decrease in demand for gasoline, or both. In 2020, the same crude oil supply and demand imbalance that caused the 2014-2016 bust remains relevant. In addition to the global oversupply of crude oil, the SARS-CoV-2 (COVID-19) pandemic slashed demand. With renewable fuels, and battery and electric vehicle technology rapidly evolving, many believe that demand for gasoline will never return to anywhere near 2019 levels.

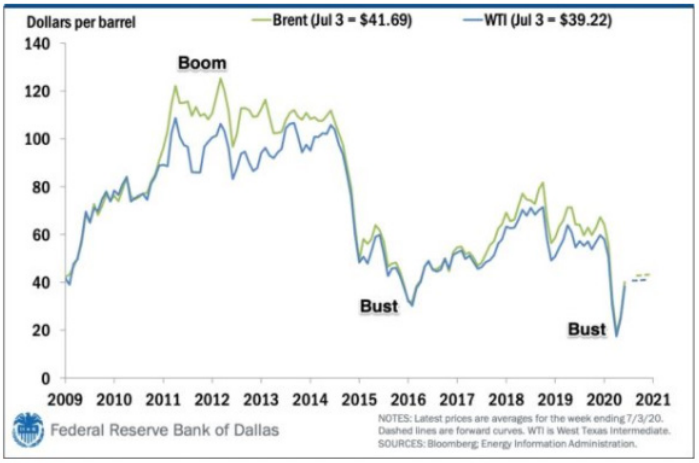

Figure 2 courtesy of econlife.com
Weekly average - Oil booms and busts through time.

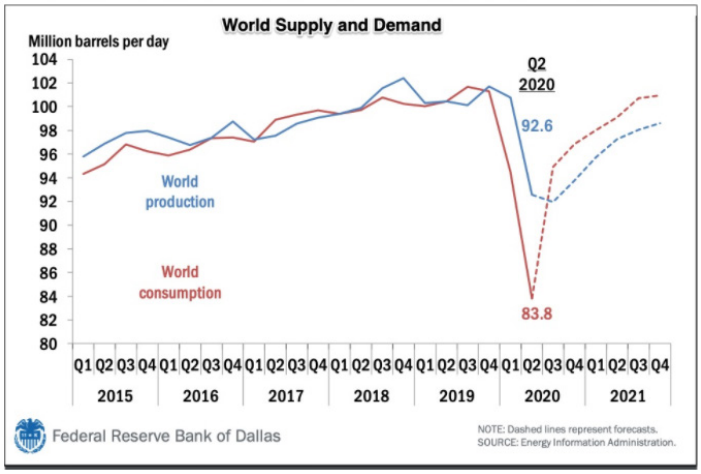

Figure 3 courtesy of econlife.com
World supply of, and demand for oil.

IS THIS THE BEGINNING OF THE END FOR GASOLINE DEMAND?

"The reports of my death are greatly exaggerated".

-Mark Twain

Is history repeating itself? Just as the horse was slowly replaced by the automobile, is the gasoline automobile slowly being replaced by the electric vehicle? Whether the electric vehicle will ever directly replace the gasoline automobile or not is debatable, but along with renewable fuels, electric vehicles will undoubtedly dilute the demand for gasoline over time as fewer and fewer gasoline-fueled automobiles are on the road.

Just as Mark Twain quipped in 1897 from London when his obituary was mistakenly published in the United States, the conventional gasoline-fueled automobile is far from its death bed though. Over the past decades, commodities traders, environmentalists, politicians, and the media have all hypothesized that the United States' seemingly insatiable thirst for oil had peaked and would start to decline substantially over the coming years as oil-replacing technologies became commercially feasible. Each year that analysts predicted oil was dead, Americans surprised them by driving more and consuming more and more gasoline.

Most of the world's population has become very familiar with gasoline automobiles. Cars are relatively inexpensive to operate and maintain, and gasoline has assuredly become as ubiquitous as hay. By comparison, though, technologies that would replace gasoline automobiles, such as electric vehicles, are still in the relative infancy of development. Electric vehicles use batteries as a source of power. Even though battery technology is evolving quickly, electric vehicles that are comfortable and have good highway driving ranges continue to be novelties for the wealthy, but not practical transportation for the masses.

