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Bringing Designed Ideas to the Market

Araceli Ortiz



Courtesy of Araceli Ortiz



**Key Concepts
from Previous Chapters**

- 2 Researching the Problem
- 5 Types of Markets

The idea of manufacturing may seem totally removed from your daily life. But whether it's your shirt, your desk, or your locker, each one has been manufactured. Everyone's life is affected by manufacturing. Even if you're reading this under a tree in the middle of a forest, the book you're holding is manufactured.

Manufacturing technologies are systems of people and machines that change materials into useful products. In the process design cycle, engineers develop new technologies. Well, manufacturing turns those ideas and designs into products—media players, folding chairs, silverware, you name it.

My name is Araceli Ortiz, and I'm a manufacturing engineer. To understand why I became a manufacturing engineer, you have to know something about my family.



Courtesy of Araceli Ortiz

In 1994, I led a team charged with redesigning Ford cars to make them more appealing to women.

All four of my brothers and sisters are engineers. My siblings and I were inspired by our parents to improve other people’s lives. After emigrating from Mexico City, my parents arrived in this country with little understanding of English or American culture—and without high-school diplomas.

But they had a strong work ethic and a solid vision of creating opportunity for their children. My father landed an assembly job at a Chrysler factory near our home. Everywhere I went as a child, I saw proof of my father’s hard work—the cars driving around the streets of our town. His everyday work affected thousands and maybe millions of people.

That was my first encounter with the manufacturing world. Throughout grade school and high school, I studied science, engineering, and computer classes in the afternoon, after regular classes. I also learned what engineers do and decided to become one. After all, an engineering degree improves one’s chances of finding well-paying work. I also liked knowing that I would be living up to my parents’ dreams by making a successful life for myself and, eventually, for my own family.

Designing a New Kind of Car for Women

As an engineer at Ford for 15 years, I got a chance to correct a big oversight in car design. In 1994, I became the director of women’s product marketing. My job was to figure out how to redesign Ford cars to appeal to women. The company had done some research and found that, by and large, women were not buying Fords as often as they bought other car brands. Why not? Well, that’s what I wanted to find out.

How do companies learn what consumers need? They conduct **market research**, the process of learning about consumers’ thoughts and attitudes about products. Market researchers might conduct telephone or Internet polls. They might consult public records at the U.S. Census Bureau, which provides information on where people live, how much money they make, and how many children they have. The company might organize a “focus group,” which is a panel of target users who talk about what they like or dislike about a certain product.

Market research is the process of learning more about consumers’ attitudes and thoughts about products.



To conduct our market research, we invited women of all ages to join our focus groups. We asked the women why they chose to buy one type of car over another.

The women told us a lot about why they weren't buying Fords. Many of them couldn't reach the pedals without moving the seat closer to the steering wheel—not a safe place to be if the airbag inflates. Others couldn't see well over the dashboard or through the rear window. Some women said they couldn't reach the back door hatch when it was open.

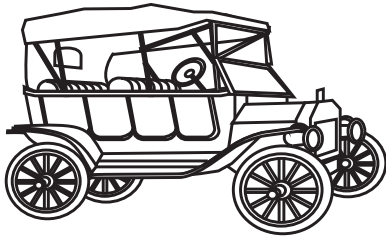
After studying their feedback, we realized the problem: Our cars had been designed for men, and not just any man. Our cars were made to fit the average American male who is between 58 and 62 tall. Now, some women are this tall, but most—including myself—are not. Behind the wheel of a car, a woman my size could not clearly see the road and couldn't reach many controls.

It wasn't very difficult to find ways to redesign the cars to fit women better and be more attractive to them. We worked with a design team to install adjustable pedals that could be moved closer to the driver's seat; we lowered the windshield and rearview mirror; and we added longer strap handles to doors so anyone could easily pull them shut. Over the years, designers have added other ergonomic touches, such as a wide central console between the driver and passenger seats that can store handbags, and doors that close automatically after children are dropped off. I like to think that our work made our competitors design cars that are safer and more appealing to women, too. They had to if they wanted to keep up with us!

