Six Sigma is enabling many organisations around the world to succeed in achieving performance breakthroughs with astonishing financial results. Richard Chua of Juran Institute outlines the fundamentals of Six Sigma and the prerequisites for successful deployment.

rganisations worldwide are under continuing pressures to control costs, maintain high levels of safety and quality, and meet cus-

What You Need to Know About Six Sigma

BY RICHARD C H CHUA, PHD

tomer expectations. A breakthrough improvement process called Six Sigma has been adopted by many companies, including Samsung Electronics and other enterprises as the effective method for achieving these and other goals.

World standard

More than just a formal programme or discipline, Six Sigma is an operating philosophy that can be shared beneficially by everyone: customers, shareholders, employees and suppliers. Fundamentally, it is also a customer-focused methodology that drives out waste, raises levels of quality, and improves the financial and time performance of organisations to breakthrough levels.

Six Sigma's target for perfection is to achieve no more than 3.4 defects, errors or mistakes per million opportunities whether it involves the design and production of a product or a customer-oriented service process. It is from this target that the "Six Sigma" name originated. Usually written as a small sigma σ in the Greek alphabet, sigma is the symbol used to denote the standard deviation or measure of variation in a process.

A process with less variation will be able to fit more standard deviations or sigmas between the process centre and the nearest specification limit than a process that is highly variable. The greater the number of sigmas within specifications, the fewer the defects. The smaller the variation, the lower the cost.

The higher the number of sigmas, the more consistent the process of delivering a good product or customer service. A Six Sigma level of performance means that we can fit in six standard deviations or sigmas between the process centre and the nearest specification limit. (See Figure 1.)

Figure 1: Six Sigma Concept



Most organisations operate at the Three Sigma level or about 66,000 defects per million opportunities (DPMO) for most of their processes and a Four or Five Sigma level in some of the mission-critical processes. Comparisons of Sigma levels, yields and the corresponding defect rates are shown in Table 1.

It would be foolish, however, to try to achieve Six Sigma levels of performance for every process in the organisation. This is because not all processes are equally important. For example, the process for requesting time-off or vacation is not as critical as the order fulfillment process. What really counts is significant improvement in the missioncritical areas – critical as defined by the customer. These mission-critical aspects of the product, service or process are called "critical-to-quality" requirements or CTQs for short.

Customer-focused

Six Sigma translates a customer's needs into separate tasks and defines the optimal specification for each, depending on how the tasks interact. Based on what the process reveals, the steps that follow can have a powerful effect on the quality of products and customer services as well as the professional development of employees.

How does Six Sigma work? Basically, it translates a customer's needs into your operational terms and defines the critical processes and tasks that must be done well. Depending on the analysis and improvement interventions that follow, Six Sigma will drive the performance of products, services, and processes to breakthrough levels. Breakthroughs are achieved using the project approach.

To quote Dr Joseph M Juran, considered by many as the father of the modern quality movement and the Breakthrough¹ process,

Table 1

SIGMA	YIELD	DPMO
1σ	31.0%	690,000
2σ	69.2%	308,000
3σ	93.3%	66,800
4σ	99.4%	6,210
5 σ	99.97%	230
6σ	99.99966%	3.4

"All improvement takes place project by project, and in no other way". Six Sigma produces results in many ways:

• Improves cycle times, quality and cost performance

• Improves effectiveness and efficiency of processes including e-commerce

• Designs products and services that will sell well

• Reduces chronic waste or the Cost of Poor Quality (COPQ)

• Grows profits by improving revenue and reducing costs

In short, Six Sigma is financially rewarding. Returns on investment (ROI) range from a 10:1 to over 100:1 ROI.

Samsung Electronics

Samsung Electronics began its Six Sigma process just under two years ago with training and expertise by Juran Institute as the first essential step to prepare for implementing the methodology. Starting from manufacturing operations and R&D in 2000, the company further deployed its application to transactional business processes and the entire supply chain to obtain significant savings and financial benefits in all 16 of its business units in South Korea and internationally.

