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A Holistic View of Six Sigma

"Only the over-all review of the entire business as an economic system can give real knowledge."
—Peter F. Drucker

You may have heard of Six Sigma, a process-focused strategy and methodology for business improvement. Companies such as General Electric, Honeywell, Motorola, DuPont, American Express, Ford, and many others, large and small, have been using it to improve business performance and realize millions of dollars in bottom-line savings (Honeywell 2002, Welch 2001, Young 2001). Six Sigma is a strategic approach that works across all processes, all products, and all industries. Six Sigma focuses on improving process performance to enhance customer satisfaction and bottom-line results. Motorola created the methodology in 1987, and the use of Six Sigma by others increased rapidly during the 1990s. Six Sigma remains in widespread use as of this writing.

You also may have heard how Six Sigma has been used to improve the performance of manufacturing organizations, but thought it doesn't apply to your situation. Perhaps you don't work in manufacturing. Perhaps you want to improve results in a financial services organization. If so, you must ask whether Six Sigma can be used to improve the performance of your organization, and if so, how. The answer to the first part is a resounding yes! In our experience, and that of many others, Six Sigma works in all processes, in all parts of the organization, and in all organizations, services and health care as well as manufacturing. The second part of the question (how) is answered throughout the remainder of this book.

Six Sigma "beyond the factory floor" refers to improving processes in the non-manufacturing parts of the economy (the rest of the economy beyond manufacturing, such as financial services, e-commerce, health care, and so on). For reasons discussed shortly, we refer to this as the *real economy*. This real economy includes businesses that do not manufacture, such as banks and law offices, non-profits (including non-profit hospitals), and all the other (non-manufacturing) parts of organizations that do manufacture products. For example, Figure 1.1 shows a systems map for a manufacturing company. You can see from this graph that manufacturing is only one of many processes—such as delivery, finance, and human resources—needed to operate the company. Figure 1.2 shows a systems map of a typical manufacturing facility. Here again you see that many non-manufacturing processes are needed to run the facility, such as purchasing, shipping, and maintenance.

The real economy therefore consists of all businesses that do not manufacture physical products as well as all the other functions and processes involved in manufacturing. All processes in an organization present opportunities for improvement. This is what we mean by a *holistic view of Six Sigma*—seeing the big picture and not allowing our deployment or results to be limited by preconceived notions about Six Sigma and where it applies.

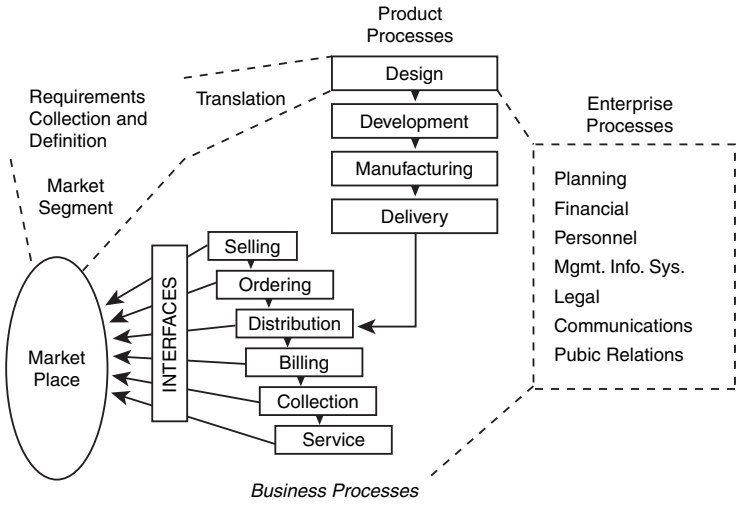

FIGURE 1.1 A corporation's core processes.

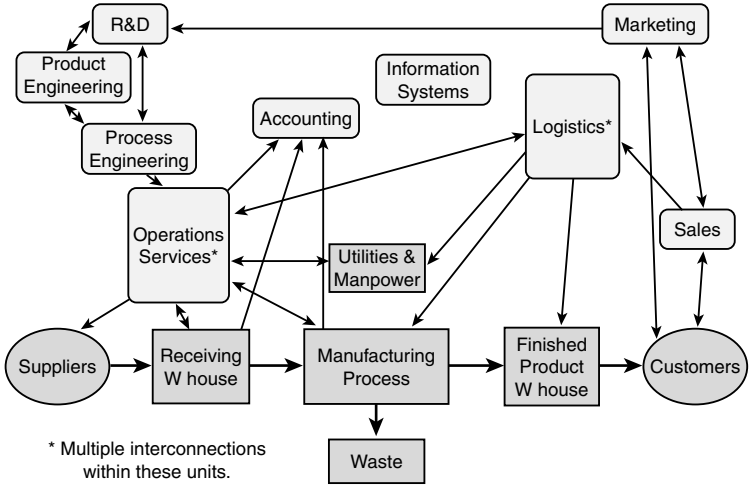

FIGURE 1.2 A manufacturing facility.

This book is organized according to the three major levels at which organizations must consider how to adapt Six Sigma to receive its full benefits beyond the factory floor:

- **The deployment (strategic) level—**How to think through overall deployment of the initiative across the entire organization.
- **The project (tactical) level—**How to select, conduct, and close out projects in these environments.
- **The methods and tools (operational) level—**How to properly apply the analytic techniques of Six Sigma when faced with difficulties common beyond the factory floor, such as skewed (non-normal) cycle time distributions, or the prevalence of discrete data.

