4.1

Technological Innovations

The sailors, moreover, as they sail over the sea, when in cloudy weather they can no longer profit by the light of the sun, or when the world is wrapped up in the darkness of the shades of night, and they are ignorant to what point of the compass their ship's course is directed, they touch the magnet with a needle, which (the needle) is whirled round in a circle until, when its motion ceases, its point looks direct to the north.

—Alexander Neckham (1157-1217)

Essential Question: How did cross-cultural interactions spread technology and facilitate changes in trade and travel from 1450 to 1750?

Although land-based empires were important during this period, various inventions allowed Europeans to venture long distances on the ocean. The magnetic compass, originally created in China for fortune telling, helped steer a ship in the right direction, as described by Alexander Neckham. The astrolabe, improved by Muslim navigators in the 12th century, let sailors find out how far north or south they were from the equator. The caravel, a small, three-masted sailing ship developed by the Portuguese in the 15th century, allowed sailors to survive storms at sea better than earlier-designed ships. **Cartography**, or mapmaking, and knowledge of current and wind patterns also improved navigation.

Demographic pressures pushed Europeans into exploration and trade. As the population grew, not all workers in Europe could find work or even food. Not all sons of the wealthy could own land because **primogeniture laws** gave all of each estate to the eldest son. In the early 17th century, religious minorities searched for a place to settle where people were tolerant of their dissent. All of these groups, as well as those just longing for adventure and glory, were eager to settle in new areas. Those who left their homelands in search of work, food, land, tolerance, and adventure were part of a global shift in demographics.

Developments of Transoceanic Travel and Trade

Europe was never totally isolated from East and South Asia. The Indian Ocean trade routes had long brought silk, spices, and tea to the Mediterranean by way of the Red Sea. Islamic traders had long known of land routes from China to the cities of Baghdad and Constantinople and from there to Rome. Then,

in the 16th century, more and more Europeans became active in the Indian Ocean, with hopes of finding wealth and new converts as their twin motives. However, Europeans faced competition from Middle Eastern traders based in kingdoms such as Oman. For example, the Portuguese set up forts in Oman but were repeatedly challenged by attempts to remove them. The **Omani-European rivalry** was one reason for Christopher Columbus's search for a new route to India.

The voyages by Columbus connected people across the Atlantic Ocean. European traders became go-betweens linking Afro-Eurasia and the Americas.

- From the Americas, they obtained sugar, tobacco, and rum.
- From Africa, they obtained enslaved people.
- From Asia, they obtained silk, spices, and rhubarb.

This extensive trade transformed Spain, Portugal, Great Britain, France, and Holland into **maritime empires**, ones based on sea travel.

Much of this trade was carried out by men. However, in Southeast Asia, Europeans conducted most of their business with women, who traditionally handled markets and money-changing services in those cultures.

Classical, Islamic, and Asian Technology

Western European countries such as Portugal, Spain, and England were developing their naval technology. They were aware of traditions of sailing that went back to the classical Greeks, such as using the stars to navigate. They combined this knowledge with new ideas developed by Islamic and Asian sailors and scholars, which they learned about because of the cross-cultural interactions resulting from trade networks. Al-Andalus, in what is now Spain, was a place where Islamic ideas diffused into Europe.

The leading European figure in this development was Portuguese ruler Prince Henry the Navigator. While he never sailed far enough out to sea to lose sight of land, he strongly supported exploration. He financed expeditions along Africa's Atlantic Coast and around the Cape of Good Hope. With his backing, Portugal explored African coastal communities and kingdoms before other European powers.

Advances in Ideas As scholars gathered knowledge, they improved the safety of sailing on the ocean. For example, Newton's discovery of gravitation increased knowledge of the tides. As a result, sailors could reliably predict when the depth of water near a shore would be decreasing, thereby exposing dangerous rocks. As people kept increasingly accurate records on the direction and intensity of winds, sailors could sail with greater confidence.

