Ron Basu

FIT SIGMA

A Lean Approach to Building Sustainable Quality Beyond Six Sigma

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Preface

BACKGROUND

Whilst passing through Miami Airport en route to Mexico City, I was killing time by perusing the newspaper, and I came across an article on 'Six Sigma' in *USA Today* which caught my eye. Dated 21 July 1998, it had a challenging message relating to the cost benefits of Six Sigma. In the current global economic downturn, this challenge is even more prevalent. At that time I was co-ordinating a global MRP(II) programme between all the manufacturing sites of GlaxoWellcome, including the Xochimilco plant in Mexico. The Global Manufacturing and Supply Division of GlaxoWellcome was considering a 'Lean Sigma' initiative which was meant to be a hybrid of Six Sigma and Lean Manufacturing. It struck me that the message in *USA Today* reflected not just the doubts (or expectations) in the minds of my colleagues but perhaps those of quality practitioners world-wide.

These doubts or expectations addressed many questions. Isn't Six Sigma simply another fad or even just a repackaged form of TQM? It appears to be successful in large organisations like Motorola and General Electric, but can small firms support such a programme? How can we apply the Six Sigma methodology originated from manufacturing operations to the far larger market of the service sector? Like any good product, Six Sigma will have a finite life cycle – so what is next? Surely one big question must be: how can we sustain the benefits in the longer term? It is good to be 'lean', but isn't it better to be 'fit' in order to stay agile?

The idea of writing a book to address these issues was mentally conceived at Miami Airport and the concept of FIT SIGMA™ was born. The resulting volume was named *Quality Beyond Six Sigma* and was published by Butterworth-Heinemann in January 2003. In the experience of the author, both in industry and management courses, the details of various tools and techniques had to be acquired from different books, publications and training manuals. It is time now to produce a comprehensive, user-friendly and 'hands-on' study. This could act as a single-source reference point for tools and techniques to be used by all practitioners and students of operational excellence. With these thoughts in mind I wrote *Implementing Quality* (published by Thomson), which was followed by *Implementing Six Sigma and Lean* (published by Elsevier). The current volume, *FIT SIGMA*, has been produced with the aim of updating *Quality Beyond Six Sigma*.

WHY FIT SIGMA?

Six Sigma and Lean Sigma may be viewed by some as 'old hat'. However, in the current global economic downturn, many organisations, including the public sector, are looking beyond traditional cost-cutting to find longer-term solutions to their financial and organisational challenges.

This near perfection for many may seem to be overkill, while to some it constitutes an impossible ideal to strive towards – especially for a small business. Many businesses are hesitant to dive into an apparently expensive Lean Sigma programme which is known to be successful for large manufacturing organisations like GE, Motorola and Dow Chemicals. There are also new challenges in many areas, including climate change, Green supply chain, emerging markets and the growing service sector. FIT SIGMA, which is an extension of Lean Sigma, is aimed to address these challenges. The methodology of FIT SIGMA – or FIT Σ – has three elements: fitness for the purpose, fitness for improvement and integration, and fitness for sustainability.

ABOUT THIS BOOK

The major new features of this book as compared to *Quality Beyond Six Sigma* include either new or rewritten chapters as follows:

Chapter 1: The Evolution of Six Sigma, Lean Sigma and FIT SIGMA™
Chapter 2: More about FIT SIGMA
Chapter 3: DMAIC Methodology for FIT SIGMA
Chapter 4: FIT SIGMA Tools
Chapter 5: FIT SIGMA in Large Manufacturing Operations
Chapter 6: FIT SIGMA in Service Operations
Chapter 7: Six Sigma in Small and Medium Enterprises
Chapter 8: FIT SIGMA in Project Management
Chapter 9: FIT SIGMA in Green Thinking

This book is a practical guide to FIT SIGMA which is necessary in the implementation of all kinds of quality programmes at whatever level or under whichever banner these may be pursued, be it continuous improvement, TQM, Six Sigma, Lean Enterprise, Lean Sigma or Lean Six Sigma, to name but a few.

WHO SHOULD USE THIS BOOK?

This volume is aimed at a broad cross-section of readership.