This book is intended as a guide for those just starting their Six Sigma deployment and as a reference for experienced Six Sigma practitioners such as Six Sigma leaders, Champions, *Master Black Belts* (MBBs), *Black Belts* (BBs), *Green Belts* (GBs), and for others who are involved in the deployment of Six Sigma and want to assess the effectiveness of such. Of course, different sections of this book are likely to be of greater value to some than to others (depending on their role with Six Sigma).

In *Statistical Thinking—Improving Business Performance* (Hoerl and Snee 2002), we explained the concept of statistical thinking and its key elements—process, variation, and data. We focused on how to use statistical thinking to improve business processes—those beyond the factory floor—by reducing variation. All processes vary, and reducing variation, both between the process average and process target, and also around the process average, is a key to improving process performance. In fact, Jack Welch (Welch 2001) states that process consistency is, in many ways, more important to customers than the average level of process performance. *Statistical Thinking—Improving Business Performance* also contains detailed descriptions of the statistical thinking and Six Sigma tools, including how they apply in a business setting. These tools include basic problem-solving tools (scatter plot, histogram, run chart, Pareto chart, and so on), regression,

experimental design, statistical inference, and so on. Since writing this book, Six Sigma is the best way we have found to actually deploy statistical thinking broadly.

In *Leading Six Sigma: A Step-by-Step Guide Based on Experience with GE and Other Six Sigma Companies* (Snee and Hoerl 2003), we showed how to deploy Six Sigma in an organization and how to integrate it with other improvement initiatives. We presented detailed case studies, both successful and unsuccessful, identified the key factors required for success, and presented a detailed deployment strategy. The last chapter included a set of commonly asked deployment questions; our answers to them are based on our experience deploying Six Sigma. The majority of this material was intended for those working in a manufacturing or engineering environment, although the issue of deployment in the real economy was discussed.

This book takes the methodology one step further, focusing on perhaps the most challenging use of Six Sigma: improving processes beyond the factory floor. This requires special attention because formal improvement methods have been applied less frequently here, resulting in less being known about how to improve these processes. For example, less data are typically available on real economy processes than manufacturing. Chapter 2 addresses the differences between manufacturing and real economy applications of Six Sigma more fully. Understanding these differences will help you better understand what is required to improve processes beyond the factory floor.

Those with a holistic view of Six Sigma will see the potential "big picture" impact it can offer, instead of seeing it as a narrow technical methodology used in manufacturing. They will realize that Six Sigma can and should be applied to all types of organizations, in all functions, and by all employees (or volunteers). The holistic approach also utilizes Six Sigma as a key organizational development strategy. For example, GE, 3M, DuPont, Honeywell, and several others have consciously used Six Sigma to develop their future leaders.

This first chapter discusses why Six Sigma is needed beyond the factory floor and how it can, and has, made significant impact here. The chapter then explains how Six Sigma should be

viewed as part of an overall process management system. Chapter 1 concludes with a brief overview of the Six Sigma methodology and a discussion of the key roles involved.

The Impact of Six Sigma Beyond the Factory Floor

It is generally agreed that more than half the opportunity for improvement in a manufacturing company lies beyond the manufacturing function. This opportunity can be as much as 30% to 40% of sales. Improvement beyond manufacturing has been limited in the past for at least three key reasons: lack of well-defined processes, lack of process metrics and data, and lack of an appreciation for the importance of reducing variation (both internally and to the customer). The advent of Six Sigma methodology and information technology systems has changed this situation, enabling organizations of all types to focus on improvement as never before.

The need for broadening the use of Six Sigma beyond the factory floor becomes clearer when you reflect on the trends within the business world. Three key trends, closely connected to one another, are driving the world economy: migration away from manufacturing-based economies, the rapid expansion of *information technology* (IT), and increasing global competition. The economies of the United States, most of Western Europe, and many other developed countries transitioned from an agricultural base in the 1800s and early 1900s to a manufacturing base in the 1900s. This movement is known as the industrial revolution, and it brought profound economic and social changes.

With the rapid expansion of IT in the late twentieth and now early twenty-first century, the world economy has continued to evolve. For example, the occupation of computer scientist did not exist during the industrial revolution. International finance, statistics and operations research, music and entertainment, e-commerce, and consumer credit are just a few examples of professional fields whose rapid expansion has been enabled by advances in IT. The overall result of this evolution is that fewer and fewer people make their living by manufacturing something. So-called white-collar jobs, such as accounting, health care, and

computer science, are replacing the traditional blue-collar jobs on the assembly line. Figure 1.3 (Bisgaard 2002) shows data on the growth of such jobs in the United States relative to drops in agriculture and manufacturing over the past century. Similar results apply to most developed countries in the world today. For the purposes of this graph, *white collar* refers to jobs involving primarily mental work (computer scientist, accountant, and so on), *blue collar* refers to primarily physical labor (construction, assembly line, and so on), and *service* refers to jobs that interact directly with customers, such as fast-food counter service, hotel receptionist, and postal delivery.

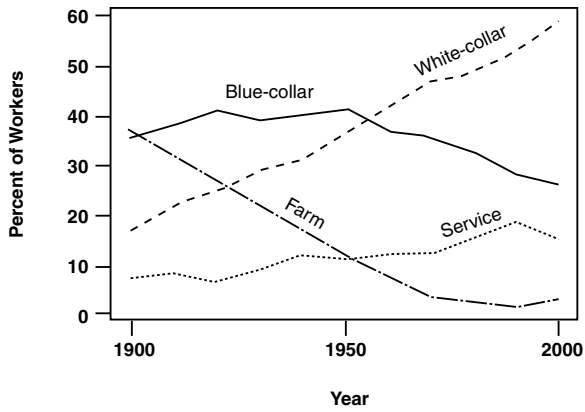

FIGURE 1.3 Occupational distribution of the U.S. labor force.

