

Before the Super Soaker became a familiar part of summer, it existed as an engineering problem that Lonnie Johnson had to work through. Johnson, a Black engineer whose career included work at NASA's Jet Propulsion Laboratory, developed the idea while experimenting with technology for a heat pump. He later formed an engineering business and licensed the invention to Larami Corporation in 1989. A *license* is an agreement permitting another party to use something, such as an invention, under specified terms. The arrangement connected Johnson's technical work with a company able to bring the toy to market. According to the National Inventors Hall of Fame, the Super Soaker generated more than \$200 million in sales two years later. Those were product sales, not a statement of Johnson's personal earnings. His achievement introduces an essential business lesson: creating something useful and organizing its production are connected accomplishments, each requiring knowledge, resources, and decisions.

Production is the process of turning inputs into outputs. *Inputs* are the resources used in the process, including materials, equipment, energy, knowledge, and human effort. *Outputs* are the resulting goods or services. A working invention may demonstrate that an idea is possible, but producing thousands of dependable units requires repeatable methods. Parts must fit, materials must perform as expected, workers need suitable tools, and finished products must meet an acceptable standard. A *prototype*, an early version used to test a design, helps discover problems before committing to larger production. That distinction applies far beyond inventions. One successful demonstration does not yet establish that a business can deliver the same result repeatedly, at a manageable cost, to paying customers. Production connects creativity with the practical discipline of making an idea usable.

For a closer look, consider a hypothetical company that develops science experiment kits for students. This company is an original teaching example, separate from Johnson's businesses. Each kit contains components for a simple activity, illustrated instructions, and materials explaining the scientific principle involved. The finished box may look straightforward, but the company must select appropriate components, test the activity, write clearly, organize assembly, and check that every package is complete. *Labor* includes the physical and mental work performed by people: the educator developing the explanation contributes labor just as the person assembling the package does. *Physical capital* means productive equipment and facilities, such as testing instruments, computers, and assembly tables. *Human capital* refers to the knowledge and skills people develop. These different resources work together; expensive equipment cannot compensate for instructions that students cannot understand.

The company's first important question is what it should do itself and what it should obtain from others. It could manufacture every component, or purchase standard components and concentrate on experiment design, educational quality, and assembly. Paying another business to perform an activity is commonly called *outsourcing*. That might involve hiring a printing company to produce the instruction booklets. The decision involves more than comparing quoted prices. An outside printer may have

better equipment and expertise, but the kit company must also consider delivery reliability, minimum order sizes, and the difficulty of correcting mistakes. Producing booklets internally might provide flexibility while requiring equipment and employee time. Johnson's licensing arrangement illustrates a related principle: a creator can participate in commercial success by working with organizations that possess capabilities the creator would otherwise have to build.

Once the activities are identified, the company needs a workable sequence. Suppose employees first count components, then assemble the kits, test selected units, and prepare orders for shipment. Dividing production into distinct tasks is called the *division of labor*. Someone who repeatedly organizes components may develop an accurate, efficient method, while another employee becomes particularly skilled at checking instruction quality. However, the stages must remain coordinated. If employees can assemble fifty kits an hour but the checking process can handle only twenty-five, unfinished work will accumulate before inspection. The inspection stage is a *bottleneck*, the part of a process that restricts overall throughput—the rate at which completed work moves through the system. Hiring more assemblers would not necessarily solve that problem. The company might need better testing equipment, clearer procedures, or additional inspection capacity.

This is where *productivity* becomes useful. Productivity compares the amount produced with the resources used to produce it. *Labor productivity* specifically compares output with working time. Suppose four employees each work five hours and complete one hundred acceptable kits. Together, they have supplied twenty labor-hours, so their output averages five kits per labor-hour. After reorganizing component storage and improving the assembly instructions, the same team completes 120 acceptable kits in twenty labor-hours. Productivity has risen to six kits per labor-hour, a 20 percent increase. The improvement comes from the process becoming more effective. The [Bureau of Labor Statistics explains productivity](#) as a relationship between output and inputs, which helps distinguish greater production from greater efficiency.

That distinction prevents a common misunderstanding about workers. If the company doubles its working hours and doubles its completed kits, total production has increased, but output per labor-hour has stayed the same. If a new machine allows the team to complete more kits in the original hours, labor productivity rises partly because the workers have better equipment. A productivity figure alone cannot tell us how much of an improvement came from effort, training, machinery, or organization. Quality matters too. Completing 120 boxes is less impressive if twenty contain missing components and must be returned. For this company, counting acceptable kits gives a more useful operational measure than counting every box leaving the assembly table. Workers' observations can be especially valuable because they see recurring problems closely: a poorly labeled bin, an awkward tool, or a component that repeatedly fails inspection.

Increasing one resource while leaving others unchanged eventually encounters limits. Imagine adding more employees to an assembly room without adding tables, tools, or

storage space. The first additional employee may help substantially by preparing components for everyone else. Further additions may contribute less because people must wait for equipment or work around one another. Economists call this *diminishing marginal returns*: additional units of an input eventually produce smaller additions to output when other relevant inputs remain fixed. “Marginal” means additional; it does not mean unimportant. The pattern describes the production arrangement, not a decline in the ability of newly hired workers. Economists call a period in which at least one production input is fixed the *short run*. In the *long run*, all inputs can be adjusted. These are conditions rather than universal calendar lengths, as explained in [OpenStax’s treatment of production](#).