- Functional managers, participants and practitioners in TQM, Six Sigma and operational excellence will find that this book will provide them with a comprehensive insight into the tools and techniques of continuous improvement in a single package. A step-by-step guide is included for the application of the appropriate tools to their improvement processes. This volume could be used as an essential handbook for all employees in a Six Sigma programme.
- Senior executives, both in the manufacturing and service industries (regardless of function), will find that this book will give them a better understanding of basic tools and techniques

and help them to support a quality improvement initiative and sustain a strong competitive position.
- Professional management and training consultants will find the comprehensive approach of tools and techniques forms an essential handbook for Six Sigma-related assignments and seminars.
- Management schools and academies and research associations will find this book valuable to fill the visible gap in the basics of operational excellence. This text will provide support to both undergraduate and postgraduate courses containing quality and operational excellence and can serve as a main text book for the quality elective component for MBA students.

The readership will be global and particularly cover North America, the UK, Continental Europe, Australia and the Asia-Pacific countries.

HOW TO USE THIS BOOK

The book allows maximum flexibility for readers and for practical usage depending on individual requirements and interests. The application areas of the study include the following.

Implementing FIT SIGMA

All organisations, whether service or manufacturing, private or public sector, large, medium or small, should particularly benefit from the specific chapters for large manufacturing organisations, service organisations, small and medium organisations, projects and Green thinking, as well as the section concerning steps of implementation in Chapter 10. The programme members and task groups should acquire a copy of the book and also gain a common understanding of tools as described in Chapter 4.

University and College Courses

It can be used as a textbook or reference tool for advanced programmes on managing quality in universities and business schools. The questions and exercises included in Appendix I should help students by allowing them the chance to practice and assess their level of understanding gained from the relevant chapters. Tutors will have the opportunity of applying these questions and exercises as part of their lecture material and course content.

Enhancing Knowledge

The book contains both the strategic approach of implementing FIT SIGMA and a detailed coverage of tools and DMAIC processes which underpin the programme. The reader, whether a CEO, employee or student, should find the book acts as a self-help method of enhancing his or her knowledge and understanding of quality and operational excellence.

ADDITIONAL FEATURES

Summary

At the end of each chapter the reader will find a summary of the key elements covered in that chapter. This should provide a sound basis for general revision.

Case Studies

Case studies have been included to encourage readers to respond in the context of practical situations. These are concisely written and provide a good learning resource for tutorials.

Statistics

Efforts have been made to minimise the fear of advanced statistics in FIT SIGMA! However, Appendix II illustrates the application of basic statistics in Six Sigma and FIT SIGMA.

Glossary

A comprehensive Glossary of relevant terms has been provided at the end of the book. This gives a ready reckoner for the common terminology and phrases experienced in managing quality.

I have made every effort to furnish you with both simple and more complex concepts which are nonetheless easy to understand. I feel confident that with enough common sense you can apply them readily to make FIT SIGMA a reality in your organisations and programmes. This is intended to offer you 'more for less' through the application of FIT SIGMA; that is, more results with less effort in your change programmes. Mahatma Gandhi once said, 'Be the change you want to be in the world'. I hope this book will in some way help you to bring about that change.

Acknowledgements

I acknowledge the help and support from my colleagues and students at Henley Business School in England and SKEMA Business School in France. As always, it has been my pleasure to work with Dr Nevan Wright, my co-author of *Quality Beyond Six Sigma* and other books.

I am grateful to the many contributors to the case examples included in the book, with special mentions to Alex Morton, Andy Liddle, Mike Waterhouse and John Barnes.

Every effort has been made to credit the authors, publishers and websites of material used in this book. I apologise if inadvertently any sources remain unacknowledged and if known I shall be pleased to credit them in the next edition.

My sincere thanks go to the staff of my publishers, especially to Jenny McCall and Gemma Valler for getting this project off the ground.

Finally, the project could not have been completed without the encouragement and help of my family, especially my wife Moira and daughter Bonnie.

About the Author

Ron Basu is Director of Performance Excellence Limited and a Visiting Fellow at Henley Business School, England. He is also a Visiting Professor at SKEMA Business School, France. He specialises in Operational Excellence and Supply Chain Management and has research interests in Performance Management and Project Management.

Previously he held senior management roles in blue-chip companies like GSK, Glaxo Wellcome and Unilever, and led global initiatives and projects in Six Sigma, ERP/MRP(II), Supply Chain Re-engineering and Total Productive Maintenance. Prior to this he worked as a Management Consultant with A.T. Kearney.

He is the co-author of *Total Manufacturing Solutions*, *Quality Beyond Six Sigma*, *Total Operations Solutions* and *Total Supply Chain Management*, and the author of books with titles *Measuring e-Business Performance*, *Implementing Quality* and *Implementing Six Sigma and Lean*. He has authored a number of papers in the operational excellence and performance management fields. He is a regular presenter of papers in global seminars on e-Business, Six Sigma and Manufacturing and Supply Chain topics.