Agricultural jobs have been decreasing steadily for more than 100 years, and blue-collar jobs began a steady decline around 1950. Clearly, the United States no longer has a manufacturing-based economy. The real economy in the United States today, as well as in most of the developed world, involves such fields as financial services, health care, e-commerce, and logistics, but less and less manufacturing, which has tended to move offshore to low-cost locations. In fact, it has been reported that manufacturing now represents less than 20% of the U.S. gross domestic product (George 2003, 3). Productivity improvements and increased use of automation continue to reduce the number of blue-collar jobs.

Some of the key players in the real economy that need to benefit from Six Sigma include the following:

- Health care
- Financial services
- Educational institutions
- E-commerce
- Government
- Retail sales
- Food service
- Logistics and transportation

Of course, the list could go on and on.

Even within manufacturing businesses, less and less of the income and profit derive from manufacturing and selling "widgets." *GE Transportation Services* (GETS), for example, is a division of GE that manufactures locomotives. In the year 2000 GE Annual Report (p. 25), GETS noted that their earnings increased that year despite lower revenues, which resulted from a softening market for locomotive sales. How did GETS increase earnings in a softening market? It was "the result of a fifth consecutive year of double-digit growth in our global services business."

By taking advantage of the latest communication and information technologies, GETS has developed value-added services, such as predicting and optimizing maintenance requirements, satellite tracking of locomotives, logistics planning, and so on. Even a "smokestack industry" such as locomotives is transitioning from selling "widgets" to selling information and value-added services. The 2001 GE Annual Report (p.5) noted that the total of contractual services agreements within GE reached the $60 billion mark (yes, $60 billion!) in 2001. These service agreements continue to grow at the time of this writing. Similarly, General Motors now makes more money from financing than they do from selling cars. The public generally thinks of GM as an automaker, but it would be more accurate to think of GM as a bank that also sells cars on the side.

These examples, the data in Figure 1.3 and system maps such as Figure 1.1, highlight the fact that even within companies that manufacture and sell things, a major portion of the people and processes critical to the organization's success lie beyond manufacturing. Part of the holistic application of Six Sigma involves taking Six Sigma to each of these areas in turn, instead of restricting Six Sigma to manufacturing. Also productivity and automation gains are reducing the cost of goods and services sold. These gains further indicate that you should look beyond manufacturing and operations for improvement opportunities.

Of course, the growth of IT has also intensified global competition, and thereby provided further impetus for real economy organizations to improve. Developing countries such as India and China are expanding the technical skills of their labor force, including in such areas as computer science and software development. With the rapid expansion of the Internet and other IT tools, developing countries have created a competitive, low-cost alternative for organizations that need skilled labor. It is now feasible for a software developer in India to work remotely for an organization located in Germany, Australia, or the United States.

In fact, *Time* magazine (Time 2003) anticipated that U.S. financial services firms would move more than 500,000 jobs to India in the next 5 years. This job-migration figure does not include migration of jobs from other developed countries, the impact of the rapidly growing Chinese economy, or the migration from industries other than financial services. This trend is reminiscent of the tremendous impact that global competition had on manufacturing industries, such as automotives and electronics, beginning in the 1970s. Clearly, improvement is just as critical to survival in the real economy today as it was to manufacturing in the latter part of the twentieth century.

This need to improve has added an additional organizational responsibility. It used to be that we had one primary task: Come to work and perform our job to serve our customers. Global competition requires of us a second task: Improve how we do our work to better serve our customers to stay ahead of the competition. Therefore, we now have two jobs: doing our work and improving

how we do our work. Six Sigma provides many of the needed road maps and tools for doing this improvement work, thereby enabling us to serve our customers more effectively and efficiently.

Fortunately, many real economy organizations are "stepping up to the plate" relative to Six Sigma and reaping impressive benefits. GE has been applying Six Sigma to financial services almost since the beginning of its Six Sigma launch. A single project in credit card collections produced almost $3 million in annual benefits (Hahn et al. 2000). *Commonwealth Health Corporation* (CHC), a health-care provider based in Bowling Green, Kentucky, generated more than $800,000 in savings in the first 18 months of deployment. Chapter 3 presents CHC's case study in detail. The gains realized by American Express from Six Sigma are discussed in Young (2001). Bank of America is also deploying Six Sigma and reaping significant financial benefits ($2 billion in the first two to three years; Jones 2004).

The early implementers of Six Sigma such as Motorola and AlliedSignal began their initiative in manufacturing and moved, sometimes slowly, to applying Six Sigma across the organization. Former Motorola CEO Bob Galvin stated, "The lack of initial Six Sigma emphasis in the non-manufacturing areas was a mistake that cost Motorola at least $5 billion over a four-year period" (George 2003, 3). Note that beginning Six Sigma in manufacturing, or operations of service companies, is a good strategy because process metrics are usually well developed and significant opportunities for improvement exist there. The goal should be to move the deployment of Six Sigma as quickly as possible to the rest of the organization to maximize its benefits.