Improvements in cartography also improved navigation. An **astronomical chart** is any map of the stars and galaxies. Mariners relied on these maps to guide ships' direction, especially before the introduction of the compass, using the skies to help them determine their location. Ancient astronomers in Babylonia and Mesopotamia had created star charts as early as the 2nd

millennium B.C.E. Charts by Chinese astronomers date back to the 5th century B.C.E. Charts were also used widely by classical Greek astronomers. Using telescopes to help create astronomical charts began in 1609, and the practice was widely used to map the stars by the end of the 17th century. Astronomers typically divided the charts into grids to help locate specific constellations and astronomical objects.

Advances in Equipment Several developments in the equipment used on ships made sailing safer and faster than ever. Ships moved adroitly, aided by a new type of rudder, another idea imported from China. The astrolabe, improved by Muslim navigators in the 12th century, allowed sailors to determine how far north or south they were from the equator.

The compass is the primary direction-finding device used in navigation. It works either with magnets or a gyroscope, which is a wheel or disk mounted to spin rapidly around an axis in various directions. Other compasses determine the location of the sun or a specific star. The magnetic compass, originally invented in China, allowed sailors to steer a ship in the right direction. It is the oldest and most familiar. It was discovered by mariners in both China and Europe in the 12th century. This type of compass works as Earth itself acts as an enormous bar magnet. Earth's magnetic field is almost parallel to the north-south axis of the globe, which means that freely moving magnets, such as those in a compass, take on the same orientation.

The lateen sail**,** or a ship sail in the shape of a triangle, was a pivotal piece of technology. Used by Arab sailors and in the Indian Ocean, it significantly affected medieval navigation and trade. The ancient square sails that preceded the lateen allowed sailing only in a single direction and had to be used with the wind. The lateen, however, could catch the wind on either side of the ship, allowing it to travel in different directions. When used with the square sail, the lateen allowed sailors to travel successfully into large bodies of water, including oceans, for the first time, thus expanding trade routes.

Source: Getty Images

Lateen sails are still used on modern sailboats.

New types of ships also improved trade. By adjusting the ratio of length to width of a ship, adding or reducing the number of masts, and using different types of sails, builders could adapt ships to improve their efficiency. (Connect: Compare the technological advances of the Mongols and Chinese of the 12th and 13th centuries with those in the chart below. See Topic 2.1.)

Three Types of Ships

Ship	Typical Length	Sails and Masts	Purpose	Primary Users	Centuries of Peak Use
Carrack	150 feet	Square and lateen on 3-4 masts	Trade	Portugal	14th to 17th
Caravel	75 feet	Lateen sails on 2 or 3 masts	Long voyages at great speed	Portuguese and Spanish	15th to 17th
Fluyt	80 feet	Square on 2 or 3 masts	Trade	Dutch	16th to 17th

Long-Term Results The long-term result of combining navigational techniques invented in Europe with those from other areas of the world was a rapid expansion of exploration and global trade. About the only part of the Afro-Eurasia world not affected by the rapid increase in global trade was Polynesia, since it was far removed from trading routes.

The introduction of gunpowder, another Chinese invention, aided Europeans in their conquests abroad. Soon enough, however, sea pirates also used the new technology, particularly the Dutch pirates known as Sea Beggars.

In North Africa and in the trading cities along Africa's east coast, Islam spread rapidly as a result of the growth of the Abbasid Empire, centered in Baghdad, and the activities of Muslim merchants. Interactions among various cultures inside and outside of Africa brought extensive trade and new technology to the continent.

Navigational techniques continued to spread throughout the 17th century. Russia's Tsar Peter the Great visited Western Europe in 1697 to observe military and naval technology. His interest in European technology led him to hire technicians from Germany and elsewhere to help build Russia's military and naval power.

KEY TERMS BY THEME

ECONOMICS: Europe primogeniture laws Omani-European rivalry	**TECHNOLOGY:** Navigation cartography astronomical chart	**GOVERNMENT:** Europe maritime empires

4.2

Exploration: Causes and Events

You can never cross the ocean unless you have the courage to lose sight of the shore.

