

CHAPTER 5

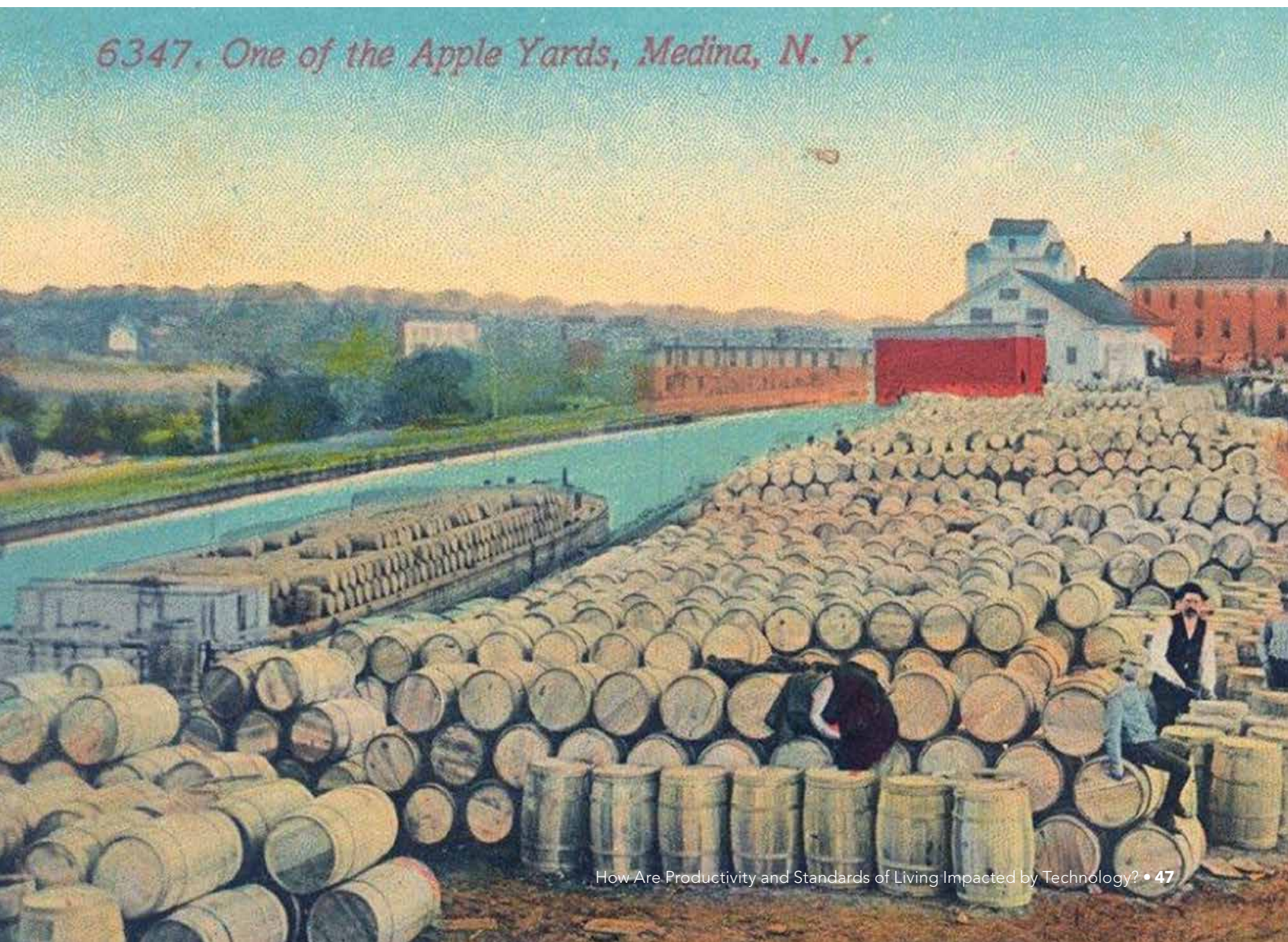
How Are Productivity and Standards of Living Impacted by **Technology?**

The Center for Economic Education and Entrepreneurship, University of Delaware

Apple barrels wait to be loaded onto barges on the Erie Canal in this historical postcard, ca. 1870.