Every production choice also has a cost. *Fixed costs* do not change with output over the relevant period and operating range; *variable costs* change as output changes. For our kit company, a monthly workspace lease might remain the same whether it produces two hundred or three hundred kits. Components and packaging generally increase with the number produced. Wages require closer attention: a salaried manager’s monthly compensation may be fixed over that range, while hourly assembly costs may vary with production. The classification depends on the arrangement. Fixed does not mean permanent, because moving to a larger space can change the lease expense. Variable does not necessarily mean an identical cost for every additional unit, because overtime or quantity discounts can change the relationship. [OpenStax’s discussion of production costs](#) separates these categories so businesses can understand how expenses respond to output.

Put those ideas into a simplified monthly calculation. Suppose the company has \$2,000 in fixed operating costs, including its workspace, equipment-use costs, software, and administration. Assume each kit adds \$12 in components, assembly labor, packaging, and selling expenses. It sells every kit it produces directly to customers for \$25. At two hundred kits, sales revenue is \$5,000. Variable costs are \$2,400, and adding the \$2,000 fixed costs brings total operating costs to \$4,400. The resulting operating profit is \$600, before any interest or income taxes. At three hundred kits, revenue becomes \$7,500 and total operating costs become \$5,600, leaving \$1,900. These invented results depend on the assumptions: every kit sells, the price remains unchanged, and the company can handle the additional work without increasing fixed costs or the \$12 variable cost.

The difference between price and variable cost explains why the second production level performs better. Each \$25 sale contributes \$13 after covering the assumed \$12 variable cost. This amount is called the *contribution margin per unit*: what each sale contributes toward fixed costs and, after those are covered, profit. The company must therefore sell enough kits for those \$13 contributions to cover \$2,000. Dividing \$2,000 by \$13 gives approximately 153.85, so it needs 154 whole-kit sales to cover the modeled operating costs. This is its *break-even* threshold under the stated assumptions. It is not a guarantee that one hundred fifty-four customers exist or that the business has enough cash to produce their orders. The calculation identifies the sales requirement, allowing the owner to compare it with realistic demand and production capacity.

Costs also include opportunities that never appear as payments to someone else. Suppose the owner develops the curriculum, supervises production, and handles customer questions without taking a salary. The \$600 operating profit in the two-hundred-kit example would then include the reward available for that unpaid work as well as the owner's investment and risk. It should not be casually described as profit earned after fully compensating everyone. Economists distinguish *explicit costs*, expenses involving payments or recorded charges, from *implicit costs*, the opportunity costs of using resources already owned. *Economic profit* subtracts both kinds of cost, while accounting profit does not deduct those implicit opportunity costs. OpenStax explains this distinction. It helps an owner recognize what the business is actually returning for the time, resources, and alternatives committed to it.

Another useful comparison separates *average cost* from *marginal cost*. Average cost is total cost divided by the quantity produced. At two hundred kits, our company's \$4,400 total cost averages \$22 per kit. At three hundred kits, its \$5,600 total cost averages about \$18.67. The fixed expense is being spread across more units. Marginal cost concerns the additional cost of additional output. Within our simplified operating range, one more kit costs \$12 to produce and sell. But if a larger order requires overtime or renting another room, that additional cost changes. The owner therefore needs to know more than the average cost of past production when considering a new order. A contract that appears attractive using yesterday's figures could require a different production arrangement tomorrow.

Growing to a larger scale can sometimes lower average costs more substantially. *Economies of scale* occur when expanding the scale of operations reduces average cost over the long run. A larger kit business might justify specialized machinery, negotiate better purchasing terms, or support employees who concentrate on particular technical tasks. Yet size also creates coordination demands. More product versions, supervisors, suppliers, and locations can make errors harder to detect and decisions slower to implement. *Diseconomies of scale* occur when expansion raises average cost because such difficulties outweigh the benefits. OpenStax's explanation of long-run costs describes both possibilities. Spreading an existing lease over more units is one useful calculation; deciding whether an entirely larger operation would be more efficient is a broader question.

Producing more also requires a plan for what happens before customers pay. Imagine a school placing an order for three hundred kits but paying several weeks after delivery. The company may need to purchase components and pay employees before receiving the sales proceeds. An order can be profitable on paper while creating a difficult timing problem. Likewise, producing kits before receiving orders creates *inventory*, goods held for future sale. Inventory can help the company deliver quickly, but it also uses money and storage space, and some products may remain unsold. A thoughtful production plan considers demand, available cash, supplier timing, and capacity together. The goal is to deliver useful products dependably while preserving the resources needed to continue operating.

The science kit ultimately reaches a student who expects the components to work and the explanation to make sense. That moment is the test of many business decisions made earlier: the choice of materials, the care taken with instructions, the organization of employees' work, and the discipline used to manage costs. Lonnie Johnson's engineering success reminds us that technical imagination can become commercially valuable when it connects with a workable route to production and customers. A business owner develops a similar understanding by learning what each resource contributes and where the process needs improvement. Excellence becomes repeatable when people can identify a problem, improve the method, verify the result, and deliver it at a cost the enterprise can sustain. The achievement is visible in the customer's hands, but it is built through the quality of the decisions behind it.