—Christopher Columbus (1451-1506)

Essential Question: What were the causes and effects of the state-sponsored expansion of maritime exploration?

Thanks in part to improved navigation techniques, Italian cities with ports on the Mediterranean had a monopoly on European trade with Asia. By controlling access to the trade routes, the Italians controlled prices of Asian imports to Europe, driving Spain and Portugal, and later France, England, and the Netherlands, into the search for new routes to Asia. Explorers hoped to find riches overseas, especially gold and silver. In addition to these economic and political reasons, explorers were interested in converting others to Christianity. Also, technological breakthroughs in sailing and navigation made bold new voyages possible.

Christopher Columbus, quoted above and credited with "discovering the New World," was fortunate in 1492 to gain the support of the Spanish monarchs, Queen Isabella and King Ferdinand, for his voyages across the Atlantic. His journeys helped increase the interest in discovery, and the English, French, and Dutch supported later exploration.

The Role of States in Maritime Exploration

European states were seeking ways to expand their authority and control of resources in the era of empire-building. Conquests brought new wealth to states through the collection of taxes and through new trading opportunities. In time it also brought great material wealth, especially in silver, to European states. Rivalries among European states stoked efforts to expand before another power might claim a territory. Religion was also a motivating force for exploration and expansion. Many Europeans believed that it was their Christian duty to seek out people in other lands to convert them.

For all these reasons, states were centrally involved in maritime exploration. Voyages such as those Columbus undertook were expensive, and without the financial support of a state, they would most likely have been too expensive

for explorers and even most merchants to be able to afford. Since religion was tightly woven into the government of most European states, preserving and spreading a state's religion became another reason for state involvement.

Also, in the 17th century, Europeans generally measured the wealth of a country in how much gold and silver it had accumulated. For this reason, countries set policies designed to sell as many goods as they could to other countries—in order to maximize the amount of gold and silver coming into the country—and to buy as few as possible from other countries—to minimize the flow of precious metals out of the country. This theory, known as **mercantilism**, required heavy government involvement.

Expansion of European Maritime Exploration

In no nation were the interests of the state and the interest of explorers as closely tied as they were in Portugal, which led the way in European exploration as it had in maritime innovations. (See Topic 2.3.)

Portuguese in Africa and India The small kingdom of Portugal, bounded on the east by the Spanish kingdoms of Castile and Aragon, could expand only overseas. Three people led its exploration:

- **Prince Henry the Navigator** (1394–1460) became the first European monarch to sponsor seafaring expeditions, to search for an all-water route to the east as well as for African gold. Under him, Portugal began importing enslaved Africans by sea, replacing the overland slave trade.
- **Bartholomew Diaz** sailed around the southern tip of Africa, the Cape of Good Hope, in 1488, into waters his crew did not know. Diaz feared a mutiny if he continued pushing eastward, so he returned home.
- **Vasco Da Gama** sailed farther east than Diaz, landing in India in 1498. There he claimed territory as part of Portugal's empire. The Portuguese ports in India were a key step in expanding Portugal's trade in the Indian Ocean and with points farther east.

Portuguese in Southeast and East Asia Early in the 16th century, the ruthless Portuguese admiral Afonso de Albuquerque won a short but bloody battle with Arab traders and set up a factory at Malacca in present-day Indonesia. He had previously served as governor of Portuguese India (1509–1515), sending strings of Indians' ears home to Portugal as evidence of his conquests.

China's exploration of the outside world came to an end after Zheng He's final voyage in the 1430s. (See Topic 2.3.) However, less than a century later, in 1514, the outside world arrived on China's doorstep in the form of Portuguese traders. At that time, Portugal's superior ships and weapons were unmatched among the Europeans. As a result of this advantage, the Portuguese had already won control of both the African and Indian coasts. They had won a decisive victory over a Turkish-Egyptian-Venetian fleet at Diu, India, in 1509.

Initial Portuguese visits had little impact on Chinese society. But the traders were followed by Roman Catholic missionaries, mainly Franciscans and Dominicans, who worked to gain converts among the Chinese people.

