

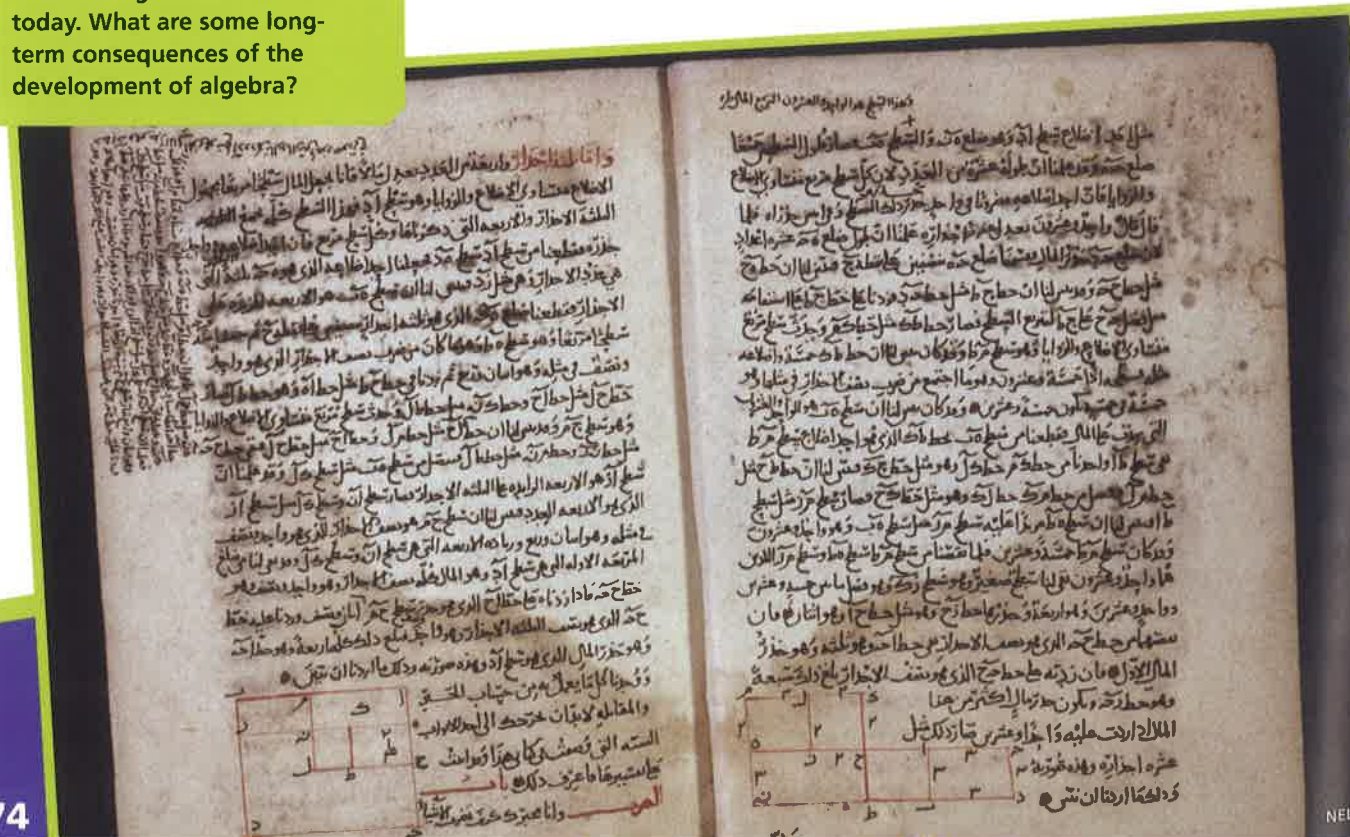
WHAT WERE SOME CONSEQUENCES

Individuals and societies are motivated to innovate for many reasons. These reasons include making daily life easier, as well as solving economic and military problems. Many innovations that remain significant today emerged between 1100 and 1550. When examining the consequences of innovations, it is important to remember that some consequences were intended—but some were unintended. **Q:** Consider a present-day innovation, such as a smartphone. What are some intended and unintended consequences of this innovation?

Some historians consider Muhammad ibn Musa al-Khwarizmi, who lived in Persia and Iraq between 780 and 850, to be the founder of algebra. The word *algebra* comes from the Arabic word *al-jabr*, which means “completion.” This photo shows two pages from an algebra book written in Arabic in the 1300s. These pages include solutions to two quadratic equations. Algebra later spread to Europe, and innovations developed during the Islamic Golden Age are still used in mathematics today. **Q:** Think about fields in which algebra is essential today. What are some long-term consequences of the development of algebra?

