Chapter 1

Defining Six Sigma

In This Chapter

- ▶ Looking at a problem-solving methodology
- ▶ Reviewing the precise statistical term
- ▶ Recognizing that Six Sigma isn't just another initiative-du-jour
- ▶ Identifying a formidable business force

It's not often that a *For Dummies* book topic first needs a formal definition. After all, you know in general what gardening, dating, and even marathon training are. But "Six Sigma"? Even if you remember that sigma is the 18th letter of the Greek alphabet, why six of them? What happened to the first five sigma?

It's okay if you don't know what "Six Sigma" is at all, or don't understand every aspect of it. That's because Six Sigma — once a precise, narrowly-defined term — has grown over time to represent a number of concepts:

- *Six Sigma* is a problem-solving methodology. In fact, it's the most effective problem-solving methodology available for improving business and organizational performance.
- *Six Sigma performance* is the statistical term for a process that produces fewer than 3.4 defects (or errors) per million opportunities for defects.
- A *Six Sigma improvement* is when the key outcomes of a business or work process are improved dramatically, often by 70 percent or more.
- A *Six Sigma deployment* is the prescriptive rollout of the Six Sigma methodology across an organization, with assigned practices, roles, and procedures according to generally accepted standards.
- A *Six Sigma organization* uses Six Sigma methods and tools to improve performance: Continuously lower costs, grow revenue, improve customer satisfaction, increase capacity and capability, reduce complexity, lower cycle time, and minimize defects and errors.

No pain, no gain

The Six Sigma approach is not for the faint of heart, nor the unprepared organization. It's intense and rigorous, and it entails a thorough inspection of the way everything is done. Six Sigma sets ambitious business objectives and measures performance in a way that forces accountability. It doesn't allow a management team to become complacent, but, rather, it exposes waste that otherwise would remain largely invisible.

Six Sigma takes a business out of its comfort zone — but for a relatively short time. After the first project gains are made and the money starts flowing to the profit margin, a cultural change takes hold. The early discomfort of changing business processes gives way to success, problems become opportunities for improvement, and the organization begins to enthusiastically leverage the methods and tools of Six Sigma — more pervasively and with a keen eye on value.

Six Sigma is a methodology for minimizing mistakes and maximizing value. Every mistake an organization or person makes ultimately has a cost — a lost customer, the need to do a certain task over again, a part that has to be replaced, time or material wasted, efficiency lost, or productivity squandered. In fact, waste and mistakes cost many organizations as much as 20 to 30 percent of their revenue! That's a shocking number. Imagine throwing 20 to 30 percent of your money away in the garbage every time you cash a check. It may sound ludicrous, but that's what many organizations do.

All businesses, organizations, and individuals have room to improve. No operation is run so tightly that another ounce of inefficiency and waste can't be squeezed out. By their nature, organizations tend to become messy as they grow. Processes, technology, systems, and procedures — the ways of doing business — become cluttered with *bottlenecks,* meaning work piles up in one part of the organization while other parts sit idle with nothing to do.

Work is often performed incorrectly, or the outcome is flawed in some way. When this happens, you scrap products and services and have to do the work over again: You consume additional resources to correct a problem before it's delivered to the customer, or the customer asks later for a "redo" — a new product or a more satisfactory service.

Sometimes, flaws and defects aren't the problem, but a product or service simply takes too long to produce and deliver. Think about the problems a mortgage company would have if it processed home loans perfectly, but did so 5 times slower than the competition. That's a perfect disaster.

Six Sigma was once a quality-improvement methodology, but now it's a general-purpose approach to minimizing mistakes and maximizing value: How many products can you produce, how many services can you deliver, how many transactions can you complete to an expected level of quality in the least possible amount of time at the lowest possible cost?

Six Sigma takes effort and discipline and requires you to go through the pain of change. But soon the pain is transformed into improved performance, happier customers, lower costs, and more success.

The Managerial Perspective

While Six Sigma has its many definitions, Six Sigma action occurs on two different levels: the managerial and the technical. At the managerial level, a Six Sigma initiative includes many units, people, technologies, projects, schedules, and details to be managed and coordinated. There are also many plans to develop, actions to take, and specialized work to complete. For all of this to work in concert, and for the technical elements of Six Sigma to be effective, you have to set the proper management orientation.