COURTESY ERIE CANAL MUSEUM, [HTTP://WWW.ERIECANALMUSEUM.ORG](http://www.eriecanalmuseum.org)

6347. One of the Apple Yards, Medina, N. Y.



HOW ARE PRODUCTIVITY AND STANDARDS OF LIVING IMPACTED BY TECHNOLOGY?		
Center for Economic Education and Entrepreneurship (CEEE), University of Delaware		
C3 Disciplinary Focus Economics and U.S. History	C3 Inquiry Focus Applying disciplinary concepts to examine sources and evaluate evidences	Content Topic Technological change and its Impact
C3 Focus Indicators D1: Explain how a question represents key ideas in the field. (D1.1.6-8) D2: Explain why standards of living increase as productivity improves. (D2.Eco.13.6-8) D3: Identify evidence that draws information from multiple sources to support claims, noting evidentiary limitations. (D3.3.6-8) D4: Present adaptations of arguments and explanations on topics of interest to others to reach audiences and venues outside the classroom using print and oral technologies (e.g., posters, essays, letters, debates, speeches, reports, and maps) and digital technologies (e.g., Internet, social media, and digital documentary). (D4.3.6-8)		
Grade Level 6–8	Resources Resources cited in chapter; CEEE website	Time Required 3–4 class periods including instruction, research, and presentations.

Introduction and Connections to the C3 Framework

In the discipline of economics, students learn the economic way of thinking, which is a reasoning process that considers costs as well as benefits when making a decision. To do this, students must use the tools of cost/benefit analysis, make an analysis of supply and demand, and consider the future consequences that may result from the decision. Using these analytical tools and following the C3 Framework’s Inquiry Arc, middle school students can learn how technological change has driven economic change since human history began.

Technology increases productivity—that is, the amount of output per unit of input. Increased productivity means more of the goods and services that increase peoples’ standards of living. These increases result not just from the change in technology, but also

from increases in the education and skill level of the work force. This lesson focuses on the impact of technology.

Technological change has resulted in increased productivity and hence higher standards of living ever since humans began using tools. Historically, adaptation to technological innovation occurs over long periods of time; however, the rate of that change has been accelerating, and citizens' responses to those innovations do not always keep pace with the changes.

Although changes can take a long time, benefits have generally accrued not only to the producers but also to other workers and society as a whole. For example, one of the unintended consequences of Gutenberg's printing press was the democratization and dissemination of information, which led to upheavals in Europe in the relationships between the ordinary citizen, the government, and the Catholic Church. Printed communication also spread changes in how to produce goods and services leading to the Industrial Revolution.

Forward to the 21st century. Information technology has allowed everyone, including some of the poorest and most isolated people on the planet, instantaneous access to current events. People also now have the ability to see how other cultures and nations live, resulting in a desire to increase their own standard of living from subsistence-level food production to a higher standard of living. As technology increases productivity, costs of production fall, which means that a worker's income has more purchasing power. Therefore, people's standards of living tend to rise. Hans Rosling's four-minute video, *200 Countries, 200 Years*, traces how countries' standards of living have increased as technological change has accelerated (see <http://www.gapminder.org>). But these benefits come with costs.

One of the major costs related to technological change is that of job destruction. Sometimes termed "creative destruction," this process leaves many individual workers scrambling to make a living with skills that have or may become obsolete through technological innovation or from increased competition from workers around the world, both skilled and unskilled. At the same time, many new jobs are created. Our students must develop skills that promote lifelong learning and which allow them to adapt to the changes in technology that are necessary for future careers, and to improve the quality of their lives.

Inquiry Arc

Dimension 1: Developing Questions and Planning Inquiries

If you ask middle school students how technology, productivity, and standards of living are related, they most likely will find the question unexciting and fail to see the importance of searching for an answer unless they see a connection to their own lives.

Use the smart phone to generate interest in technology and its impact. Pose the following questions. How many of you use smart phones? How does the use of smart phones affect your lives or activities in which you participate? How would your life change if smart phones didn't exist? Have smart phones made people more productive? If so, in what way? Explain that a technological change is a new way of doing something or is manifested in a product that does things differently. Point out that a smart phone is an example of a technological change and one that certainly has affected their lives.