When the decision by Samsung Electronics Company Ltd Vice Chairman and CEO, Mr Jong-Yong Yun, was made to position the company for the future, the catalyst was Six Sigma. The methodology's thinking and methods are being integrated throughout the company by growing the critical number of internal specialists needed to teach, implement, maintain and grow this competence in the future. No one nor any operation in Samsung Electronics is exempted from the process.

General Electric

Mr Jack Welch, who retired earlier this

year as General Electric's CEO, has been a Six Sigma leader and international role model in what a CEO must do to achieve major results. He said, "Six Sigma, originally focused on reducing waste and elevating the quality in our products and processes, has delivered billions of dollars to GE's bottom line in savings. Six Sigma has grown from an internally focused activity to an outside focus – also improving the productivity and efficiency of our customers' operations. Increasing the intimacy between GE and its customer base is making everyone more productive and helps all of us grow through tough economic environments".

6 Six Sigma has evolved to an even larger role in GE. It's rigorous process discipline and relentless customer focus has made it the perfect training ground and vehicle for the future leadership of GE.

"Today," Mr Welch explained, "Six Sigma has evolved to an even larger role in GE. It's rigorous process discipline and relentless customer focus has made it the perfect training ground and vehicle for the future leadership of GE. Our best and brightest employees are moving into Six Sigma assignments. I'm confident that when the Board picks a successor to Jeffrey Immelt 20 years from now, the man or woman chosen will be someone with Six Sigma in his or her blood. Six Sigma has become the language of leadership in our company."

Honeywell

Honeywell, after its merger with AlliedSignal, expanded the impact of AlliedSignal's Six Sigma deployment. Even though the company's workplace safety record is excellent, Six Sigma tools produced dramatic improvements in making Honeywell sites around the world even safer. Reportable cases were reduced 43% and lost workday cases by 50% in 1999 compared to the previous year. After each company location received an easy-to-use online tool kit, there was a 33% improvement in global safety performance and US\$1.4 million in productivity improvements. Honeywell then shared its learning with key customers.

Figure 2: Breakthrough Improvement



Growing interest in Six Sigma

The Six Sigma movement is gaining interest also in health care, finance, law, engineering, marketing and other fields. In addition to achieving major benefits in manufacturing, inventory, delivery and repetitive processes, the discipline is migrating to transactional processes such as completing an invoice, writing a contract, and processes within airlines, banking, hospitals, government and other service organisations.

All of this means:

- Optimising equipment usage
- · Fewer rejects or errors

• Cutting response times to customer inquiries

• Reducing inspection, maintenance, inventory and supply chain costs

When implemented strategically, Six Sigma also:

- · Helps turn over working capital faster
- Reduces capital spending

• Makes existing capacity available and new capacity unnecessary

• Fosters an environment that motivates employees

• Improves morale, teamwork and career potential

Mechanics of Six Sigma

The process begins with a *breakthrough in attitude*¹. The leadership of a company or organisation must realise that continuous improvement is no longer sufficient to achieve strategic, financial and operational goals quickly. *Breakthrough* improvement is needed to drastically reduce chronic waste, ie, waste that is systemic and chronic to the workings of the com-

pany or organisation. (See Figure 2.) The cost of this chronic waste is what Dr Juran calls the *Cost of Poor Quality* (COPQ). In most companies, COPQ accounts for about 25% of the cost of annual sales.

Most of this waste is hidden because traditional accounting systems do not

measure them adequately. What is visible and accounted for is only the tip of the iceberg (See Figure 3).

The project-by-project improvement

eliminate selected

portions of the COPQ

iceberg. The methodol-

ure, Analyse, Improve,

Control, or DMAIC for

evaluate and select projects; prepare the

launch the team.

ure the size of the

mission; and select and

· Measure - meas-

problem, document the process, identify key

customer requirements,

• Define - identify,

short.

ogy consists of five phases: Define, Meas-

approach is used to implement Six Sigma, in order to reduce or

Figure 3: Cost of Poor Quality

As a company gains a broader definition of poor guality, the hidden portion of the iceberg becomes apparent: **Customer Returns Testing Costs** aspection Costs Recalls OPQ ranges from 15-25% C. Duertin **Total Cost** nium Em Excess Inventor d Capacity ©2001 Juran Institute, Inc. All rights reserved

different from DMAIC in many ways.

development of a Team Charter.