From good to great the Six Sigma way

In the best-selling business book *Good to Great,* author Jim Collins studied companies that achieved a distinct break with the past by dramatically improving their performance, as reflected in market value appreciation. He set out to discover their secret — the stuff they held in the black box called "what we did to become great" and to beat the performance of the average company in their market by 3, 7, or even 18 times.

Collins' empirical research led him to several interesting conclusions. Greatness is not a function of larger-than-life leaders, exorbitant executive compensation, killer business strategies, advanced technologies, mergers and acquisitions, or big change initiatives. Over the long run, as it turns out, these are all collective crutches an organization leans on to prop itself up — but none of these enable a company to become great.

So what makes a company great? According to Collins' research, it is this: disciplined people, disciplined thought, and disciplined actions over an extended period. Having "the right people on the bus," as Collins puts it, having the "discipline to confront the most brutal facts of your current reality," in thought and in action, is the recipe for greatness.

Simply, this good-to-great result comes from the right people applying the right principles in the best possible way. Interestingly, this is what Six Sigma is all about: selecting the right people to drive and lead systematic improvement in a prescribed, disciplined, measurable, and repeatable manner.

Radical corporate success

Six Sigma performing companies realize staggering business success:

- **General Electric** profited between $7 to $10 billion from Six Sigma in about five years.
- **Dupont** added $1 billion to its bottom line within two years of initiating its Six Sigma program, and that number increased to about $2.4 billion within four years.
- **Bank of America** saved hundreds of millions of dollars within three years of launching Six Sigma, cut cycle times by more than half, and reduced the number of processing errors by an order of magnitude.
- **Honeywell** achieved record operating margins and savings of more than $2 billion in direct costs.
- **Motorola,** the place where Six Sigma began, saved $2.2 billion in a four-year time frame.

Six Sigma helps organizations achieve breakthrough improvement, not incremental improvement. In short, Six Sigma is a path to dramatic improvement in value for your customers and your company.

Bridge between science and leadership

From a management standpoint, Six Sigma culminates in the predictability and control of performance in a business or a business process, by applying the methods of science to the domain of leadership.

Early in the 20th century, Henry Ford applied the principles of science to the production of cars. By following set processes and by optimizing repeatable processes, Ford and others made goods that displayed little variation in their final states and could be mass-produced without requiring extensive education and years of finely honed skills among the assembly-line staff. We have witnessed how the achievements of machinery, technique, process, and specialization of labor collectively enable the explosion of mass-production and the consumer society. Science dictates how all the parts, materials, machines, and people on the assembly line interact to turn out many “widgets” at the highest possible speed and the lowest possible cost.

Managerially speaking, the goal of Six Sigma is to inject similar control, predictability, and consistency of results into the production of a successful organization, such that the widget comes off the production line absolutely consistently.

Countless times every day in the United States, people open a water faucet and experience the flow of clean, clear water. The reason is because reliable purification systems treat the water and pressure systems ensure the water is there. This is what Six Sigma does; it treats the processes in a business so that they deliver their intended results reliably and consistently.

The methodology of Six Sigma was first applied in a manufacturing company, but it also works in service and transactional companies (like banks and hospitals), where it has been implemented many times with great success. Six Sigma dramatically improves the way any process works — whether that process is in the chemical industry, the oil industry, the service industry, the entertainment industry, or anything else.

Management system orientation

Six Sigma is so appealing to managers because it delivers management results.

Clear value proposition and ROI

Six Sigma is characterized by an unwavering focus on business return on investment (ROI). A Six Sigma project can improve a business characteristic by 70 percent or more, stimulating increased operating margins for businesses, while at the same time increasing the value those businesses provide to their customers. Six Sigma initiatives and projects have a direct, measurable financial focus and impact.

Top commitment and accountability

A Six Sigma initiative begins at the top. The leadership and management of an organization must actively commit to the Six Sigma initiative, setting performance goals and developing tactical implementation plans. Management team members must be personally accountable for achieving the performance improvement goals they set for their respective organizations and business units.

Customer focus

Six Sigma, through its *voice of the customer (VOC)* tools, drives business processes through customer requirements. No operational, process, and business improvements can occur without a definitive understanding of who the customers are and what they need, want, and are willing to buy. Six Sigma managers become savvy about the needs and requirements of customers, in a way that also enables the business to become stronger and more profitable.