After graduating in Manufacturing Engineering from UMIST, Manchester, Ron obtained an MSc in Operational Research from Strathclyde University, Glasgow. He has also been awarded a PhD at Reading University. He is a Fellow of the Institution of Mechanical Engineers, the Institute of Business Consultancy, the Association for Project Management and the Chartered Quality Institute. He is also the winner of an APM Project Management Award.

Ron lives with his wife Moira in Gerrards Cross, England and has two children, Bonnie and Robi.

Contents

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The Evolution of Six Sigma, Lean Sigma and FIT SIGMA™

1.1 INTRODUCTION

> Today, depending on whom you listen to, Six Sigma is either a revolution slashing trillions of dollars from Corporate inefficiency, or it's the most maddening management fad yet devised to keep front-line workers too busy collecting data to do their jobs.
>
> *USA Today*, 21 July 1998

At the time of writing, it has been 12 years since the above statement was made. During this time the 'Six Sigma revolution' has created a huge impact in the field of operational excellence, yet conflicting views are still prevalent.

Let us evaluate the arguments for both sides. On a positive note, the success of 'Six Sigma' in General Electric (GE) under the leadership of Jack Welch is undisputed. In the GE company report of 2000, their CEO was unstinting in his praise: 'Six Sigma has galvanised our company with an intensity the likes of which I have never seen in my 40 years at GE.' Even financial analysts and investment bankers compliment the success of Six Sigma at GE. An analyst at Morgan Stanley Dean Witter recently estimated that GE's gross annual benefit from Six Sigma could reach 5% of sales and that share values might increase by between 10% and 15%.

However, the situation is more complex than such predictions would suggest. In spite of the demonstrated benefits of many improvement techniques such as total quality management (TQM), business process re-engineering and Six Sigma, most attempts by companies to use them have ended in failure (Easton and Jarrell, 1998). Sterman *et al.* (1997) conclude that companies have found it extremely difficult to sustain even initially successful process improvement initiatives. Yet more puzzling is the fact that successful improvement programmes have sometimes led to declining business performance, causing lay-offs and low employee morale. Motorola, the originator of Six Sigma, announced in 1998 that its second-quarter profit was almost non-existent and that consequently it was cutting 15,000 of its 150,000 jobs.

To counter heavyweight enthusiasts like Jack Welch (GE) and Larry Bossidy (Allied Signal), there are sharp critics of Six Sigma. In fact, Six Sigma may sound new, but critics say that it is really just statistical process control in new clothing. Others dismiss it as another transitory management fad that will soon pass.

It is evident that like any good product, Six Sigma should also have a finite life cycle. In addition, business managers can be forgiven if they are often confused by the grey areas of distinction between quality initiatives such as TQM, Six Sigma and Lean Sigma.

Against this background, let us examine the evolution of total quality improvement processes (or in a broader sense, operational excellence) from ad-hoc upgrading, working up to TQM and then to Six Sigma and finally to Lean Sigma. Building on the success factors of these processes, the vital question is: how do we sustain the results? The author has named this sustainable process FIT SIGMA™ (see Basu and Wright, 2003).

So, what is FIT SIGMA? Firstly, take the key ingredient of quality, then add accuracy in the order of 3.4 defects in 1,000,000. Now implement this across your business with an intensive education and training programme. The result is Six Sigma. Now let's look at Lean Enterprise, an updated version of classical industrial engineering. It focuses on delivered value from a customer's perspective and strives to eliminate all non-value-added activities ('waste') for each product or service along a value chain. The integration of the complementary approaches of Six Sigma and Lean Enterprise is known as Lean Sigma. FIT SIGMA is simply the next wave. If Lean Sigma provides agility and efficiency, then FIT SIGMA allows a sustainable fitness. In addition, the control of variation from the mean (small sigma 'σ') in the Six Sigma process is transformed to company-wide integration (capital Sigma 'Σ') in the FIT SIGMA process. Furthermore, the philosophy of FIT SIGMA should ensure that it is indeed fit for the organisation.

The road map to FIT SIGMA (see Figure 1.1) contains three waves and the entry point of each organisation will vary:

- First Wave: As is to TQM.
- Second Wave: TQM to Lean Sigma.
- Third Wave: Lean Sigma to FIT SIGMA.