Intangible Impact

Six Sigma is increasingly recognized as an effective method for changing culture (how an organization does its work and rewards its people) as well as improving the bottom line. This is particularly important for those real economy organizations that do not have the legacy of a continual-improvement culture. As discussed in Chapter 2, our experience, and that of many others, is that few organizations outside of manufacturing have such a

legacy. In the process of deploying Six Sigma, leaders enhance many systems that define the organization's culture, including developing a greater focus on improvement, changing recognition and reward systems, improving communication systems, and improving performance management systems.

Many companies are seeing Six Sigma as a way to develop leaders, build teamwork, and empower employees. Companies such as GE, DuPont, 3M, Honeywell, and American Standard have required BB and GB certification for promotion up the ranks of management. Jack Welch, then CEO of GE, stated in the 2000 Annual Report, "The generic nature of a Black Belt assignment, in addition to its rigorous process discipline and relentless customer focus, makes Six Sigma the perfect training for growing twenty-first century GE leadership." Banks, hospitals, dot.coms, and other organizations operating beyond the factory floor are beginning to see and reap these types of organizational benefits of Six Sigma.

The use of Six Sigma as a leadership development tool becomes clear when you think about what a leader does. A leader enables an organization to change the way it works, to move from one paradigm to another paradigm. Changing the way people work requires changing the process they use to do their work. Six Sigma provides the strategy, methods, and tools to improve processes. A leader skilled in the use of Six Sigma is a more effective leader, thereby making Six Sigma an effective leadership development tool. This is just as true in the real economy as it is on the factory floor.

Integration of Process Design, Process Improvement, and Process Control

Unfortunately, Six Sigma is often promoted with a great deal of hyperbole, fanfare, and outright hype. Some authors make Six Sigma sound like an organizational "snake oil" that will magically solve any issue or problem. In fact, Snee and Hoerl (2003) is the only book that we are aware of on the subject that discusses unsuccessful Six Sigma efforts. It is important for readers to understand that Six Sigma is a rigorous, disciplined improvement methodology that utilizes scientific tools and formal deployment strategies. As

such Six Sigma provides leaders with a set of concepts, methods, and tools that enables them to align organizations to focus on improvement, provide road maps for change and improvement, and empower the right people to make the needed improvements. Therefore, to reap maximum long-term benefits from Six Sigma, organizations must eventually integrate it into an overall process management system utilizing the Six Sigma goals of rapid organizational change and improvement. Typically, this integration is the last phase in Six Sigma deployment (Snee and Hoerl 2003) and occurs years after launching a Six Sigma initiative. As discussed in Chapter 6, Six Sigma is not an organizational cure-all; some issues and projects are best addressed by methods other than Six Sigma.

As you think about using Six Sigma holistically as a key element of your improvement strategy, and eventually as part of your overall process management system, it is important to keep in mind the three major aspects of process management: process design/redesign, process improvement, and process control. Process design/redesign focuses on the design of new processes and the redesign (reengineering) of existing processes. Six Sigma can contribute significantly to design efforts through *design for Six Sigma* (DFSS), which can utilize the *define, measure, analyze, design, verify* (DMADV) framework. DMADV is the framework used by GE and other organizations. Other frameworks have been proposed (Creveling et al. 2003). Process improvement focuses on the improvement of existing processes without changing the fundamental design of the process. Process control focuses on keeping the process operating on target and within requirements so that the process produces products and services that satisfy customers profitably.

The key distinction between process improvement and process control is that process improvement determines how to drive the process to new levels of performance. Process control, on the other hand, identifies root causes for why the process performance has deteriorated, so that performance can be brought back to normal levels. For example, most of the routine mainte-

nance done on cars is process control—such as doing a tune-up or oil change to maintain performance. By switching to titanium spark plugs and premium gasoline, however, an owner might be able to improve the cars' performance beyond its original capability. This would be an example of process improvement. Further improvement might require redesign of the engine.

Six Sigma uses the *define, measure, analyze, improve, control* (DMAIC) framework to improve and control existing processes. In general, the DMAI phases focus on improvement, and the C phase focuses on process control and sustaining the gains. It is interesting to note that Six Sigma considers the need for control and implements a formal control plan in each design and improvement project. Chapter 6 further discusses these aspects of Six Sigma and how they should integrate with an overall process management system.

The Essence of Six Sigma

This section provides a brief overview of Six Sigma for those with minimal background in the initiative. Table 1.1 summarizes the key elements of Six Sigma. Further detail on each of these elements is provided in Chapter 4. The approach can be broken into three key aspects: deployment of a management initiative, improvement projects, and a set of methods and tools. See Snee and Hoerl (2003) for more detail on deployment aspects of Six Sigma, and Breyfogle (2003) for more detail on the methods and tools.

TABLE 1.1 Key Aspects of Six Sigma

Deployment	Projects	Methods and Tools
Improvement	Right projects (linked to business goals)	Process thinking
Breakthrough	Project management (project reviews)	Process variation
Systematic, focused approach	Sustain the gains (new projects)	Facts, figures, data

continues

TABLE 1.1 Key Aspects of Six Sigma (*continued*)

Deployment	Projects	Methods and Tools
Right people (selected and trained)	Results (process and financial)	Define, measure, analyze, improve, control
Communication	Project tracking	8 key tools
Recognition and reward	and reporting	(sequenced and linked)
Six Sigma initiative		Statistical tools
reviews		Statistical software
		Critical few variables

Deployment Aspects

Breakthrough Improvement. Six Sigma is about business improvement; it is not about culture change per se, although it will radically change culture. The strategy is to get the improvements, and then create the infrastructure and systems (culture) that will grow and maintain the gains. Six Sigma is not about quality—at least not in the traditional sense of the word—although it results in improved quality. It is not about training, although training is used to build the skills needed to deploy it. Viewing Six Sigma as a massive training initiative is a low-yield strategy. Six Sigma is about breakthrough business improvement, not incremental improvement. Six Sigma projects are defined to produce major improvements (30% to 60% and more) in process performance in 4 to 6 months with a significant bottom-line impact. Such changes greatly affect how business is conducted day to day. As the Six Sigma mindset permeates the organization, individuals become aware of non–value-added work, ineffective processes, and poor performance and take action to make the needed improvements.