THE ISLAMIC GOLDEN AGE

The period between about 700 and 1200 is often called the Islamic Golden Age because many technological, cultural, and scientific innovations were developed in areas where Islam was widely practised. In 859, for example, the first university in the world was created in Morocco. This university—the University of al-Qarawiyyin—continues to operate today.



WHAT WERE SOME CONSEQUENCES

OF KEY INNOVATIONS?

Some historians consider Muhammad ibn Musa al-Khwarizmi, who lived in Persia and Iraq between 780 and 850, to be the founder of algebra. The word *algebra* comes from the Arabic word *al-jabr*, which means "completion." This photo shows two pages from an algebra book written in Arabic in the 1300s. These pages include solutions to two quadratic equations. Algebra later spread to Europe, and innovations developed during the Islamic Golden Age are still used in mathematics today. **Q:** Think about fields in which algebra is essential today. What are some long-term consequences of the development of algebra?

Individuals and societies are motivated to innovate for many reasons. These reasons include making daily life easier, as well as solving economic and military problems. Many innovations that remain significant today emerged between 1100 and 1550. When examining the consequences of innovations, it is important to remember that some consequences were intended—but some were unintended. **Q:** Consider a present-day innovation, such as a smartphone. What are some intended and unintended consequences of this innovation?

THE ISLAMIC GOLDEN AGE

The period between about 700 and 1200 is often called the Islamic Golden Age because many technological, cultural, and scientific innovations were developed in areas where Islam was widely practised. In 859, for example, the first university in the world was created in Morocco. This university—the University of al-Qarawiyyin—continues to operate today.

Medical Innovations

During the Islamic Golden Age, several medical innovations emerged in the Islamic world. These included the first public hospitals and medical schools, as well as new surgical techniques.

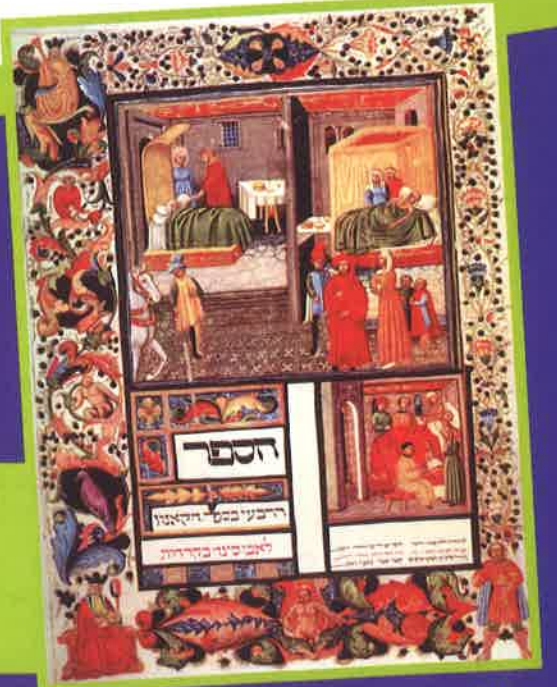
Abu al-Qasim Khalaf ibn al-'Abbas al-Zahrawi (known in Europe as Albucasis) and Abu 'Ali al-Husayn ibn 'Abd Allah ibn Sina (known in Europe as Avicenna) were two influential Muslim surgeons and thinkers. Al-Zahrawi created a 30-volume medical encyclopedia, and ibn Sina wrote medical textbooks. The works of both were translated into Latin, the language used by European scholars, as well as into other languages.



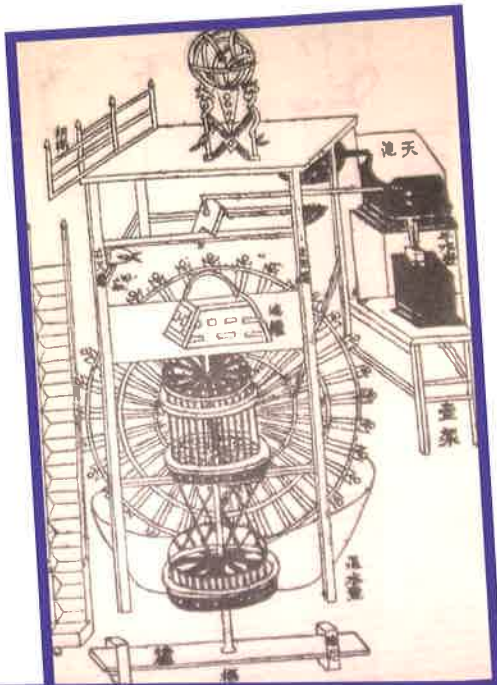
This drawing of the inner workings of the human body was included in the medical book created by Mansur ibn Muhammad ibn Ahmad ibn Yusuf ibn Ilyas in the 1300s. Ibn Ilyas's book was not the first to include a drawing of human anatomy. Including drawings of human anatomy in medical books was part of a tradition developed by Muslim doctors. **Q:** How would a drawing like this have helped to change the way that medicine was practised?