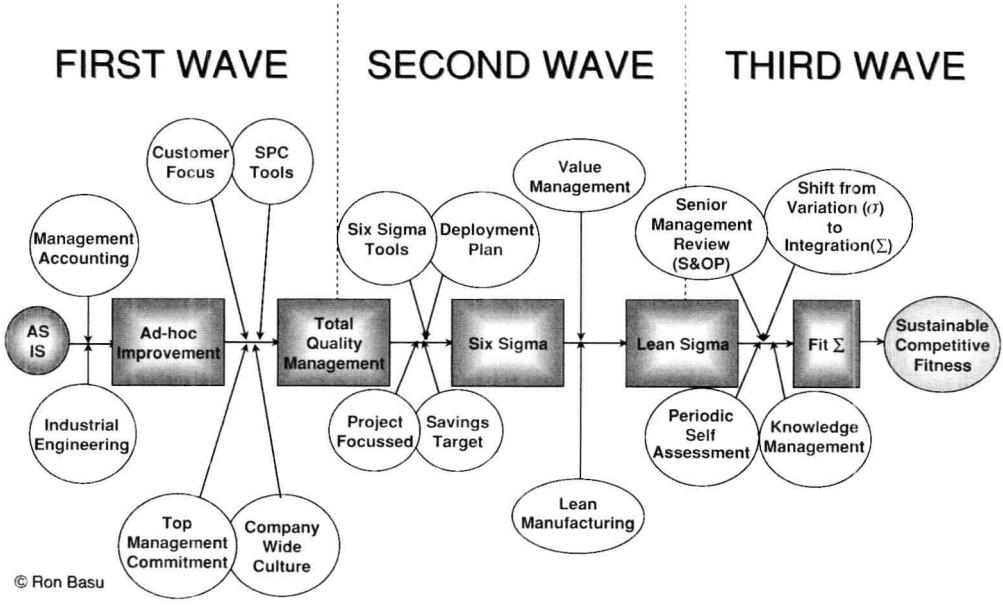

Figure 1.1 Road map to operational excellence

1.2 FIRST WAVE: AS IS TO TQM

The organised division of labour to improve operations may have started with Adam Smith in 1776. However, it is often the industrial engineering approach, which has roots in F.W. Taylor's 'Scientific Management', that is credited with the formal initiation of the first wave of operational excellence. This industrial engineering approach was sharpened by operational research and complemented by operational tools such as management accounting.

During the years following the Second World War, the 'First Wave' saw through the rapid growth of industrialisation; but in the short term the focus seemed to be upon both increasing volume and reducing the cost. In general, improvement processes were 'ad-hoc', factory-centric and conducive to 'pockets of excellence'. Then in the 1970s the holistic approach of TQM initiated the 'Second Wave' of operational excellence. The traditional factors of quality control and quality assurance are aimed at achieving an agreed and consistent level of quality. However, TQM goes far beyond mere conformity to standard. TQM is a company-wide programme and requires a culture in which every member of the organisation believes that not a single day should go by within that organisation without in some way improving the quality of its goods and services.

1.3 SECOND WAVE: TQM TO LEAN SIGMA

Learning the basics from W.E. Deming and J.M. Juran, Japanese companies extended and customised the integrated approach and culture of TQM (Basu and Wright, 1998; Oakland, 2003). Arguably, the economic growth and manufacturing dominance of Japanese industries in the 1980s can be attributed to the successful application of TQM in Japan. The three fundamental tenets of Juran's TQM process are firstly, upper management leadership of quality; secondly, continuous education on quality for all; and finally, an annual plan for quality improvement and cost reduction. These foundations are still valid today and embedded within the Six Sigma/Lean Sigma philosophies. Phil Crosby and other leading TQM consultants incorporated customer focus and Deming's SPC tools and propagated the TQM philosophy both to the USA and the industrialised world. The Malcolm Baldridge Quality Award, ISO 9000 and the Deming Quality Award have enhanced the popularity of TQM throughout the world, while in Europe the EFQM (European Foundation of Quality Management) was formed. During the 1980s, TQM seemed to be everywhere and some of its definitions – such as 'fitness for the purpose', 'quality is what the customer wants' and 'getting it right first time' – became so over-used that they were almost clichés. Thus the impact of TQM began to diminish.