Connected business metrics

You know by now that Six Sigma is different from other performance improvement approaches in its focus on business financials and measurable operational improvements. To support this, the Six Sigma management system must include performance measures that are readily accessible and visible to everyone whose actions or decisions determine performance levels and operational quality.

Process orientation

Six Sigma improves the performance of processes — any business or work process — in how those processes effectively and efficiently transform material and other inputs into the desired outputs. This is the focal point of using Six Sigma to improve performance: the design, characterization, optimization, and validation of processes.

Project focus

The Six Sigma project is the tool by which processes and systems are characterized and optimized. Program leadership identifies opportunities for Six Sigma improvement projects and assigns Six Sigma specialists to execute them. We provide details about how to select Six Sigma projects in Chapter 4, how to implement projects in Chapters 5 through 10, and how to manage projects using tools in Chapter 12.

Enabling tools and technology

Properly managing a Six Sigma initiative that spans an entire organization or a significant part of an organization requires the ability to simultaneously manage many projects, processes, analyses, data banks, training activities, and people. Generally speaking, several classes of tools and technology are employed to accomplish this:

- Tools for designing, modeling, managing, and optimizing processes
- Tools for the broad-scale management of multiple projects across multiple organizational units
- Tools for collecting data, conducting analytical calculations, and solving performance problems
- Tools and technologies for training, educating, transferring knowledge, and managing knowledge

We provide a comprehensive view of the many Six Sigma tools and technologies in Chapters 11 and 12.

The historical perspective

The Six Sigma methodology was formalized in the mid-1980s at Motorola. New theories and ideas were combined with basic principles and statistical methods that had existed in quality engineering circles for decades. The building blocks were enhanced with business and leadership principles to form the basis of a complete management system. The result was a staggering increase in the levels of quality for several Motorola products, and the inaugural Malcolm Baldrige National Quality Award was bestowed on the company in 1988.

Everyone wanted to know how Motorola had done it. Then-president Robert Galvin chose to share Motorola's Six Sigma secret openly, and by the mid-1990s, corporations like Texas Instruments, Asea Brown Boveri, Allied Signal, and General Electric had begun to reap similar rewards. By 2000, many of the world's top corporations had a Six Sigma initiative underway, and by 2003, over $100 billion in combined savings had been tallied.

Six Sigma became the global standard of quality business practice, embraced by the American Society for Quality. Universities worldwide now offer courses. Dozens of consulting and software companies have brought products and tools to market. By the end of 2004, over 200 books on Six Sigma were in print, and entering the term "Six Sigma" into Google returned some 2,320,000 hits.

An infrastructure for change

Installing and managing a Six Sigma management system require a certain infrastructure — an underlying set of mechanisms and structures upon which to develop the Six Sigma improvement strategies and enact the tactics of project implementation and process improvement. The key elements of an effective Six Sigma infrastructure include the following:

- A fully documented Six Sigma leadership system, strategic focus, business goal configuration, deployment plans, implementation schedules, and activity tracking and reporting techniques
- A strategy, methodology, and system for training and preparing executives, managers, Champions, Black Belts, Green Belts, Yellow Belts, financial auditors, process owners, and all others involved in the Six Sigma initiative; we define and describe all the Six Sigma job roles in Chapter 3
- Competency models and compensation plans, Six Sigma participant and leader selection guidelines, position and role descriptions, reporting relationships, and career-advancement policies and plans
- Guidelines for defining project-savings criteria, aligning accounting categories with Six Sigma goals and metrics, forecasting project savings, auditing and evaluating project ROI, validating project savings, and reporting project ROI

- Hard criteria for selecting projects, designating project-type categories, developing project problem-definition statements, targeting intended project savings and ROI, approving selected projects, and managing projects through to completion; we give you more about project management in Chapter 4
- Information-technology-related structures, procedures, dashboards, tools and systems for designing and managing processes, tracking project and initiative progress, reporting results, storing information and data, and performing analytical functions; we look at these in more depth in Chapters 11 and 12
- A strategy for consistently communicating the Six Sigma initiative across the enterprise, and an Internet or intranet site that provides a common reference and knowledge base that contains important information, motivational content, recognition stories, educational material, contact information, and so on
- A management review process for assessing the effectiveness of Six Sigma from the top to the middle to the bottom of the organization:
    - At the top, the focus is on the aggregate process, projects, and results for entire implementation business units.
    - In the middle, the focus is on the process and results of operational units with multiple Six Sigma projects.
    - At the lower levels, the focus of management review is on making sure individual projects are on track and yielding their intended process-improvement and financial results.