The transition from the horse-drawn carriage to the automobile took over 50 years. Likewise, it may be decades from today before the gasoline-powered automobile is completely pushed off the road.

THE FUTURE STATE OF ENERGY INFRASTRUCTURE

As electric vehicles become more common on the road, it stands to reason that the demand for petroleum-based energy products will decline. What will happen to the infrastructure that is in place to produce, refine, store, and transport petroleum products? As you read this article, petroleum exploration companies are filing for bankruptcy protection, oil and gas wells are being shut in, and decades-old refineries are being permanently shut down. In the fall of 2020, the oil industry continues to experience one of its worst-ever busts.

Photo courtesy of iStock/Ron and Patty Thomas
Fuel tanker trucks at a refinery fueling station in California

Energy infrastructure will need to adapt to the realities of the new marketplace. The transition to new market conditions will continue downstream from the oil fields and refineries to the gasoline bulk storage terminals and gasoline stations.

Bulk storage terminals play a particularly important role in the process of filling up America's gasoline tanks. Like giant liquid warehouses, storage terminals receive gasoline and other products by pipeline, rail, and vessel, then store these products in large aboveground tanks. To keep retail gasoline stations from running dry, tank trucks drive into special areas at the terminal called loading racks where flexible loading arms are extended to make a connection between the truck and the terminal's tanks. In most storage terminals, loading and inventory are controlled by a sophisticated network of computers. The majority of storage terminals do not own their inventory – their customers do. Terminal operators make money by storing their customers' inventory until it is needed and then loading it into delivery trucks. If for some reason terminal customers cannot access the inventory that they own – for example, if the terminal loading equipment is not operating correctly and trucks can't load – a serious financial problem can arise, especially if gasoline stations run dry.

Gasoline tank truck drivers can tell you that some terminals are better at loading trucks than others. To meet the expectations of their customers in an increasingly competitive environment, gasoline storage terminals will need to become more dependable. Gasoline suppliers and retail operators must keep enough product on hand to meet

ever-changing swings in demand due to weather and other factors. Truck fleets, too, have considerable pressure placed upon them to keep stations supplied while ensuring that truck drivers do not exceed their allowed hours of service.

It's far from easy to operate gasoline stations and tank truck fleets profitably in this complex environment. It shouldn't be surprising that terminal customers and their truck fleet operators are looking to motivate terminal companies to be both cost-competitive and dependable. Though they might use different terminology, they all are looking for gasoline terminals to be efficient, reliable, and resilient.

OPERATING A BULK STORAGE TERMINAL IN THE FUTURE

Unfortunately, in the past, terminal prices and reliability were at opposite ends of the spectrum – it was difficult to achieve both states simultaneously. This was primarily because of competition for finite gasoline demand between many terminals in a given market geography. Cut-throat pricing won the business, but it also put pressure on terminal margins and cash flow. Restricted cash flow in turn caused some critical equipment to be "run to failure". Running equipment to failure means that there are times when the terminal has a reduced loading rate, or cannot load at all because an important component has failed and must be taken out of service.

Today, most terminal operators are struggling to meet their customers' expectations for reliability and competitive pricing. As demand for petroleum products slowly declines over the coming decades, the retail market will require fewer and fewer terminals to meet their needs for gasoline and other traditional petroleum products. Terminals will battle for the remaining business, and many existing terminals will be sold or closed.

Like any other marketplace in America, competitive pricing plays an important role in who makes the cut and who doesn't – but pricing is just one part of the equation. Over the last decade, terminal customers have become increasingly interested in storing their inventory in terminals that are safe, efficient, and well maintained. These preferences are driven down to terminal operators through written contracts with requirements for fast loading rates, short waiting times, and good safety and environmental records.