In order to complement the gaps of TQM in specific areas of operation excellence, high-profile consultants marketed mostly Japanese practices in the form of a host of three-letter acronyms (TLAs), such as JIT, TPM, BPR and MRP(II). Total productive maintenance (TPM) has demonstrated successes outside Japan by focusing on increasing the capacity of individual processes. TQM was the buzzword of the 1980s but it is viewed by many, especially in the US quality field, as an embarrassing failure – a quality concept that promised more than it could deliver. Phil Crosby pinpoints the cause of TQM 'failures' as 'TQM never did anything to define quality, which is conformance to standards'. Perhaps the pendulum swung too far towards the concept of quality as 'goodness' and the employee culture. It was against this background that the scene for Six Sigma appeared to establish itself.

Six Sigma began back in 1985 when Bill Smith, an engineer at Motorola, came up with the idea of inserting hard-nosed statistics into the blurred philosophy of quality. In statistical terms, sigma (σ) is a measure of variation from the mean; thus the greater the value of sigma, the fewer the defects. Most companies produce results which are at best around four sigma, or more than 6000 defects. By contrast, at the six sigma level, the expectation is only 3.4 defects per million as companies move towards this higher level of performance.

Although invented at Motorola, Six Sigma has been experimented with by Allied Signal and perfected at General Electric. Following the recent merger of these two companies, GE is truly the home of Six Sigma. During the last five years, Six Sigma has taken the quantum leap into operational excellence in many blue-chip companies including DuPont, Ratheon, Ivensys, Marconi, Bombardier Shorts, Seagate Technology and GlaxoSmithKline.

The key success factors differentiating Six Sigma from TQM are:

1. The emphasis on statistical science and measurement.
2. A rigorous and structured training deployment plan (Champion, Master Black Belt, Black Belt and Green Belt).
3. A project-focused approach with a single set of problem-solving techniques such as DMAIC (Define, Measure, Analyse, Improve, Control).
4. Reinforcement of the Juran tenets (Top Management Leadership, Continuous Education and Annual Savings Plan).

Following their recent application in companies like GlaxoSmithKline, Ratheon, Ivensys and Seagate, the Six Sigma programmes have moved towards the Lean Sigma philosophy, which integrates Six Sigma with the complementary approach of Lean Enterprise. Lean focuses the company's resources and its suppliers on the delivered value from the customer's perspective. Lean Enterprise begins with Lean Production, the concept of waste reduction developed from industrial engineering principles and refined by Toyota. It expands upon these principles to engage all support partners and customers along the value stream. Common goals to both Six Sigma and Lean Sigma are the elimination of waste and the improvement of process capability. The industrial engineering tools of Lean Enterprise complement the science of the statistical processes of Six Sigma. It is the integration of these tools in Lean Sigma that provides an operational excellence methodology capable of addressing the entire value delivery system.

1.4 THIRD WAVE: LEAN SIGMA TO FIT SIGMA

Lean Sigma is the beginning of the 'Third Wave'. The predictable Six Sigma precisions combined with the speed and agility of Lean produces definitive solutions for better, faster and cheaper business processes. Through the systematic identification and eradication of non-value-added activities, optimum value flow is achieved, cycle times are reduced and defects eliminated.

The dramatic bottom line results, and extensive training deployment of Six Sigma and Lean Sigma must be sustained with additional features for securing the longer-term competitive advantage of a company. The process to do just that is FIT SIGMA. The best practices of Six Sigma, Lean Sigma and other proven operational excellence best practices underpin the basic building blocks of FIT SIGMA.

Four additional features are embedded in the Lean Sigma philosophy to create FIT SIGMA. These are:

1. A formal Senior Management Review process at regular intervals, similar to the Sales and Operational Planning process.
2. Periodic self-assessment with a structured checklist which is formalised by a certification or award, similar to the EFQM award but with more emphasis on self-assessment.
3. A continuous learning and knowledge management programme.
4. The extension of the programme across the whole business, with the shifting of the theme of the variation control (σ) of Six Sigma to the integration of a seamless organisation (Σ).

1.5 MORE ABOUT SIX SIGMA

Six Sigma is an approach that takes a whole-system attitude to the improvement of quality and customer service so as to enhance the bottom line. The Six Sigma concept matured between 1985 and 1986, and grew out of various quality initiatives at Motorola. Like most such quality initiatives since the days of Dr Deming in the 1960s, and in particular the concept of TQM, Six Sigma requires a total culture throughout an organisation. This means that everyone, at all levels, should possess a passion for continuous improvement with the ultimate aim of achieving virtual perfection. The difference with Six Sigma is the setting of a performance level that equates to 3.4 defects per 1 million opportunities. To ascertain whether Six Sigma has been achieved requires a common language throughout the organisation (at all levels and within each function) and standardised, uniform measurement techniques of quality. The overall Six Sigma philosophy has a goal of **total** customer satisfaction.