Complete culture change

A Six Sigma initiative often begins with outside consultants providing methods, tools, and training, but over time, the knowledge is internalized and applied organically within the organization. The ultimate goal is for everyone in the organization to have a working ability to understand customers' requirements, collect data, map processes, measure performance, identify threats and opportunities, analyze inputs and outputs, and make continuous improvements. In Chapter 3, we provide more details about culture change.

The Technical Perspective

Six Sigma performance is the statistical term for a process that produces fewer than 3.4 defects or errors per million opportunities. Behind that single statistic lies a methodology that includes a plethora of data, measurement, analysis, improvement, and control tools and supporting technologies. This section is an overview of the technical side of Six Sigma.

Quality and grade

Quality is different from *grade.* A product can be low grade but high quality, such as 87 versus 91 octane gasoline. As long as the 87 octane gas meets its required specification, it is of high quality, even though it's a lower grade. Only if a certain batch of low-grade gas doesn't meet its 87 octane requirement can you say it is of low quality, or defective.

Therefore, quality is always relative to intent. A quality $12 haircut is different from a quality $30 haircut. A quality economy car is expected to be different from a quality luxury car. A discount online stockbroker can provide a higher-quality experience than a full-service broker, relative to the expectations attached to both, respectively.

Product, service, and transactional quality

The technical objective of Six Sigma is to ensure the high quality and reliability of products, services, and transactions — the lifeblood of all businesses and organizations. Banks, government agencies, hospitals, car washes, toy makers, semiconductor plants, professional services firms — all organizations of any type — provide products, services, and transactions, or some combination of the three.

For example, most auto manufactures do much more than build cars. They also provides services, such as routine maintenance and warranty repairs, through their dealerships. Through their financing arms, they approve and process car payments, a transactional business activity.

The technical goal of Six Sigma is for products, services, and transactions all to be performed with the highest possible quality as efficiently and effectively as possible. This requires performance targets for all components in a system, and for each important characteristic of every component. For example, a car axle (component) has to have the proper form, fit, and function to perform as intended, and if it is to fit together with other components of the car.

Aiming for the target

In Six Sigma, important characteristics are referred to as CTXs, where the *C* stands for "critical," the *T* stands for "to," and the *X* represents what the characteristic is linked to: quality, cost, time, satisfaction, and so on. For example, a critical-to-quality characteristic would be called a CTQ. Graphically, you can depict the target values of any CTX in Figure 1-1.

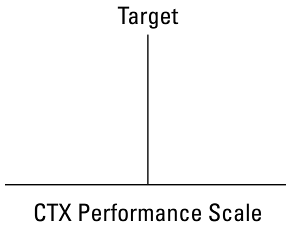

Figure 1-1: Target of a generic CTX.

A performance scale in some kind of units, such as time, length, size, and so on, indicates the measured value of your CTX. The goal of Six Sigma is to come as close to your performance target as often as possible. If you're making an axle, your goal is to make all your axles for a certain car the same length every time. This is the consistency a customer needs, and the predictability a business needs.

The reality of variation

But what really happens? In reality, you can't hit the target value perfectly all the time, no matter how good you are or how hard you try. You can get close, but you will always have some variation.

In other words, every instance of a product coming off of a production line is in some way different from every other instance. The thickness of a part is never exactly the same. The amount of time it takes to execute a certain business transaction varies from instance to instance.

In the world of making products, delivering services, and conducting transactions, there is always a distribution of performance around a target. Normally, that distribution takes on the shape you see in Figure 1-2. This famous shape is called the *normal distribution*, and is also known as the *bell curve.*

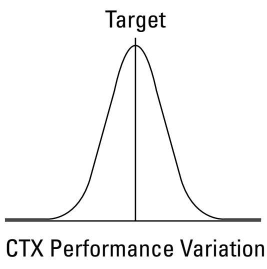

Figure 1-2: Performance variation around a target.