A Systematic and Focused Approach. Not all executives are used to the discipline that such an approach requires. There are road maps and step-by-step procedures for the managerial and technical aspects of Six Sigma. These processes and systems enable the key players in the initiative, such as Champions, BBs, and GBs to move up the learning curve more quickly and keep the organization focused on rapid improvement. (These and other titles are

defined in the "Roles of Six Sigma Leaders" section later in this chapter.) Six Sigma is not an art, although experience, good judgment, and creativity are certainly required.

Right People. Six Sigma is about selecting and training the right people to fill the key roles. Successful organizations select their most talented people to fill the key Six Sigma positions (Champions, MBBs, BBs, and GBs). Most companies consider these people to be their future leaders. After those selected complete their Six Sigma assignments, they move into leadership positions and utilize their Six Sigma experience to guide others in improving the organization using the same approach. In this way, the cycle of continuous improvement is ingrained into the culture of the organization, and the company is assured of having "enlightened" leaders in the future.

Communication. It is important that a communication plan be developed to support the Six Sigma initiative. In the early stages of deployment, people will be asking a number of questions: What is Six Sigma? Why is our organization using this approach? Why are we doing this now? What will the benefits be? What progress are we making? Answers to these questions and other related messages must be communicated in a clear, concise, and consistent way. The message must be repeated several times, using a variety of media to make sure that everyone is exposed to understandable information. Clear understanding of the what, why, and how of the initiative will help generate the support in the organization needed to ensure that the BB and GB projects and the Six Sigma initiative as a whole succeed.

Recognition and Reward Plan. A recognition and reward program must be created to support the Six Sigma initiative. People want to know "what's in it for me." This helps them decide whether to get involved and at what level of intensity. We know of no organization that has successfully implemented Six Sigma without a recognition and rewards program to recognize and reinforce the desired behavior. Such a program typically includes both financial and psychological rewards.

Management Reviews of the Six Sigma Initiative. It is widely recognized that regular review of initiatives is needed to ensure the success of the initiative. Accordingly, regular reviews of the Six Sigma initiative (preferably quarterly) are required to

monitor progress, to ensure the initiative milestones are being met, and to identify when adjustments and major changes to the deployment plan are needed. It is unlikely that a Six Sigma initiative will succeed without regular reviews by the senior management team who is accountable for the success of the program.

Improvement Projects

Right Projects. Six Sigma is about working on the right projects: those that support the business strategy. Six Sigma projects are linked to the goals of the business and to key problems that must be solved if the organization is to be successful (for example, critical customer complaints, process downtime producing stockouts, major accounts receivables issues). As you will see in later chapters, project selection is often where the battle is won or lost. Even top talent cannot salvage a poorly selected project. BBs and GBs work on important projects during as well as after the training. The specific roles of the BBs and GBs, who lead the improvement projects and are the primary "doers" in Six Sigma, are outlined later in this chapter and discussed more fully in Chapter 4.

Working on the right projects obviously requires careful business planning and coordination. Having BBs and GBs pick their own projects is not a good strategy in our experience. It is important, however, that the goals of the BB and GB projects are realistic and achievable so that the projects will be successful and the BBs and GBs—and organization as a whole—will build confidence that Six Sigma will work "here."

Project Management and Reviews. Six Sigma is about effective project management, including project selection, planning, and management reviews. Proper planning is important to ensure success. Such planning helps to avoid "scope creep" (project size and definition slowly growing beyond what is reasonable to accomplish considering the allotted time and resources), misalignment with management, lack of resources, projects that move at glacial speed, and other common project pitfalls. Management reviews are critical to success. Projects should be reviewed weekly by Project Champions and monthly by business leaders. As noted previously, the overall Six Sigma system should be reviewed quarterly and annually. Management reviews are critical to success. The lack of management reviews significantly reduces the impact of the Six

Sigma effort. The reviews keep the BBs and managers focused on the project and emphasize the long-term commitment of management to improve the performance of the organization, ensuring it will be a long-term source of products, services, and employment.

Sustaining the Gains. As previously noted, a methodology for sustaining the gains is an integral part of the Six Sigma approach. This methodology is usually called the *control plan* and is one of the unique aspects of Six Sigma. The control plan can be viewed at both a tactical and strategic level. At the tactical level, it sustains the gains of individual projects; at the strategic level, it sustains and broadens the gains of the Six Sigma initiative overall. A key element of the strategic control plan is a system for the continual identification of new projects and the placing of those projects in the project hopper. As the BBs complete their projects, they are assigned new projects that have been taken from the hopper. It is helpful to think of the project hopper as a "project portfolio," the contents of which blend together to drive the improvement needs of the organization (Snee and Rodebaugh 2002).