This example shows how social acceptance affects what gets mass-produced. To some degree, what people buy determines what is manufactured; buying a product helps ensure another will be made to replace it. When our earlier models were designed, few engineers considered women's needs. Most companies now realize that it's critical to consider all kinds of users as they design and produce products. For this reason, it's important to have as diverse a design team as possible. When companies don't design for a varied group of users, they may endanger the users they have overlooked. At the same time, they risk losing customers!

The Car: A Case Study in Mass Production

People influence what kinds of products are manufactured by what products they purchase. But as soon as these products are widely used, they can take on lives of their own, affecting people and societies in profound ways. Cars are a fairly recent invention. In the late 1880s, just about everybody got around by bicycle, horse and buggy, trolley, train, or ship. By the turn of the 20th century, only a few companies made automobiles, by hand, and only the very rich could both afford them and have the time to learn how to drive them. Early cars cost between \$3,000 and \$6,000, a huge sum considering the average American's yearly income was only about \$1,000.



Ford's Model T was first introduced in 1908.

Cars cost so much because it took so much time and labor to make them. In 1899, an automotive factory could build only about 100 cars a year. A skilled factory employee would build most or the entire car himself.

But then a young entrepreneur named Henry Ford, the founder of Ford Motor Company, had a revolutionary idea. He developed the **assembly line system** for manufacturing automobiles. In Ford's assembly line, the chassis, or frame, of the car was hooked onto a constantly moving conveyer belt. Workers stayed at stations along the assembly path and performed the same task repeatedly on multiple vehicles. As the chassis moved through the factory building, workers along the assembly line would attach the engine, the steering column, the fenders, and so on, until a complete car would roll off the conveyer belt. As soon as one worker finished a task, the next car would come along and the worker would start again.

The assembly line system boosted production of cars dramatically. The system allowed for **continuous production**, which means that products were built in a steady flow. In fact, after a few years of fine-tuning, Ford Motor Company could make cars six times faster than companies still building by hand. The assembly line is still widely used today.



The **assembly line system** allows for continuous manufacturing, whereby goods are produced at a steady rate.

Economy of Scale

Because he could make so many cars, Ford sold his cars for much less money than his competitors could. He had achieved what economists call an *economy of scale*. An economy of scale is reached because, as production increases, the cost of producing each additional unit decreases. In other words, because Ford produced such a large number cars, each car cost less to produce.

To understand why, think of the price of a car as having four parts: 1) the cost of the materials; 2) the cost of labor to assemble the car; 3) the cost of the factory and machinery needed to produce the car; and 4) the profit made on each car.



- **Materials**

cost less because it's possible to get discounts when buying large quantities of materials.



- **Labor**

costs less if it's not necessary to train workers how to build an entire car.



- **Factory and Machinery**

costs, sometimes called capital, are spread over the number of cars produced during the lifetime of the equipment.



- **Total Profit**

is greater because more cars are sold.

To produce one car, a company would need to buy all of the materials, hire a team of skilled workers to assemble it, and build a factory. To produce many cars, a company saves money by buying large quantities of materials. Labor costs are lower because the company can hire less-skilled workers to complete only one task, and these assembly line workers can produce more cars faster. Factory and machinery costs, sometimes called *capital costs*, are spread out over the number of cars produced during the lifetime of the equipment. Only one factory is needed whether the company makes 1,000 or 10,000 cars. The more cars a factory produces, the less each car costs to produce. Total profits grow as more cars are sold.

How Did Ford Devise the Assembly Line?

Revolutionary as it was, Ford's assembly line didn't come out of nowhere. In fact, it was the result of manufacturing breakthroughs that started long before recorded history. Historians believe that the very earliest humans most likely made tools by hand for their personal use.