Notice the shape of the normal distribution. It's symmetrical about the central line, with just as much area under the curve to the left as on the right. In Six Sigma, you encounter the normal distribution curve repeatedly, because it reveals itself again and again in the course of natural events.

Specifications have their place, and only their place

Henry Ford knew about variation nearly 100 years ago when he was mass producing his Model T cars. There is variation in everything, and all the many car parts would vary in their CTX dimensions. So what did he do? How could Henry account for this annoying phenomenon of variation?

He and the other industrialists of his day incorporated specifications and standards into their businesses. Recognizing that parts would vary at the component characteristic level, Ford designated variation limits within which to operate. By doing so, he could accept the inevitable presence of variation while not ignoring its tendency to create defects and cause business loss.

Figure 1-3 shows a performance CTX with a normal distribution and the acceptable upper and lower limits of performance. With these specifications defined, you have a way to measure quality. You have a way of bounding an acceptable extent of variation for your customers and for the business. Having performance specification limits for component characteristics gives you parameters for defining, measuring, analyzing, improving, and controlling quality.

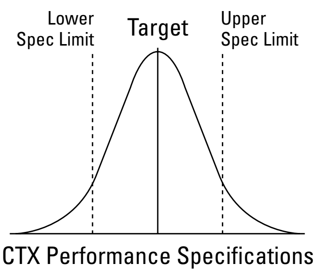

Figure 1-3: Performance specifications around a target.

Consider these examples: A mortgage company has a goal of refinancing loans within two weeks of receiving a completed application. A pest-control company believes it must arrive within 30 minutes of all scheduled appointment times. An office-furniture company determines that to be competitive, it must not produce more than two defective pieces of furniture for every 100 produced.

Here are more examples:

- A automotive engineer designs an axle. She knows that for optimal performance within the power train, the axle needs to 3.325 inches in diameter. Realizing that there will be variation in the thousands of axles that will be produced, the engineer places an upper diameter limit on her design at 3.330 inches and a lower diameter limit of 3.320 inches. In the engineer's judgment, axles that fall within this range will be acceptably close to the target.
- The manager of a pizza company asks his employees to put between 7 and 9 ounces of cheese on each large pizza. His goal is 8 ounces, and he knows that having a pizza with too much or too little will lead to customer complaints.

Quality is defined by *conformance to standards or specifications.* When you operate or perform within the specification limits, you have quality. When you fall outside the limits, you have defects.

An even better definition may be this: Get as close to the target with the least amount of variation as possible. While specification limits are important and necessary, you want to focus on trying to hit your performance target and minimizing variation, because variation leads to defects and errors, which lead to poor quality, which leads to dissatisfied customers and business loss.

The journey from one to many

In the preceding section, quality is defined in terms of aiming for a performance target and achieving the least amount of variation possible — for one characteristic or one component. Now you can talk about quality in the overall assembly of a product, service, or transaction.

Consider the company which must operate at high levels of quality at the level of individual characteristics and components, because so many of them have to fit and work together to make a whole product. For example, the average car has about 10,000 individual quality characteristics, or CTXs. That's a lot of stuff that has to work together. If you work at an automotive company, how many cars do you make? How many papers have to get processed every day? How much material and supplies are ordered and purchased in every month? Millions upon millions — billions.

Suppose you have a die, and every time you roll the die and get a 1, that's considered a *defect.* With a six-sided die, then, you have one chance in six (17 percent) of rolling a defect, or a five out of six chance (83 percent) of success. But imagine now you have a pair of dice, and you roll them both together. Now the chance of success — no defects — is only 69 percent. (We show you how to calculate these probabilities in Chapter 6.) With three dice, the chance of rolling defect-free further decreases to 58 percent. Now image rolling 20 dice or 50 dice or 100 dice. With a hundred dice, you are almost certain to have a defect. (The actual probability of never getting a 1 when rolling 100 dice is less than one in 82 million!)

In Six Sigma, we call this concept of compounding defect risk *rolled throughput yield,* and we explain it mathematically in Chapter 6. In practical terms, the reality of rolled throughput yield means you have to establish an extremely high probability of success for each individual component characteristic if you ever expect your final products, services, and transactions to be highly successful and defect-free.