Right Results. Six Sigma is about getting the right results—improvements in process performance that are linked to the bottom line. The team estimates what a project is worth, typically with the help of the finance organization, before work is initiated. After the project has been completed, the team calculates the bottom-line savings. Many organizations, such as GE, require a sign-off from the finance organization verifying the financial impact and identifying where in the income statement it will show up. In this way you will know exactly what the bottom-line impact of the project has been. Surprisingly, many previous improvement initiatives discouraged focus on the financials when identifying or evaluating projects.

Project Tracking and Reporting. To monitor the progress of the initiative, check on the achievement of milestones, and provide a corporate memory, a project tracking and reporting system is needed. The tracking system is typically a software system that contains the bottom-line financial results and the improvements to process performance metrics for each project. Such systems typically have the capability to generate management reports on financial and process performance improvements for any process, business, function, organizational level, and so forth.

Six Sigma Methods and Tools

Process Thinking. The first key method is process thinking—taking the view that all work is a process that can be studied and improved. All work in all parts of the organization, whether it is in manufacturing, new product development, finance, logistics, or procurement, is accomplished by a series of interconnected steps. When you view problems from the framework of a process with inputs, processing steps, and outputs, a common approach to improving processes and solving problems can be applied. Because Six Sigma had its roots in electronics manufacturing, there is a common misunderstanding that Six Sigma can only help in this one activity. This mistake is analogous to assuming that the Internet can only be useful in the defense industry (where it originated).

Figure 1.4 shows a schematic of a customer order process. Process variables are divided into four groups: process inputs, controlled variables, uncontrolled variables, and process outputs. Examples of these variables for the customer order process are shown in Figure 1.4. The process inputs include those things used to produce the process outputs. The controlled variables are those that run the process and, as the name implies, can be controlled ("knobs" on the process). The uncontrolled variables are those that affect the output of the process but over which there is limited control. Obviously, the inputs come from suppliers, which could be the person down the hall or another process or raw material supplier; and the outputs go to customers, either internal or external to the organization. Viewing processes this way produces the SIPOC model (*suppliers, inputs, process, outputs, customers*). In the SIPOC model, all processes, no matter the source, begin to look similar in nature, enabling common improvement strategies to be used.

Process Variation. Variation is present in all processes and every aspect of work. Unintended variation reduces process performance, decreases customer satisfaction, and negatively impacts the bottom line. Customers want a consistent product or service, one that they can count on to provide the same value all the time. Products need to work as anticipated and be delivered and serviced on time, just as financial transactions need to proceed smoothly with minimal disruptions and just as patients need to be able to count on health-care providers for consistent and quality care.

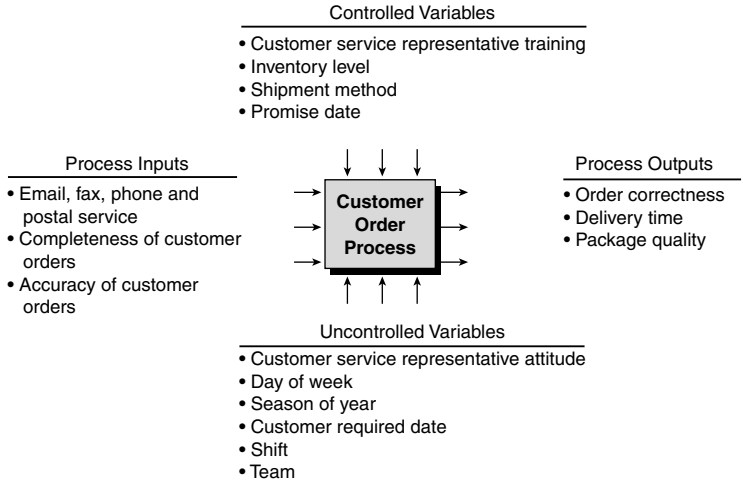

FIGURE 1.4 Schematic of a customer order process and its variables.

Six Sigma is focused on reducing the negative effects of process variation in two major ways: (1) It shifts the process average to the desired target level, and (2) it reduces the variation around the process average. This results in a process performing at the right average level with minimal variation from product to product or transaction to transaction. The need to address variation is the primary reason for including so many statistical tools in the Six Sigma toolkit. Statistics is the only science focused on identifying, measuring, and understanding variation, and therefore is a tool you can use to reduce variation.

Facts, Figures, and Data. Six Sigma is about facts, figures, and data—in other words, data-based decision making versus reliance on gut feeling and intuition. The approach requires data on all key process and input variables (see Figure 1.4). The project doesn't proceed until adequate data are available. The focus on the use of data, along with process thinking and variation, helps integrate the scientific method into the Six Sigma methodology. The integration of process thinking, understanding of variation, and data-based decision making is often referred to as *statistical thinking* (Hoerl and Snee 2002).

DMAIC Improvement Methodology. The primary improvement methodology of Six Sigma has five key phases: *define, measure, analyze, improve, and control* (DMAIC). All improvement projects touch on these phases in one way or another. (New design projects use a different process called *design for Six Sigma*.) The tools of Six Sigma are integrated into these phases. This is a strength and uniqueness of Six Sigma. All projects utilize the same improvement process, although the individual applications may be quite different. In contrast to most statistics training that throws a lot of tools on the table and lets practitioners fend for themselves, the DMAIC framework shows practitioners how to integrate and sequence the tools into an overall improvement strategy. This enables practitioners to attack virtually any problem in a systematic manner.