The Jesuits soon followed and tried to win over the Chinese court elite. Scientific and technical knowledge were the keys to success at the court. Jesuit missionaries in Macau, such as Matteo Ricci (an Italian, arrived 1582) and Adam Schall von Bell (a German, arrived 1619), impressed the Chinese with their learning. However, they failed to win many converts among the hostile scholar-gentry, who considered them barbaric.

Trading Post Empire To ensure control of trade, the Portuguese had constructed a series of forts stretching from Hormuz on the Persian Gulf (built in 1507) to Goa in western India (built in 1510) to Malacca on the Malay Peninsula (built in 1511). The aims of the fort construction were to establish a monopoly (complete control over a market) over the spice trade in the area and to license all vessels trading between Malacca and Hormuz. The forts gave Portugal a global **trading post empire**, one based on small outposts, rather than control of large territories. The Portuguese also restricted Indian Ocean trade to those who were willing to buy permits.

Portuguese Vulnerability The Portuguese succeeded in global trade for several decades, but Portugal was a small nation, lacking the workers and the ships necessary for the enforcement of a large trade empire. Many Portuguese merchants ignored their government and traded independently. Corruption among government officials also hampered the trading empire. By the 17th century, Dutch and English rivals were challenging the Portuguese in East Asia, including islands that are today part of Malaysia and Indonesia.

The Dutch captured Malacca and built a fort at Batavia in Java in 1620. From Batavia, the Dutch attempted to monopolize the spice trade. As a result, the English focused on India, pushing the Portuguese out of South Asia.

In the early 16th century, the Portuguese also travelled to Japan to trade, followed by Christian missionaries in 1549. They formed large Catholic settlements until the 1600s, when Japanese rulers outlawed Catholicism and expelled the missionaries.

Spanish in the Philippines Portuguese explorers such as Vasco da Gama were the first Western Europeans to reach the Indian Ocean by sea by going around the southern tip of Africa. Spanish ships, however, became the first to circumnavigate the globe when the government sponsored the voyage of **Ferdinand Magellan**. He died on the voyage in the Philippine Islands in 1522, but one of the ships in his fleet made it around the world, proving that the earth could be circumnavigated.

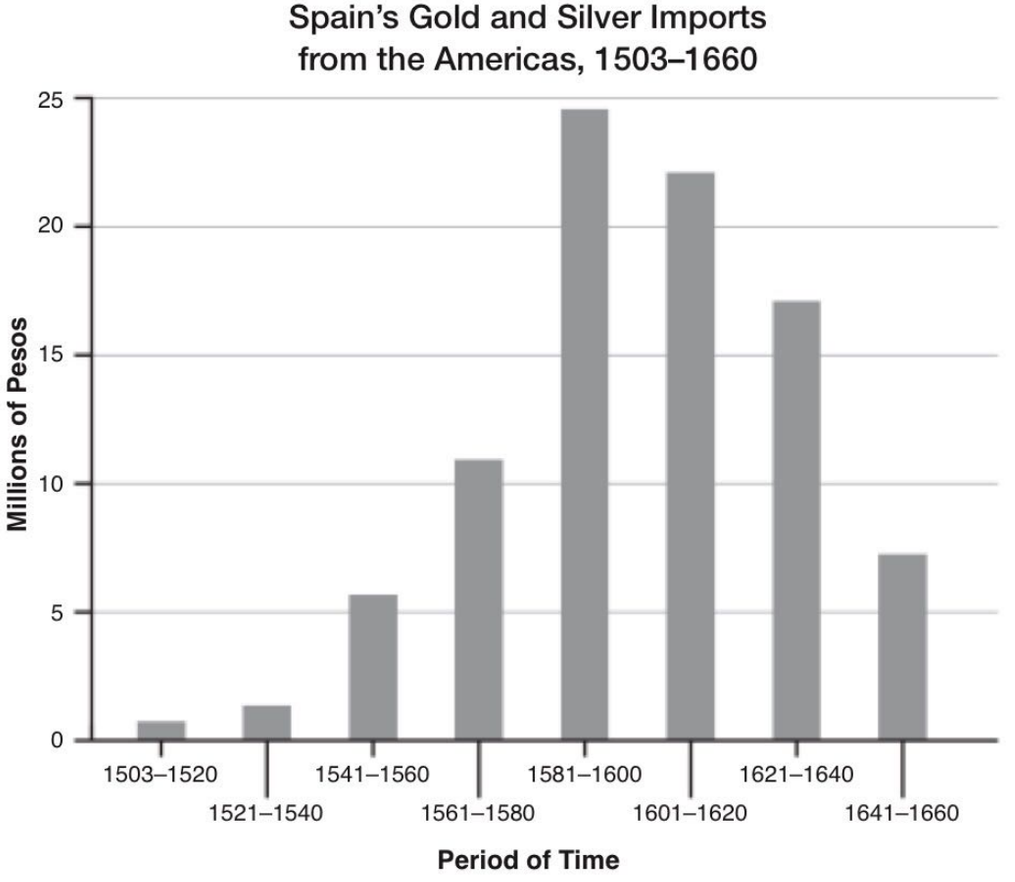
Spain annexed the Philippines in 1521 when Magellan's fleet arrived there. The Spanish returned in 1565 and started a long campaign to conquer the Filipinos, who put up fierce resistance. **Manila** became a Spanish commercial center in the area, attracting Chinese merchants and others. Because of the Portuguese and Spanish occupations, many Filipinos became Christians.