Exposing the hidden factory

Very few companies can actually achieve Six Sigma (fewer than 3.4 defects per million opportunities) or even five sigma performance (fewer than 233 defects per million opportunities) in their final products, because there are so many critical processes, process activities, machines, people, and materials that have to interact along a chain of causation and span of time.

Here's an example: The chemical properties of the catalyst, that is combined with the base material, that is mixed by the processing machine, that is controlled by the in-line gauges, that is operated by John, that is inspected by Sally, that is packaged by robots, that is stored in the warehouse, that is shipped to the customer via FedEx — all these have to operate in synch within certain limits of variation if the system is to reliably yield its intended outcomes. Remembering, too, that before any of this, the whole system, including the product itself, was designed by a team of engineers who are by no means infallible.

If any one of the many critical activities is compromised or doesn't function to its expectation, risk and error are propagated throughout the entire system. The system itself is also an opportunity-rich environment for hiding risk and error, because problems arising in one place and time are caused in another place and time, and the space between is extremely difficult to navigate without the proper methodologies, equipment, and people.

Among Six Sigma practitioners, this reality of fixing the results of propagated error is known as the *hidden factory* or *hidden operation.* You can almost see the wheels turning, the rework and cover ups, the hours and days of wasted time in a company of people who constantly correct mistakes. Every time a corrective action is taken or a machine is re-run, or a warranty claim is processed, you incur unnecessary rework. When you accept these events as "that's just the way it is," you've mentally hidden all of these activities from your improvement potential.

This is the hidden factory that runs in the background of all organizations. It is the factory that fixes problems, corrects mistakes, and otherwise wastes both time and money — a company's two most precious commodities. Six Sigma eliminates the hidden factory, and, as a result, returns precious time and money back to the business.

Watch out for the wiggle, bump, and jitter

Humans aren't the only ones with variable behavior. Machines vary, too. Process inputs and outputs vary, and single characteristics vary, which causes their assemblies to vary as well.

You can see variation. You can visually plot the behavior of people, processes, products, and systems and look at it like a picture. A plot like this helps you see immediately that every characteristic you can measure has a performance distribution.

Furthermore, you can plot behavior today, come back next week and plot it again, and compare the difference. What if you plotted behavior one day and it looked one way, and next week it looked different? Comparing a single snapshot to the accumulated variation over time is an example of the change in behavior from the short term to the long term. Figure 1-4 shows two probability distributions for a critical characteristic: short term (solid line) and long term (dotted line). As you can see, in the long-term the variation in the behavior of the characteristic expands.

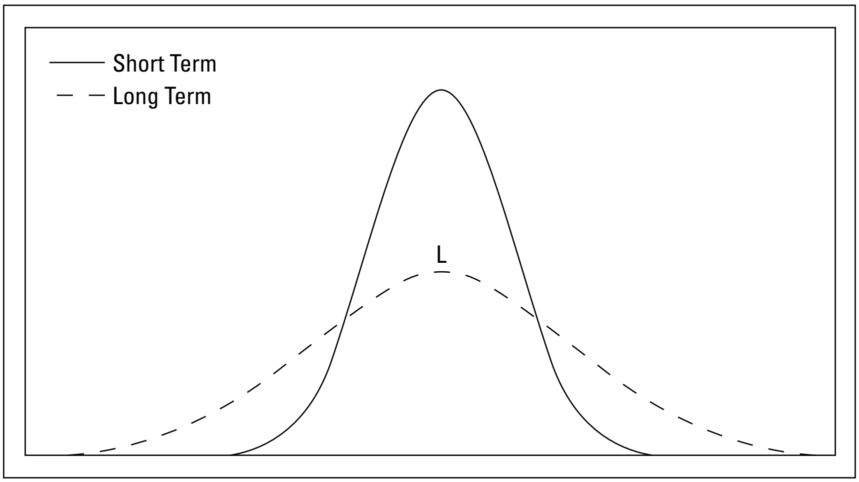

Figure 1-4: Short-term and long-term variation.

TIP

This is a common occurrence. Here's what's happening. The probability of a defect in the short term does not account for certain changes that take place over the long term. Examples include the variation among different batches of incoming material, the impact of seasonal road traffic on delivery time, the different working styles and habits of different personnel. Joe may be a great machine operator, but he can't work 24 hours a day. Eventually, he has to be relieved by Jim, who works a little differently from Joe. Each one has their own performance variations, but combined together it enlarges the range.