But today, manufacturing means not just making objects by hand but making them in a mechanical way for industry. Modern-day manufacturing began when early people started to specialize in making weaponry, clothing, and other goods. Instead of having to learn a little about a lot of different trades, people could dedicate themselves to mastering and improving processes and skills. Later, this approach produced a wide variety of goods and products.

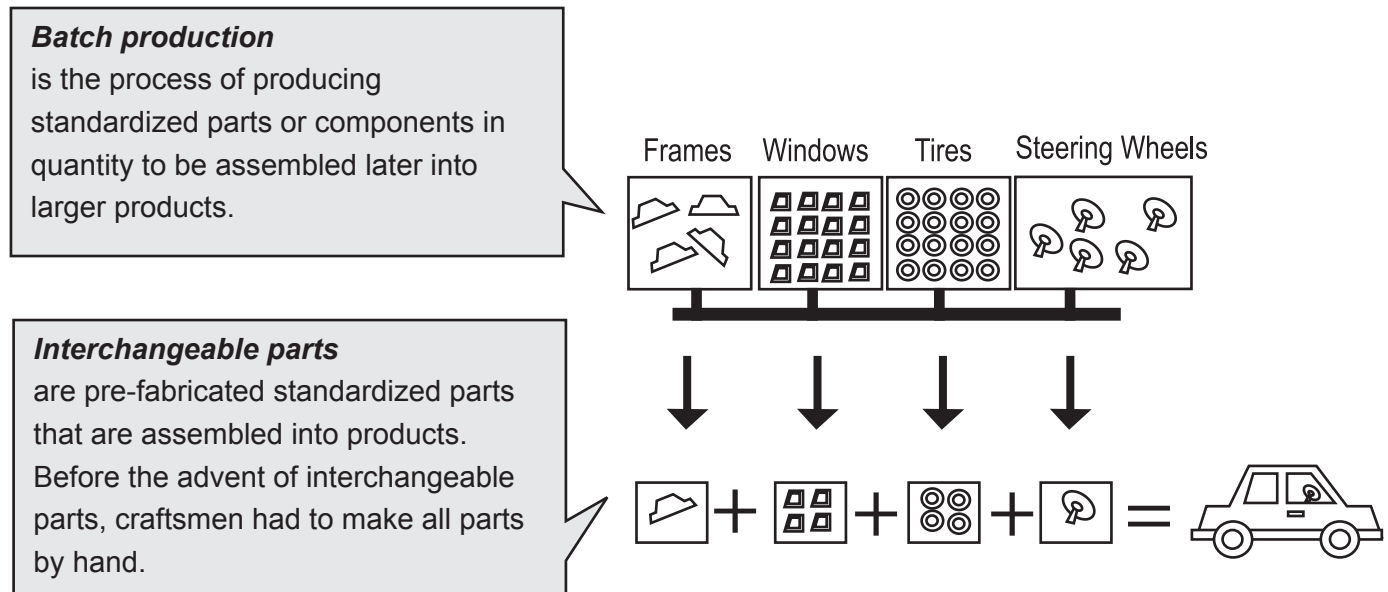
Ford's assembly line system was an extension of this specialization, with each worker learning and repeating one task over and over on each car that came down the line. But assembly lines would never have been so successful without the contribution of another early inventor, Eli Whitney. Whitney best known for inventing the cotton gin, a machine that removes seeds from cotton, but he also built a firearms factory near New Haven, Connecticut, in the early 1800s.



Whitney realized that he could save time and money if his muskets were assembled from standardized, **interchangeable parts**. A trigger mechanism for one gun, for example, could fit into every gun in exactly the same way. A worker only had to learn enough about gunsmithing to install one size and type of trigger. Rather than hiring experienced gunsmiths, who were scarce and demanded high pay, Whitney could hire less-experienced workers and train them to do simple tasks.

Ford's assembly line depended on Whitney's idea of interchangeable parts, while another area of the factory used batch production. **Batch production** is the process of producing parts in quantity to be built into larger products. Steering wheels, tires, and windows were all produced in batches then attached to cars on the assembly line.