Following this discussion, inform students that they are going to analyze different technologies to answer this compelling question: *How are productivity and standards of living impacted by technology?*

The C3 Framework suggests that students should be able to “explain how a question represents key ideas in the field.” (D1.1.6-8) The compelling question framing this lesson focuses on the key idea of the effect of technology on productivity and standards of living. Lead students in a discussion about this key idea. You can structure this discussion around these prompts.

- What is an example of a technology that has changed your life?
- What are some technologies that you have learned about in history that helped improve economies?
- What are some modern technologies that are making lives better for people in less developed countries?

The discussion could go in a lot of directions. Some students may argue that smart phones in fact make them less productive rather than more so. Teachers may be inclined to agree! But there are clear examples where this is not the case. In developing countries, for example, online banking via smart phone has revolutionized the livelihoods of many people who do not have access to good roads. Students might argue that throughout history, technological change has impacted people's standards of living and quality of life. The construction of the Erie Canal, which most students study sometime during their middle school experience, demonstrates the links between technology, productivity, and standards of living over time. Inform students that they are going to explore the answer to the compelling question by first using economic analysis to study the impact of the construction of the Erie Canal and then applying this economic way of thinking to a technological change of their choice.

To answer the compelling question, students will need to apply an economic way of thinking using cost/benefit analysis. Additionally, you might extend the lesson to have students examine supply and demand, assess future consequences, and make connections among events and developments in broader historical contexts. This can be accomplished through chronologically viewing the productivity changes caused by the technological innovations.

With your support, students can inquire about the compelling question and deepen their understanding of the economic impact of technology. To guide the students in their research, use these supporting questions, which can be utilized when studying any technological change:

- How did this technology affect productivity?
- How did this technology affect standards of living?
- How did this technology affect the quality of life?

RESOURCE

One of the richest sources for learning about technological changes and their impact is the NPR program, *Engines of Our Ingenuity*, a radio podcast with transcripts, written by Professor John Leinhard at the University of Houston. (<http://www.uh.edu/engines>) The site contains over 2900 episodes. An overview of issues related to technology as an overarching construct can be found in Episode #1410, *Homo Technologicus*.

Dimension 2: Connections to Disciplinary Tools and Concepts

The C3 Framework says that students should be able to “explain why standards of living increase as productivity improves.” (D2.Eco.13.6-8) One way to support students as they develop such knowledge is to provide historical examples related to the concept. One of the most important economic tools for analyzing the effect of a technological change is a cost/benefit analysis. Using the authoritative sources (see our list of sources at the end of this chapter), have groups of students identify the costs and benefits (or the losers and gainers) of the construction of the Erie Canal—from before the canal was built through later expansions and other technological innovations.

From their research, students can organize their findings into a cost/benefit chart. See the sample Erie Canal Cost/Benefit Analysis Chart below (Figure 1). This cost/benefit analysis leads students to see how shipping on the canal changed life from Buffalo to Albany to New York City and to the Western territories.

Figure 1 Erie Canal Cost/Benefit Analysis Chart

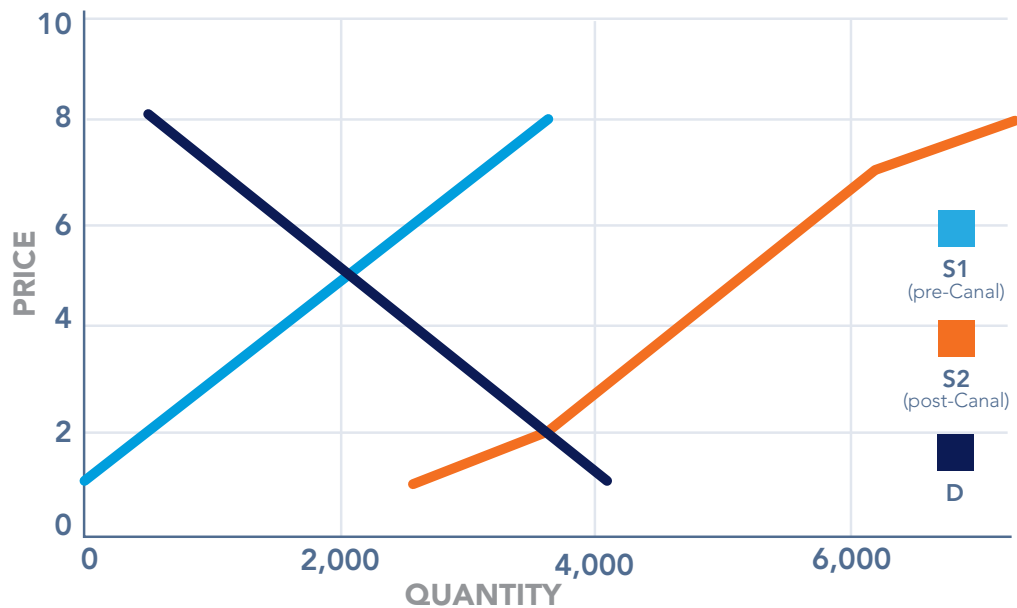
TECHNOLOGY: CANALS	
Costs (What was given up?)	Benefits (What gains were made?)
High cost of construction	Faster way to move goods
Take a lot of time to build	Lower costs of shipping
Tax increases	Lower prices for products
Competition is greater	Wider variety of manufactured goods
Job losses if jobs are not near the canal Loss of income for owners of mules and horses over time	Increased jobs—canal construction, for western farmers, bargemen, barge construction, steam powered tugboats, merchants in cities
Increased prices for goods in the interior parts of NY not near the canal	More produce/grains for cities in the East