DMAIC is by far the most widely used road map in Six Sigma deployment. Other road maps are possible, but none are as useful in our judgment because of the effectiveness and elegant simplicity of DMAIC. We note that in the case of design for Six Sigma, DMADV or some other road map should be used. The key elements of deployment, projects, and methods and tools are still applicable.

Eight Key Tools. Six Sigma utilizes many individual tools, but the following eight tend to be most frequently applied:

- Process mapping
- Cause-and-effect matrix
- Measurement system analysis
- Capability study
- Failure modes and effects analysis (FMEA)
- Multi-vari study
- Design of experiments
- Control plans

These eight key tools are linked and sequenced in the DMAIC framework to ensure proper integration. This relatively small number of improvement tools helps the BBs and GBs move up the learning curve more quickly. They learn the order in which

to use the tools and how the output of the use of one tool becomes the input for another tool. You will learn more about application of the tools beyond the factory floor in Chapter 7.

Statistical Tools. Some, but not all, of these tools are statistical tools. As noted earlier, statistical tools are required so that process variation can be dealt with effectively. Six Sigma has effectively integrated statistical tools with those from other disciplines, such as industrial engineering, quality management, operations research, mechanical and electrical design, and reliability. The result is a toolkit much broader and more powerful than available within any one discipline. Because the toolkit is diverse and flexible, and because the focus is on a limited set of core tools, BBs and GBs do not need to become professional statisticians to be successful. They are trained to use key statistical thinking and methods and data to improve processes.

User-Friendly Statistical Software. Another reason Six Sigma has been effective is the general availability of user-friendly statistical software that enables effective and broad utilization of the statistical tools. The statistical software package most widely used in Six Sigma is Minitab. JMP and other statistical software systems are also used in some Six Sigma deployments. Prior to the availability of such user-friendly software, statistical methods were often the domain of professional statisticians, who had access to, and specialized training in, proprietary statistical software. Specialists in statistical methods have an important role to play in Six Sigma, but practitioners who are not professional statisticians do the vast majority of statistical applications.

Critical Few Variables. The final key methodology of Six Sigma is its focus on the identification of the critical few input and process variables. Most processes, from performing surgery to closing the books for a global conglomerate, involve a large number of potentially important input and process variables. Studying each in-depth, and then managing them on an ongoing basis, would be time-consuming and prohibitively expensive. Fortunately, often just three to six critical process input variables drive the process output variables. Identification of these variables can lead to effective ways to optimize and control the process in a parsimonious and cost-effective way. Six Sigma finds, and then focuses attention on,

these few key variables. This principle of focusing attention on a few key things is consistent with general principles of good management. The ultimate goal is to move from measuring outputs and making process adjustments (reactive) as the primary method of process control to measuring and then adjusting process inputs (proactive) to control the process and achieve the desired process performance.

Roles of Six Sigma Leaders

Six Sigma has well-defined leadership roles, and success depends on each of the roles fulfilling its unique responsibilities. Some of the key players involved in a Six Sigma initiative are shown in Figure 1.5. The lines in Figure 1.5 show the key linkages between the roles. For this discussion, we define the organization as the unit that has responsibility for identifying the improvement opportunities and chartering the Six Sigma projects. This could be a corporation, a division, a facility, or a function. The leadership team (often called the *Six Sigma Council*) leads the overall effort and has responsibility for approving the projects undertaken by the BBs. In the case of a finance function, the leadership team might be the *chief financial officer* (CFO) and selected members of his or her staff.

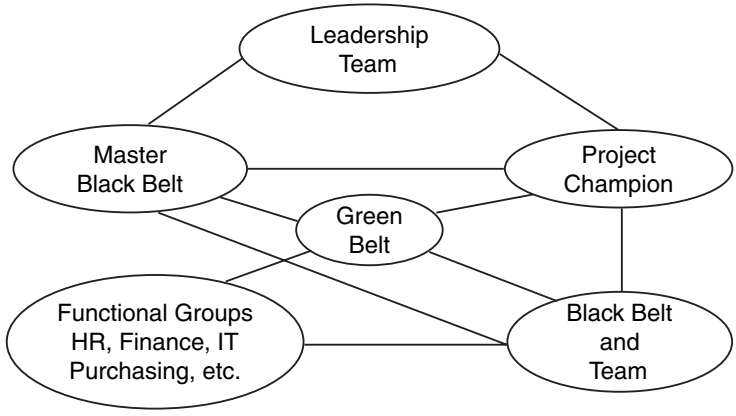

FIGURE 1.5 Roles of leaders.

Each project has a Champion who serves as its business and political leader. (Some organizations use the term *Champion* to refer to the overall leader of the Six Sigma effort.) The project Champion is typically a member of the leadership team and has the following responsibilities:

- Facilitating the selection of projects
- Drafting the initial project charters
- Selecting BBs and other resources needed to conduct the project
- Removing barriers to the successful completion of the project
- Holding short weekly progress reviews with the BBs

The BBs lead the team that does the actual work on the project. BBs are hands-on workers who are assigned to work full time on their projects and do much of the detailed work. The BB also leads the team, acts as project manager, and assigns work (for example, data collection) to the team members as appropriate. See Hoerl (2001) for a more detailed discussion of the BB role and the key skills required to perform it.

BB projects are typically defined so that they can be completed in 4 to 6 months, are focused on high-priority business issues, and are targeted to produce $175,000 to $250,000 per year to the bottom line. The team that works with the BB is typically comprised of 4 to 6 members who may spend as much as 25% of their time on the project. The amount of time spent by each team member will vary depending on the person's role. The team may also include consultants and specialists as well as suppliers and customers. BBs also act as mentors for GBs, as do MBBs.