The Lure of Riches

Columbus and other European explorers sought a new route to Asia and hoped to find gold, silver, and other valuable resources. The Spanish found so little of value in their first two decades of contact that they considered stopping further exploration. The English, after sponsoring voyages in the 1490s, made little attempt to explore or settle for almost a century.

However, European interest in the Americas was rekindled when the Spanish came into contact with the two major empires in the region, the Aztecs in Mesoamerica and the Incas in South America. These empires had the gold and silver that made exploration, conquest, and settlement profitable. In addition, Europeans soon realized that, by using enslaved Native Americans and later enslaved Africans, they could grow wealthy by raising sugar, tobacco, and other valuable crops.

Trade Across the Pacific China was a particularly enthusiastic consumer of this silver from the Western Hemisphere. Silver, for example, made its way from what is now Mexico across the Pacific Ocean to East Asia in heavily armed Spanish ships known as **galleons** that made stops in the Philippines. At the trading post in Manila, Europeans exchanged silver for luxury goods such as silk and spices, and even for gold bullion. The impressive Manila galleons allowed the silver trade to flourish. Indeed, the Chinese government soon began using silver as its main form of currency. By the early 17th century, silver had become a dominant force in the global economic system.



Source: Earl J. Hamilton "Imports of American Gold and Silver into Spain, 1503–1660." *The Quarterly Journal of Economics*. 1929.

Spain's rivals in Europe also explored and claimed regions in the Americas. French, English, and Dutch explorers all looked for a **northwest passage**—a route through or around North America that would lead to East Asia and the precious trade in spices and luxury goods.

French Exploration In the 1500s and 1600s, the French government sponsored expeditions in search of a northwest passage. In 1535, for example, French explorer **Jacques Cartier** sailed from the Atlantic Ocean into the St. Lawrence River at today's northern U.S. border. He did not find a new route to Asia, but he did claim part of what is now Canada for France. Eventually, explorers such as Cartier and **Samuel de Champlain** (explored 1609–1616) realized there were valuable goods and rich resources available in the Americas, so there was no need to go beyond to Asia.

Like the Spanish, the French hoped to find gold. Instead, they found a land rich in furs and other natural resources. In 1608, they established a town and trading post that they named **Quebec**. French traders and priests spread across the continent. The traders searched for furs; the priests wanted to convert Native Americans to Christianity. The missionaries sometimes set up schools among the indigenous peoples. In the 1680s, a French trader known as La Salle explored the Great Lakes and followed the Mississippi River south to its mouth at the Gulf of Mexico. He claimed this vast region for France.