· Define - provides direction with

 Measure – translates several customer needs into several CTQs, what is critical to

determine key product characteristics and process parameters, document potential failure modes and effects; theorise on the causes or determinants of performance.

 Analyse – plan for data collection, analyse the data, and establish and confirm the "vital few" determinants of performance.

 Improve – design and carry out experiments to determine the mathematical cause-effect relationships, and optimise the process.

• Control – design controls, make improvements, implement, and monitor.

There is another methodology for designing and developing a new product, service or process. Design for Six Sigma follows the DMADV cycle. DMADV is

quality in the eyes of the customer. DMAIC typically focuses on one CTQ, which is related to the problem at hand.

• Analyse – identifies alternative design concepts and develops one or more into a high-level design. DMAIC focuses on identifying root causes of a problem.

 Design – develops a detailed design with associated design elements and identifies critical to process variables.

• Verify – implements the pilot and prepares for full-scale rollout and puts control mechanisms in place.

The actual process begins when an appropriate group of senior managers receive training in the methodology for about two to three days and become

Champions. This group then selects projects, mentors and supports the overall process.

Once criteria are established and business unit managers and Champions are identified, projects are selected for their potential in breakthrough improvement. This means evaluating opportunities for strategic relevance, operational efficiency, product and service quality related to customer satisfaction or dissatisfaction, and bottom-line savings.

6 Six Sigma Project Teams are supported by the leadership of each business unit through the Champions. As influential members of management, they are expected to promote the application, acceptance and evolution of the process within their business units.

Six Sigma Project Teams are supported by the leadership of each business unit through the Champions. As influential members of management, they are expected to promote the application, acceptance and evolution of the process within their business units in the following ways:

- · Project selection
- · Leadership reviews
- · Project support
- · Resource allocation
- Career development.

Employees who become members of each Project Team enter the process by becoming Green Belts first, which requires four to eight days of training in the overall improvement cycle. They become support personnel with emphasis on graphical analysis techniques. These teams are led by other employees, called Black Belts, who are fully trained in the Six Sigma process.

Once selected, Black Belt candidates undergo rigorous training in the methodology that lasts about five months and consists of four weeks of training organised around the DMAIC improvement cycle. Each week in the classroom is followed by four to five weeks of practical application on the same projects back in their business units.

If properly selected, these initial projects will produce significant bottom-line savings and, typically, return more than the entire training investment. Each project is targeted to save at least \$100,000.

With 20 participants in the workshop, one can expect to save more than \$2 million. After certification, Black Belts are expected to guide three to six projects per year, which increases further the ROI of Six Sigma. To become certified as Black Belts, candidates must:

• Complete oral and written examinations

• Perform two or more projects successfully with a significant benefit to the organisation's financial performance

• Manage one or more projects each year to demonstrate measurable results.

When Black Belt training has been completed, employees are able to:

• Develop, coach and lead crossfunctional teams

• Mentor and advise management on prioritising, planning and launching projects

• Disseminate tools and methods to team members

Achieve results that match the compa-

ny's business strategies with a positive benefit to financial performance.

The total number of employees trained in Six Sigma throughout the world must be in the hundreds of thousands by now. More and more companies, like Samsung and GE, are planning for these employees to move up the ranks to top management levels. In the final analysis, success in achieving results with this process depends on whether top management, particularly CEOs, accept responsibility for their non-delegable roles.

Management responsibilities

Dr Juran says success depends on whether the CEO accepts responsibility for his or her *non-delegable tasks*:

• Set up and serve on the Six Sigma management council

- · Establish goals
- · Lead the deployment process
- · Allocate needed resources

Assign responsibilities for review and measurement

• Lead employee recognition ceremonies

• Revise the company's reward system.