This page from al-Zahrawi's volume on surgery shows various surgical instruments. From the 1100s to the 1500s, nearly all European authors of surgical textbooks referred to al-Zahrawi's work and copied from him. **Q:** What does the use of al-Zahrawi's work reveal about the consequences of his innovations?



This photo shows a page from an illustrated Hebrew translation of Ibn Sina's *Canon of Medicine*, published in 1027. This translation dates to the early 1400s. **Q:** What does this translation reveal about the influence of Ibn Sina's medical textbook?



In 1094, Su Song, a Chinese inventor, designed a clock tower that was more than 12 metres high. The clock included a mechanical device to increase its accuracy in measuring time. **Q:** What consequences do you think resulted from the ability to measure time more precisely?

MECHANICAL CLOCKS IN EUROPE

Economists Lars Boerner and Battista Severgnini, authors of the following excerpt, have studied the invention of mechanical clocks in Europe.

Until the late Middle Ages, ... [early clocks] did not play any role in basic life and business activities. Market openings and activities started with the sun rise and typically ended at noon when the sun was at its zenith [its highest point in the sky], while a labour day was as long as the sun was up and pay by the hour did not exist.

Different attitudes on punctuality had started by the late Middle Ages, when the first public mechanical clocks were introduced and spread across European cities. These clocks were typically built on church towers or on the communal tower of the town, and were mechanical devices that produced a weight-driven acoustic signal every hour. The day was typically divided into two units of twelve, and the bells rang [at the beginning of every hour].

Q: What significant differences do you think mechanical clocks would have made in Europeans' lives?

Innovations in Measuring Time

For thousands of years, societies around the world tried to devise a method of accurately measuring the passage of time. Some methods, such as the sundial, were based on the movement of the Sun. Other methods involved measuring water or sand as it passed into a container. All these methods had drawbacks, and none was particularly precise.

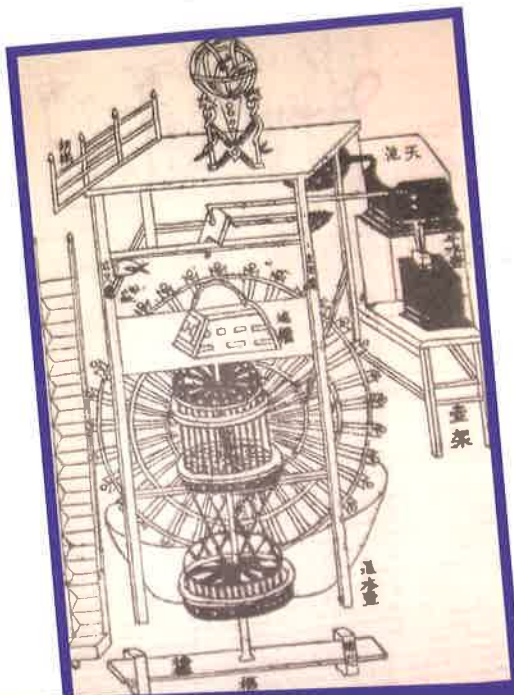
Early innovations in accurate timekeeping occurred in China. As the innovations spread across Asia and into Europe, European inventors drew on them to develop mechanical clocks that featured weights and springs. The English word *clock* comes from *clocca*, the Latin word for "bell."

THE OLD WAYS AND THE NEW

The following excerpt is from an article titled "Time and Clocks in the Middle Ages" by historian Elizabeth York Enstam.

Technology changes people by changing their habits and how they get through the day, yet the old ways survived alongside the convenient, orderly hours of the clock. For many people, time continued to be organized by light. In town and countryside alike, farmers, craftsmen, artisans, dressmakers and homemakers as well, rose when the rooster crowed to begin working at sunrise regardless of what the clock tolled. Town dwellers continued to keep livestock, including chickens, within the city limits, and ordinary soldiers took roosters to war with them to signal the dawn. The wealthier families who could afford clocks, and anyone who lived close enough to hear the town or the abbey clock's bells, would know the hour of sunrise and sunset, but few, it seems, forgot the age-old ways of estimating, at any given time of day, the hours of light remaining before nightfall.