Unlike the Spanish—or the English who were colonizing the East Coast of what is now the United States—the French rarely settled permanently. Instead of demanding land, they traded for the furs trapped by Native Americans. For this reason, the French had better relations with natives than did the Spanish or English colonists and their settlements also grew more slowly. For example, by 1754, the European population of **New France**, the French colony in North America, was only 70,000. The English colonies included one million Europeans.

English Exploration In 1497, the English king sent an explorer named **John Cabot** to America to look for a northwest passage. Cabot claimed lands from Newfoundland south to the Chesapeake Bay. The English, however, did not have enough sea power to defend themselves against Spanish naval forces—although English pirates called "sea dogs" sometimes attacked Spanish ships. Then in 1588, the English surprisingly defeated and destroyed all but one third of the Spanish Armada. With that victory, England declared itself a major naval power and began competing for lands and resources in the Americas.

At about the same time the French were founding Quebec, the English were establishing a colony in a land called Virginia. In 1607, about one hundred English colonists traveled approximately 60 miles inland from the coast, where they built a settlement, **Jamestown**, on the James River. Both the settlement and the river were named for the ruling English monarch, James I. Jamestown was England's first successful colony in the Americas, and one of the earliest colonies in what would become the United States. The first colonies in the present-day United States were Spanish settlements in Florida and New Mexico.

Comparing Transoceanic Voyages, c. 1300–c. 1800				
Sponsoring Empire	**Explorer**	**Key Voyages**	**Purpose**	**Impact**
China	Zheng He	• India • Middle East • Africa	To open up trade networks with India, Arabia, and Africa and to spread Chinese culture	China decided not to continue exploring
England	John Cabot	• North America	To find a sea route to the East going west from Europe	Claimed land in Canada for Britain and established a shorter, more northerly route across the Atlantic than Columbus's route.
Portugal	Vasco da Gama	• West coast of Africa • India	To open a sea route from Europe to India and China	Portugal expanded trade and cultural exchange between India and Europe
Spain	Christopher Columbus	• Caribbean islands • Central America	To find a sea route to India and China going west from Europe	Spain led the European exploration and colonization of the Americas
Spain	Ferdinand Magellan	• South America • Philippines	To demonstrate that Europeans could reach Asia by sailing west	Spain established links between the Americas and Asia across the Pacific Ocean

Dutch Exploration In 1609, the Dutch sent **Henry Hudson** to explore the East Coast of North America. Among other feats, he sailed up what became known as the Hudson River to see if it led to Asia. He was disappointed in finding no northwest passage. He and other explorers would continue to search for such a route. Though it would travel through a chilly region, it offered the possibility of being only half the distance of a route that went around South America.

Though Hudson did not find a northwest passage, his explorations proved valuable to the Dutch. Based on his voyage, the Dutch claimed the Hudson River Valley and the island of Manhattan. On the tip of this island, they settled a community called **New Amsterdam**, which today is known as New York City. Like many port towns, New Amersterdam prospered because it was located where a major river flowed into the ocean.

New Amsterdam became an important node in the Dutch transatlantic trade network. Dutch merchants bought furs from trappers who lived and worked in the forest lands as far north as Canada. They purchased crops from lands to the south, particularly tobacco from Virginia planters. They sent these goods and others to the Netherlands in exchange for manufactured goods that they could sell throughout colonial North America (Connect: Explain how one of the European explorers in 4.2 compares to Marco Polo. See Topic 2.5.)

KEY TERMS BY THEME

ECONOMICS: Europe
mercantilism
trading post empire
Manila

GOVERNMENT: Portugal
Prince Henry the Navigator

TECHNOLOGY: Maritime
galleons

GOVERNMENT: Exploration
Christopher Columbus
Bartholomew Diaz
Vasco Da Gama
Ferdinand Magellan
northwest passage
Jacques Cartier
Samuel de Champlain
John Cabot
Henry Hudson

GOVERNMENT: Colonies
Quebec
New France
Jamestown
New Amsterdam