Mr Bob Galvin at Motorola, Mr Larry Bossidy at AlliedSignal – now Honeywell, and Mr Jack Welch at GE are role models for making Six Sigma and opportunities for Black Belt employees a vital part of the culture during their tenure as CEOs.

Top management can overcome the powerful forces in any company that may resist unity of direction. The answer is to find a universal improvement process like Six Sigma that fits all functions in an organisation. Six Sigma is an extremely healthy and productive cultural change that takes time to complete. It is not free. It requires resources and training, but customer satisfaction, quality products and services, and a highly competitive enterprise produce a significant return on investment, satisfaction all employees have from being on a winning team, and pride in being part of such a company.



Road map for success

People, companies, industries, economies, and nations will maintain leadership and a competitive edge only if they have a consistent mental attitude and a thirst for more effective ways to produce new, saleable products and services. The human element is finally taking advantage of an era of technological development that created a discipline based on the reality that higher levels of unbelievable quality at lower cost can be achieved to compete in an everchallenging global economy.

Six Sigma is more than a road map for success. It is the route to profitable growth. Six Sigma continues to help companies remain competitive through productivity gains, improved asset utilisation, margin expansion and higher revenue growth. A continuing strategy is to use these gains for growth through expansion as well as acquisition, product innovation, maintaining the levels of quality, market penetration, higher revenues, and increased earnings. Pd

1 The concept of breakthrough was introduced by Dr Joseph M Juran in the seminal work, Managerial Breakthrough (McGraw-Hill, 1964), and re-published as a 30th Anniversary Special Edition in 1994 by McGraw-Hill.

RICHARD C H CHUA, PHD is the Executive Vice President and Managing Director (Asia Pacific) of Juran Institute, Inc. Juran Institute, with world headquarters in Wilton, Connecticut, US, is a pioneer and leader in helping organisations achieve breakthrough improvement and Six Sigma levels of performance. Website: www.juran.com, Tel: (800) 338-7726 or (800) 829-1531. The author can be reached at rchua@juran.com.

READER SURVEY – PRODUCTIVITY DIGEST DECEMBER 2001

COVER FEATURE		Little Interest			Considerable Interest		
Recognising Managers Who have Made the Difference	1	2	3	4	5	6	
Public Libraries and Services Radically Transformed under Christopher Chia		2	3	4	5	6	
Nanz Chong-Komo Proves Her Mettle		2	3	4	5	6	
Tan Kin Lian's Guiding Principles to Management Excellence		2	3	4	5	6	
High Flyer Nelson Wong Steers Aerospace Company to Greater Heights		2	3	4	5	6	
FEATURES							
INSIGHT: Developing the Best Team at Baxter	1	2	3	4	5	6	
Singapore Franchise Mark – Mark of a Quality Franchise	1	2	3	4	5	6	
A Hospital in a Garden – Going Beyond Healthcare	1	2	3	4	5	6	
What You Need To Know About Six Sigma	1	2	3	4	5	6	
PRODUCTIVITY TOOLS							
The Art of Being Blunt Tactfully	1	2	3	4	5	6	
Building Teams Across Borders	1	2	3	4	5	6	
BOOK	1	2	3	4	5	6	
PRODUCTIVITY UPDATES							
Second Off-budget Package to Help SMEs and Workers Tide over Difficulties	1	2	3	4	5	6	
Enhanced e-Commerce Incentives for Companies		2	3	4	5	6	
Freddy Soon's Contributions Win International Recognition		2	3	4	5	6	
eTutor Moves ITE a Step Closer to Becoming an Online Learning Community		2	3	4	5	6	
SPA News		2	3	4	5	6	
PSB Scientist Wins Regional Metrology Award		2	3	4	5	6	
Initiating Cross-border Business Collaboration	1	2	3	4	5	6	

Help us to better satisfy your needs by rating the articles in this issue and returning this survey to us.

Please return to:

Editor, Productivity Digest

Singapore Productivity and Standards Board PSB Building, 2 Bukit Merah Central, Singapore 159835 or Fax: (65) 278 6667

What would you like more of?_____

What would you like less of?_____

Name (optional) Designation _____ Company ____ Tel

Fax