GBs may lead a project under the direction of a Champion or MBB, or they may work on a portion of a BB project under the direction of the BB. GB projects are typically less strategic and more locally focused than are BB projects. A GB project is typically worth $50,000 to $75,000 per year to the bottom line and should be completed in 4 to 6 months. GBs do not work full time on improvement projects and typically have less-intensive training. GBs work on improvement projects in addition to their existing

job responsibilities. As noted earlier, several companies have recognized the value of Six Sigma as a leadership development tool and have the objective of all members of the professional staff being at least a GB.

The MBB is the technical leader and enables the organization to integrate Six Sigma within its operations. The MBB has typically completed several BB projects and 2 to 5 weeks of training beyond the 4 weeks of BB training. The MBB helps the Champions select projects and review their progress. The MBB provides training and mentoring for BBs and, in some instances, training for GBs. The MBB is also responsible for leading mission-critical projects as needed, and sharing project learning and best practices across the organization. In essence, these resources are intended to combine technical skills beyond that of a BB with managerial and leadership skills similar to a Champion.

The functional support groups, such as human resources, finance, IT, and legal, assist the Six Sigma effort in four key ways, beyond improving their own processes through Six Sigma projects:

1. They provide specialized data as needed by BBs, GBs, and teams outside their function.
2. They provide expertise associated with their functional responsibilities.
3. They provide members for the BB and GB project teams when appropriate.
4. They help identify improvement opportunities for the organization to pursue.

Functional support groups (Enterprise Processes in Figure 1.1) are typically involved in more aspects of the organization's work than other groups, such as manufacturing. They interact across the organization, and as a result they see where improvements are needed in cross-functional processes operated by the organization. In a hospital, for example, the finance organization interacts with procurement, operations management, marketing, legal, IT, and external insurance agencies, and therefore can more easily pinpoint cross-functional issues that require attention.

There are two other types of Champions in addition to the Project Champion. As noted earlier, an organization typically names a Corporate Six Sigma Champion who reports to the president or CEO and has overall responsibility for developing the Six Sigma infrastructure. In large organizations, it is not unusual for each business and each functional unit (human resources, finance, IT, etc.) to name what they will call a Business or Functional Champion. Different organizations have used different titles for such roles, such as Quality Leader, Six Sigma Leader, and Six Sigma Champion. The role is basically the same: to oversee the implementation of Six Sigma in that unit. It is more prudent to focus on the actual role, and not get hung up on the title.

The Rest of the Story

This book is divided into four main parts: the case for Six Sigma beyond the factory floor, ensuring successful deployment, ensuring project success, and ensuring proper application of methods and tools. In this overall flow, we address strategic, tactical, and operational aspects of deploying Six Sigma. In Chapter 1, we have set the context for the book, highlighting the growing importance of health care, financial, service, and non-manufacturing functions to our economy, and the tremendous opportunity and need for improvement in these areas. We refer to these operations as the *real economy*. In Chapter 2, we address the fundamental barrier to improvement—the attitude that "we're different"—and show that, in fact, improvement efforts in diverse processes and environments have much more in common than they have differences. We find that Six Sigma works very well beyond the factory floor.

In Chapters 3 and 4, we present deployment case studies, key lessons learned from these cases, and a Six Sigma deployment road map that has been shown to be effective in a number of companies from a number of different environments. The focus of these two chapters is on the management systems that must be put in place to effectively deploy Six Sigma. One of the key things that makes Six Sigma different from earlier improvement methods is the existence of an infrastructure of management systems to support the deployment of Six Sigma. One of the key reasons that

previous improvement approaches, such as *total quality management* (TQM) and *statistical process control* (SPC) were not as successful long term was that these approaches lacked an effective deployment method. This is not the case with Six Sigma.

Chapters 5 and 6 focus on ensuring project success. The successful completion of projects, one after another in a steady stream, is at the heart of Six Sigma. The discussion consists of case study presentations, the Six Sigma method for doing project-by-project improvement and keys to completing successful projects. Chapter 7 discusses technical considerations essential to successful improvement in the real economy. Many of these issues are not discussed elsewhere in the literature. The topics include the tools used and unique aspects of the data analysis in applications beyond the factory floor.

Chapter 8 discusses some next steps you may want to consider to make Six Sigma an integral part of the way your organization does business and serves its customers (and community). The goal is to get more out of Six Sigma. This can be accomplished by making Six Sigma part of, if not, your strategic signature—something for which your organization is known. As a result, all work in all areas of the organization will be using some aspect of Six Sigma to help make them successful. When others look at your organization, they will see Six Sigma as your signature.

Summary

This chapter has provided a general overview of Six Sigma—the key elements of the initiative and the key concepts, methods, and tools—and the tremendous opportunities for using Six Sigma to improve processes, functions, and organizations beyond the factory floor. An overview of the roles in Six Sigma was also provided. Now that you have a general idea of what Six Sigma is, its key uniqueness, and the roles of the players involved, you are in a position to consider the fundamental barrier to deploying Six Sigma: the common perception that "we're different," and therefore Six Sigma won't work here. As with most excuses, the belief that "we're different" does have a kernel of truth. Chapter 2 elaborates

on what about the real economy really is different from manufacturing, what is really the same, and how to get beyond this issue. Process thinking and leadership are suggested as two key "antidotes" for this and other excuses.

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