Contract requirements communicate the desired future state where terminals are operated safely, efficiently, and reliably. To achieve this state, the equipment necessary for loading operations must not be allowed to fail in service. This can often be achieved through built-in redundancy, but it can also be achieved by selecting reliable components. Programmable logic controllers (PLCs), pumps, motors, valve actuators, loading arm swivels, and tank truck couplers are examples of items that are absolutely necessary for terminal functionality, but which can unexpectedly fail in service – even when maintained according to their manufacturer's instructions.

RELIABILITY AND SAFETY

Avoiding unexpected component failures is good for business because terminal customers can load their inventory when they want to, but reliability is good for terminal employees too. Terminal employees often perform dangerous repairs under less than ideal conditions. Catastrophic equipment failures never seem to occur on a Tuesday afternoon shift – it is more often the case that broken equipment needs to be repaired during a cold, dark Saturday night call out. A terminal with reliable components has fewer callouts because there are fewer in-service equipment failures. Because maintenance is performed under the best possible conditions, workers are exposed to fewer hazards.

RESILIENCE

A terminal must operate reliably to win the battle for a customer's business, but a terminal must be flexible to keep the customer happy under all conditions. Resilience represents an ability to return to full operation as quickly as possible after a business disruption, such as a storm or earthquake. This adaptability usually derives from good disaster planning, but there's more to it than that. In the same sense that a terminal can be more reliable because their equipment doesn't fail unexpectedly, so too a terminal can be more resilient if it can restore electrical power and replace damaged equipment quickly, allowing normal business operations to resume.

Typically, storage terminals cluster together around pipeline junctions, railheads, and deep-water ports near high volume gasoline markets. Because terminals are collocated, the cites that they serve are vulnerable to supply disruptions should a disaster simultaneously damage all of the terminals. Such was the case in 2012 when Superstorm Sandy devastated the metro New York City gasoline terminals located in northern New Jersey. Because the terminals were either damaged or had no electrical power, trucks could not load and gasoline could not be delivered to retail gasoline stations. The problems persisted for weeks, causing gasoline shortages throughout New Jersey and New York.

Photo courtesy of iStock/SteveByland
Gas lines in New Jersey after Hurricane Sandy

To avoid this, terminal companies have identified the need for comprehensive disaster planning. These plans consist of repair and recovery procedures, contact information for utility company representatives, portable backup power generators, and suppliers who can expedite delivery of critical components that might be damaged by wind and water such as PLC controllers, pumps, motors, valve actuators, and loading rack com-

ponents like loading controllers, overfill/ground monitors, swivels, and loading arms. The most resilient terminals have the best plans for recovery and have invested significant time, effort, and money to be sure that the resources they've identified are available when needed.

TERMINAL OPERATORS SHOULD PREPARE FOR THE FUTURE

Gasoline terminals with a proven track record for reliability and resilience will be the gold standard for terminals in the future. Terminal equipment like Dixon's loading arms, rack overfill/grounding monitors, swivel joints, API couplers, and cam and groove fittings are designed and tested to help our customers operate safe, efficient, and reliable terminal facilities.

Along with supplying some of the most dependable fuel loading equipment available, Dixon's inventory provides terminal operators the ability to adjust to rapidly changing conditions. Whether a terminal is damaged due to severe weather or must be reconfigured due to the changing needs of the marketplace, our vast inventory of fuel loading equipment and repair parts are readily available for rapid deployment.

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Superstorm Sandy
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Austin McClain is a liquid energy Terminal Specialist at Dixon. He has over two-decades of experience in petroleum pipeline and terminal operation, including construction, maintenance, environmental health and safety, and emergency response. He works closely with engineers and end-user customers to select loading systems that improve terminal safety, efficiency, and reliability.

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Founded in 1916, Dixon is a premier US-based worldwide manufacturer and supplier of hose couplings, valves, dry disconnects, swivels and other fluid transfer and control products. Dixon's products and services support a wide range of industries including chemical processing, petroleum exploration, refining and transportation, steelmaking, construction, mining, manufacturing and processing.

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