Q: Reread the final sentence of this excerpt from Enstam's article. Do you think her statement remains true today? What does your response to the previous question reveal about the long-term consequences of the development of the mechanical clock?



In 1094, Su Song, a Chinese inventor, designed a clock tower that was more than 12 metres high. The clock included a mechanical device to increase its accuracy in measuring time. **Q:** What consequences do you think resulted from the ability to measure time more precisely?

MECHANICAL CLOCKS IN EUROPE

Economists Lars Boerner and Battista Severgnini, authors of the following excerpt, have studied the invention of mechanical clocks in Europe.

Until the late Middle Ages, ... [early clocks] did not play any role in basic life and business activities. Market openings and activities started with the sun rise and typically ended at noon when the sun was at its zenith [its highest point in the sky], while a labour day was as long as the sun was up and pay by the hour did not exist.

Different attitudes on punctuality had started by the late Middle Ages, when the first public mechanical clocks were introduced and spread across European cities. These clocks were typically built on church towers or on the communal tower of the town, and were mechanical devices that produced a weight-driven acoustic signal every hour. The day was typically divided into two units of twelve, and the bells rang [at the beginning of every hour].

Q: What significant differences do you think mechanical clocks would have made in Europeans' lives?

Innovations in Measuring Time

For thousands of years, societies around the world tried to devise a method of accurately measuring the passage of time. Some methods, such as the sundial, were based on the movement of the Sun. Other methods involved measuring water or sand as it passed into a container. All these methods had drawbacks, and none was particularly precise.

Early innovations in accurate timekeeping occurred in China. As the innovations spread across Asia and into Europe, European inventors drew on them to develop mechanical clocks that featured weights and springs. The English word *clock* comes from *clocca*, the Latin word for "bell."

THE OLD WAYS AND THE NEW

The following excerpt is from an article titled "Time and Clocks in the Middle Ages" by historian Elizabeth York Enstam.

Technology changes people by changing their habits and how they get through the day, yet the old ways survived alongside the convenient, orderly hours of the clock. For many people, time continued to be organized by light. In town and countryside alike, farmers, craftsmen, artisans, dressmakers and homemakers as well, rose when the rooster crowed to begin working at sunrise regardless of what the clock tolled. Town dwellers continued to keep livestock, including chickens, within the city limits, and ordinary soldiers took roosters to war with them to signal the dawn. The wealthier families who could afford clocks, and anyone who lived close enough to hear the town or the abbey clock's bells, would know the hour of sunrise and sunset, but few, it seems, forgot the age-old ways of estimating, at any given time of day, the hours of light remaining before nightfall.

Q: Reread the final sentence of this excerpt from Enstam's article. Do you think her statement remains true today? What does your response to the previous question reveal about the long-term consequences of the development of the mechanical clock?

From Eyeglasses to Telescopes

Since ancient times, curved glass or crystals known as reading stones were used to help enlarge text. In the 1200s, many Europeans began to use eyeglasses made with two curved glass lenses. Historians say that the first eyeglasses were made in Pisa, Italy, in about 1286. By the early 1400s, the use of eyeglasses had spread throughout Europe.

Over time, improvements in lenses led to the development of telescopes and microscopes. These new technologies led to significant advances in the understanding of astronomy and biology.

Q: Read the two quotations by Girolamo Fracastoro and Vincent Ilardi. Fracastoro's comments were made before telescopes and microscopes were developed in the 1600s. How do Fracastoro's comments foreshadow what was to come? What were some unintended consequences of the invention of eyeglasses?



This is a section of a larger painting that was created by Conrad von Soest in 1403. It is thought to be one of the oldest pictures of someone using eyeglasses. **Q:** What would have been the immediate consequences of the invention of eyeglasses for those who had access to them?

"If anyone looks through two spectacle lenses, one placed on top of the other, he will see everything much larger and closer... Indeed, certain spectacle lenses are made of such density that if someone looks through them at the Moon or at another star he will judge them to be so close they do not even appear to exceed the [height of church] steeples."

– Girolamo Fracastoro, *physician, 1538*

"Are eyeglasses one of the most important inventions in the last two thousand years? They have been nominated for this distinction in a poll of some 80 scholars carried out on the Internet ... Spectacles 'have effectively doubled the active life of everyone who reads or does fine work—and prevented the world being ruled by people under 40,' commented [psychologist Nicholas Humphrey]."

– Vincent Ilardi, *historian, in Renaissance Vision from Spectacles to Telescopes, 2007*