By the time Ford's assembly line caught on as a model for other factories, America's Industrial Age was in full swing. The British invention of the steam engine had boosted productivity and increased manufacturing jobs throughout the late 1800s. American cities grew as new workers, many of them immigrants, poured in to fill growing factories. The assembly line system pushed production even higher in the early 1900s, and that trend has continued until today. That's the reason I'm here. After all, my father immigrated here to work in the auto industry.





Courtesy of Araceli Ortiz

Welcome to the Car Culture

With the assembly line system, Henry Ford could keep his prices low by producing a whole lot of cars. He charged less than \$300 per car in the 1920s. Millions of Americans, not just the very wealthy, could afford them. By the late 1920s, over 26.5 million cars were registered in the United States, enough cars to seat every living American at the time. Cars became a symbol of mobility and freedom—the American way of life.

For these millions of cars, the federal government paved miles of roadway between cities and towns across the country. Voters insisted that politicians spend money to widen and improve city streets rather than improve public transportation systems. Suburban homes dotted the land outside cities, and the workers who lived in suburbia drove to and from work every day. Motels and fast food restaurants—the first ever—sprouted up along interstates, aiming to please road-weary motorists.

By the mid-1900s, the car had transformed America. The nation's highway system meant people could travel more easily, and the number of cars on the road grew. It became difficult for pedestrians to travel in most cities. Suburbs sprawled farther away from city centers. Cars had once been a luxury item, but now most Americans used them to get to work.

The car has had countless positive effects on American society, and they continue to improve the lives of Americans today. Our society is very mobile, thanks to our vehicles, which help us to get where we need to be—work, home, or at play. Ambulances bring patients to the hospital quickly. Trucks carry food, goods, and other necessities across the country. If cars and trucks could no longer be used, many parts of our society would come to a standstill.

But there is another side of the story. The rise of the car culture has led to a number of serious issues. Few could have anticipated how many car-related fatalities and injuries would result. The U.S. Department of Transportation reports that vehicles claim more than 42,000 Americans lives each year. Vehicles remain one of the leading causes of death in this country. Could the car's first designers ever have predicted that?

Our car culture has also affected the quality of our air. The Environmental Protection Agency (EPA) reports that, in many cities, the automobile is the single largest cause of air pollution.

These health and environmental costs represent unintended consequences of a technology. **Unintended consequences** are the unforeseen effects of new technologies that arise after a technology is accepted into everyday life—effects that the designers failed to foresee.

Not all unintended consequences are bad. The Internet's designers didn't predict that their innovation would lead to the World Wide Web giving millions of people instant access to information about almost any topic.

Just about every new mass-produced technology results in some unintended consequence. It's the responsibility of today's engineers to design products in a way that minimizes the possibility of negative consequences. Will engineers in the future avoid unintended consequences? Engineers can create diverse teams of experts to explore environmental, health, and other effects of emerging technologies during the design stage. But what can consumers do? Consumers can learn all they can about using a new technology before they buy it. Remember, even if you don't become an engineer, your decisions about technology will affect everyone's future.

Unintended consequences
of new technologies are effects that arise after technologies have become mainstream, effects that the designers failed to foresee.



What's the Story?

1. What are manufacturing technologies?
2. List ten kinds of technologies that are manufactured.
3. Why had relatively few women purchased Ford cars before Araceli did her research?
4. How did Ford research the problem?
5. What is the difference between assembly line production and batch production?
6. Why are interchangeable parts critical for the success of an assembly line system? Be sure to define interchangeable parts in your answer.
7. Why is it more cost effective for companies to produce objects in mass quantities than it is for them to produce only a few?



Connecting the Dots

8. Considering both the work at IDEO and at Ford, explain why market research is a valuable tool for companies.
9. How did Araceli use the engineering design process to change automobile design at Ford?



What Do You Think?

10. Araceli asks two important questions at the end of the chapter: How can engineers avoid unintended consequences in the future? How much power do consumers have to minimize unintended consequences? Choose one question and answer it in a paragraph.