The next tool that students can use to analyze the effects of technology on standards of living is supply and demand analysis. Staying with our Erie Canal example, assign students a specific good that was shipped on the canal (i.e., wheat, corn, lumber, minerals, clothing, dishes, manufactured goods) or the resources that were used in the shipping process (tools, barges, steam engines, “hoggees,” who were workers that guided the

mules, stables for the mules, harnesses). Using this data, students can construct a supply and demand graph. The graph below (Figure 2), shows the prices, supply and demand for flour before and after the construction of the Erie Canal. The graph demonstrates that the decrease in the cost of production increased supply. This in turn decreased the prices of the goods, both agricultural and manufactured. The net effect was that workers and consumers had more money to spend on goods and services, which increased their standard of living. Similar supply and demand analyses can be applied when examining the impact of any technological change, which reinforces the relationship between productivity and standard of living. From supply and demand analysis, students should conclude that every technological change results in an increase in productivity which in turn increases supply leading to lower prices of goods and services. Lower prices increase consumers' purchasing power, making them better off.

Supply/demand graphs can be scary, but there is no need to panic. Remember that when supply increases (i.e. increase in productivity), we can make more stuff (Q) for a lower price (P). On the other hand, if supply decreases, as in the case of wars or natural disasters, we produce less stuff and prices increase. Middle school students can comprehend this concept with your help.

Figure 2 Supply and Demand for Flour on the Erie Canal



The information for Figure 2 is taken from Scott Derks and Tony Smith, *The Value of a Dollar: Colonial Era to the Civil War, 1600-1865* (Grey House Publishing, 2005).

Dimension 3: Evaluating Sources and Using Evidence

Dimension 3 of the C3 Framework sets forth an expectation that students will construct arguments and explanations emerging from their inquiries, using information from sources as evidence. (D3.3.6-8) Underlying this search for evidence is the application of the economic way of thinking. Remind students that their analysis of the construction of the Erie Canal gave them the opportunity to learn about the economic way of thinking in an historical context.

Now, have students select another technological change and use the economic way of thinking to address the compelling and supporting questions.

COMPELLING QUESTION

- How are productivity and standards of living impacted by technology?

SUPPORTING QUESTIONS

- How do specific technologies affect productivity?
- How do specific technologies affect standards of living?
- How do specific technologies affect the quality of life?

Examples of technological change are numerous and can be a bit overwhelming for students. To scaffold the process, provide students with a list of technologies that they can examine using the same approaches described in the section on Dimension 2.

- Automobiles
- Internet
- Pony Express
- Radio and Television
- Refrigeration
- Telegraph
- Transcontinental Railroad
- Telephone
- Washing machine

Support students as they locate relevant information (see the sources at the end of this chapter) regarding the costs and benefits of their assigned technology. Students should complete the blank cost/benefits chart for their technology. If students are working in groups or pairs, make sure you convene the groups as a whole class so they can share their findings. The collective findings, for all nine technologies, will be useful as students begin to synthesize their findings in response to the compelling question.

Dimension 4: Communicating Conclusions and Taking Informed Action

For this lesson, the explanations and arguments that students construct focus on the relationship between standards of living and productivity, given technological change.