Short-term variation doesn't necessarily refer to a specified period of time for every type of performance distribution. The time period involved in short-term performance variation for a restaurant meal is different from the period involved for the performance of electricity delivered to your home by a power plant. Chapter 5 provides more detail and understanding on why this is the case and what it means for the Six Sigma practitioner.

Why six and why sigma? (Putting the pieces together)

The two preceding sections describe two interesting phenomena. One is considering performance in terms of the hundreds and often thousands of separate characteristics in a product, service, transaction, process, or system. Two, whatever performance level you achieve in the short term will become eroded over the long term. The term Six Sigma comes from the statistical basis of the approach and methodology used to address these two concerns: the roll-up of characteristic behaviors and the natural increase in variation in each characteristic over the long-term.

The sigma scale is a universal measure of how well a critical characteristic performs compared to its requirements. The higher the sigma score, the more capable the characteristic. For example, if a critical characteristic is defective 31 percent of the time, you say that this characteristic operates at two sigma. But if it runs at 93.3 percent compliance, you say that it operates at three sigma. Table 1-2 shows the sigma scale.

Table 1-2 The Sigma Scale

Sigma	*Percent Defective*	*Defects per Million*
1	69%	691,462
2	31%	308,538
3	6.7%	66,807
4	0.62%	6,210
5	0.023%	233
6	0.00034%	3.4
7	0.0000019%	0.019

If a characteristic operates at three sigma, that means that, 6.7 percent of the time, the variation in its performance exceeds acceptable levels. This could be an invoicing process that goes longer than the company's allowed time limit, or a forged bolt that is manufactured longer than customer requirements. Whatever the critical characteristic may be, if it is three sigma, it is defective 6.7 percent of the time, or 66,700 times out of a million. In Chapter 6, we explain more detail of how the sigma scale is created and why its called "sigma."

What the originators of Six Sigma discovered is that when they worked to have each critical characteristic in the system — the product, the service, the transaction — perform at a Six Sigma level, the risk of the individual characteristics being incorrect was small enough (0.00034 percent or 3.4 defects per million opportunities) that when all the parts were assembled together, the overall system still performed at an exceptional level. And even when long-term effects inevitably entered into each characteristic, the overall system performance remained high. These companies now had a method for competing at a whole new level on the global market. That's why six is the magic number.

So why six and not five sigma? Good question. For the complex products on which this method was originated, there were enough characteristics rolled together and enough long-term degradation that only six would do. Four or five sigma just didn't provide enough relief from these two constraints.

For transactional and service companies now adopting Six Sigma, their systems and environments are often less complex — they don't have as many critical characteristics coming together. So they don't necessarily need to have each critical characteristic operating at Six Sigma. In these cases, four or five may actually do.

But the magnitude of the earlier success of Six Sigma has made the name stick. And almost all companies, regardless of their size or complexity, recognize the benefits of aiming for a Six Sigma goal. Even if the milestone of Six Sigma is never reached, the act of working toward that goal drives breakthrough changes.

There are instances where great companies are able to produce Six Sigma quality in their final products, services, and transactions — especially when safety or human life is involved. For example, did you know that you are about 2,000 times more likely to reach your destination when you fly than your luggage is? That's because airline safety operates at a level higher than Six Sigma, while baggage reliability operates at about four sigma.

Table 1-3 How Good Is Good?

99% Good (3.8 Sigma)	*99.99966% Good (Six Sigma)*
20,000 lost articles of mail per hour	7 articles of lost mail per hour
Unsafe drinking water for almost 15 minutes per day	One unsafe minute of drinking water every seven months
5,000 incorrect surgical operations per week	1.7 incorrect surgical operations per week
2 short or long landings at major airports every day	1 short or long landing at major airports every five years
200,000 incorrect drug prescriptions each year	68 incorrect drug prescriptions each year
No electricity for almost 7 hours each month	One hour without electricity every 34 years
11.8 million shares incorrectly traded on the NYSE every day	4,021 shares incorrectly traded on the NYSE every day
3 warranty claims for every new automobile	1 warranty claim for every 980 new automobiles
48,000 to 96,000 deaths attributed to hospital errors each year	17 to 34 deaths attributed to hospital errors each year