A survey (Basu and Wright, 2003) was conducted with the following leading companies in the UK who had adopted the Six Sigma approach to quality:

- Motorola.
- Allied Signal (Honeywell).
- General Electric.
- Raytheon.
- DuPont Teijn.
- Bombadier Shorts.
- Seagate Technology.
- Foxboro (Invensys).
- Norando.
- Ericson.

The results indicated that the main driver leading to the application of Six Sigma within a company is cost savings rather than customer satisfaction! In coming to this conclusion, the firms benefited from informal networking with members of the above companies as well as leading consulting groups such as Air Academy Associates, Rath and Strong, Price Waterhouse Cooper, Iomega and Cambridge Management Consulting. The surveyed companies reported between them a long list of intangible and indirect benefits. However, these plus points did not seem to be supported by any employee or customer surveys.

Nonetheless, very real results from the adoption of Six Sigma continue to be reported. For example, in 1997 Citibank undertook a Six Sigma initiative and after just three years it was reported that defects had reduced by 10 times (see Erwin and Douglas, 2000 for details). Likewise, General Electric state that the initial $300 million invested in 1997 in Six Sigma will deliver between $400 million and $500 million savings with additional incremental margins of $100 to $200 million. Wipro Corporation in India says that from a start in 1999, after just

two years defects were reduced to such an extent as to realise a gain of eight times over their initial investment in Six Sigma.

The application of operational excellence concepts is now extended to non-manufacturing processes. 'Firms such as Motorola [and] General Electric ... successfully implemented Six Sigma. Motorola saved $15 billion in an 11 year period. General Electric saved $2 billion in 1999 alone ... Although Six Sigma initiatives have focused primarily on improving the performance of manufacturing processes, the concepts are widely applied in non-manufacturing, administrative and service functions' (Weinstein *et al.*, 2008).

1.6 WHAT IS SIX SIGMA?

So just what is the enigma of Six Sigma? Sigma is a classical Greek letter (σ), which is used in mathematical and statistical models to signify the standard deviation from the mean. This might sound like statistical mumbo-jumbo, but in reality it is a very simple concept. The mean (more correctly referred to as the arithmetic mean) is what most of us would call the average. For example, if a cricket player batted 10 times and the total of his or her 10 scores is 650, then the average is 65 (even though s/he might have 'scored' nil on one occasion and 250 on another). This is because mathematically, each turn to bat contributes to the average. In statistical terms, the arithmetic mean of the total score of 650 is 65, arrived at by dividing the total number of runs by the number of innings (650/10).

The next basic concept in statistics is frequency distribution. An often-quoted example in statistical textbooks is the tossing of 10 coins 100 times. The result of each throw of the 10 coins could range from 10 heads and no tails, to 10 tails and no heads, or any combination in between – i.e. one head and nine tails, two heads and eight tails, and so on. We would expect that if the coins are evenly balanced then we are more likely to have a probability of five heads and five tails than we are to get 10 heads and no tails!

Table 1.1 shows the result of tossing 10 coins 100 times. This can be shown as a histogram (see Figure 1.2) and also as a distribution curve (see Figure 1.3).

The curve shown in Figure 1.3 is an example of a normal distribution curve. The curve is bell-shaped (i.e. it is symmetrical from the midpoint). Of course not all distributions will give this outline, but under normal circumstances given a large enough population, in our example concerning 100 throws of 10 coins, it is very likely that the distribution curve will be similar to that shown in Figure 1.3. The midpoint is shown on our curve as 'x'. In statistical language, x represents the measure of central dispersion but in everyday English the term 'midpoint' indicates the same thing and is good enough for us!

If we assume a normal distribution curve as shown in Figure 1.3, one standard deviation from both sides of the midpoint (midpoint plus or minus one sigma) will include 68.27% of the total, and two standard deviations (two sigma) from both sides of the midpoint will include 95.45% of the total. Thus three standard deviations (three sigma) will cover 99.73%. If we extend out to six standard deviations (six sigma) from each side of the midpoint we cover 99.99966% of the total!

Table 1.1 Result of tossing 10 coins 100 times

Number of heads	0	1	2	3	4	5	6	7	8	9	10
Frequency	1	2	5	12	18	23	16	10	9	3	1