A response to the compelling question in this lesson is highly dependent on the supporting questions about the costs and benefits of technological change. The C3 Framework suggests that developing explanations in response to supporting questions is key to a successful inquiry. (D4.2.6-8) The supporting questions included in this chapter were stipulated to frame students' investigation of specific technologies.

Students should compose a response to each of these supporting questions for their assigned technology. As they share responses, students should begin to synthesize ideas toward developing a response to the compelling question.

Students can share findings with their peers through PowerPoint slides, a news article, visuals, posters, and short videos. Regardless of the method chosen, each presentation should include the answers to the supporting questions above and ultimately the compelling question. Student presentations should make the case on why their technology had the greatest impact on productivity, standard of living, and quality of life.

Sources

ERIE CANAL

- <http://www.eriecanal.org> under the historical documents
- <http://www.canals.ny.gov/history/history.html>
- http://xroads.virginia.edu/~MA02/volpe/canal/history_body.html (On the history of canal politics)
- <http://www.uh.edu/engines/epi1420.htm> (This episode gives numbers on how the canal reduced the time and thus the costs of shipping goods from Albany to Buffalo, then down the Hudson to New York harbor.)
- http://www.canals.org/researchers/Canal_Profiles/United_States/Northeast/Erie_Canal
- <http://www.lerner.udel.edu/centers/ceee>. See under Resources.

PONY EXPRESS

- <http://www.nps.gov/poex/historyculture/index.htm>
- <http://ponyexpress.org/history/>
- <http://www.sfmuseum.org/hist1/pxpress.html>

TELEGRAPH

- http://www.americaslibrary.gov/jb/civil/jb_civil_telegrap_2.html
- <http://www.history.com/topics/telegraph>

TRANSCONTINENTAL RAILROAD

- <http://www.uh.edu/engines/epi2844.htm>
- http://www.archives.gov/exhibits/treasures_of_congress/text/page15_text.html
- http://www.americaslibrary.gov/jb/civil/jb_civil_telegrap_2.html
- <http://www.pbs.org/weta/thewest/program/episodes/five/index.htm>
- <http://www.pbs.org/weta/thewest/resources/archives/five/railact.htm>

TELEPHONE

- <http://www.uh.edu/engines/epi1487.htm>
- <http://www.uh.edu/engines/epi1098.htm>
- <http://www.uh.edu/engines/epi748.htm>
- <http://www.learnnc.org/lp/editions/nchist-newcentury/5092>

RADIO AND TELEVISION

- <http://www.history.com/topics/radio-and-television>
- <http://www.uh.edu/engines/epi1681.htm>
- <http://www.uh.edu/engines/epi1649.htm>

AUTOMOBILES

- <http://www.uh.edu/engines/epi1596.htm>
- <http://www.uh.edu/engines/epi2402.htm>
- <http://www.uh.edu/engines/epi2520.htm>
- <http://www.uh.edu/engines/epi2560.htm>
- <http://www.history.com/topics/model-t>
- <http://l3d.cs.colorado.edu/systems/agentsheets/New-Vista/automobile/>

REFRIGERATION

- <http://www.history-magazine.com/refrig.html>
- <http://goarticles.com/article/History-and-Impact-of-Refrigeration-on-Society/5627038/>
- <http://www.uh.edu/engines/ashrae.htm> (democratization of comfort)

INTERNET

- <http://www.history.com/topics/invention-of-the-internet>
- <http://www.uh.edu/engines/epi2117.htm>
- <http://www.ideafinder.com/history/inventions/internet.htm>
- <http://www.uh.edu/engines/epi2798.htm>
- <http://www.uh.edu/engines/epi675.htm>

WASHING MACHINE

- http://www.ted.com/talks/hans_rosling_and_the_magic_washing_machine.html
- <http://www.smh.com.au/federal-politics/society-and-culture/how-the-washing-machine-changed-the-world-20120407-1wi1k.html>

About the University of Delaware's Center for Economic Education and Entrepreneurship

The University of Delaware's Center for Economic Education and Entrepreneurship (CEEE) provides opportunities for professional development, develops dynamic teacher resources, and produces engaging student programming statewide. CEEE's primary goal is to ensure that economics, personal finance, and entrepreneurship are integrated into the K–12 core curriculum to prepare Delaware students to make informed decisions in today's global economy.

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